Prepare for the Pediatric Emergency Medicine Board Examination

Muhammad Waseem
Isabel A. Barata
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ISBN 978-3-030-28370-4 ISBN 978-3-030-28372-8 (eBook)
https://doi.org/10.1007/978-3-030-28372-8

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The young developing field of pediatric emergency medicine (PEM) encompasses a broad range of subjects. Following the completion of my PEM fellowship, I struggled to find a good review book to help me prepare for the Pediatric Emergency Medicine boards. The few review books available at the time did not address many of the topics listed by the American Board of Pediatrics (ABP) Pediatric Emergency Medicine Specialty content specifications. During my preparation for the exam, I found myself writing notes in the margins next to each of the content-specific items. This experience made me realize that a resource based on ABP PEM content specifications would be invaluable to pediatric emergency medicine fellows, as well as emergency medicine residents, to prepare for taking the board examinations.

In planning for this book, I wanted to make it more than just another book of questions and answers. Indeed, I was fortunate to be able to assemble motivated contributors from a broad range of backgrounds and levels of expertise. These contributors have provided a rich blend of perspectives. We hope that you find this book to be a helpful resource, whether studying for the Pediatric Emergency Medicine, General Pediatric, or Emergency Medicine boards or if merely using it to enrich your general knowledge base.

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The original version of this book was revised. Copyright page text has been updated. The correction to this book can be found at https://doi.org/10.1007/978-3-030-28372-8_36

Acknowledgments

I would like to acknowledge my wife, Farhana, and my children, Yumna and Afnan, who have been a source of pride and joy and been unbelievably supportive despite my crazy schedule. They have been extremely patient and tolerant of my working vacations and weekends. I also thank my parents and the many mentors who have taught and inspired me.

I also would like to acknowledge my colleague, Heidi Pinkert, for reviewing many chapters and providing valuable suggestions.

New York, NY, USA Muhammad Waseem

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Resuscitation

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Viraj S. Lakdawala

Question 1

A 6-year-old boy presents to the Emergency Department for an urticarial rash, wheezing, and vomiting after trading lunches with another child at school. The patient has a known allergy to peanuts. What is the most appropriate initial dose of epinephrine for this patient?

A. 1 mg/kg SC
B. 0.01 mg/kg IM
C. 0.1 mg/kg IM
D. 0.01 mg/kg IV
E. 1 mg/kg IV

Correct Answer: B

This patient is showing symptoms of an acute allergic reaction with multiple system involvement. When two or more systems are involved, the patient is in anaphylaxis. The most appropriate initial dose of epinephrine is 0.01 mg/kg IM of 1:1000 concentration. An intramuscular dose can be given prior to starting a peripheral IV line, as this will result in immediate medication delivery. The intramuscular epinephrine should be injected in the anterolateral thigh. In the event of shock, the perfusion to the subcutaneous tissue is not predictable; therefore, the subcutaneous route should not be used. One should suspect anaphylaxis if there is urticaria, wheezing, with a triggering exposure.

Take-Home Message
First-line treatment for anaphylaxis is 0.01 mg/kg of 1:1000 epinephrine administered intramuscularly.

ABP Content Specification
- Know the indications for and pharmacologic action of epinephrine in resuscitation.
- Know the routes of administration of drugs used in resuscitation.

Question 2

A 4-year-old girl arrives to the ED in acute respiratory distress. You determine that she requires endotracheal intubation and mechanical ventilation. What is the most appropriate cuffed endotracheal tube size for this patient?

A. 3.5 mm
B. 4.0 mm
C. 4.5 mm
D. 5.0 mm
E. 5.5 mm

Correct Answer: C

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_1

The generally accepted formula for estimating tube size is:

- Predicted size of uncuffed tube = (age/4) + 4
- Predicted size of cuffed tube = (age/4) + 3.5

In general, during preparation for intubation using the formulas, not only should the provider have the estimated tube size ready but also at least two endotracheal tubes 0.5 mm smaller and larger (one cuffed and one uncuffed) ready in case the estimate is either too large or too small.

Take-Home Message
Use the formula to estimate ET tube size and be prepared with tubes 0.5 mm size smaller and larger.

ABP Content Specification
- Know the use of advanced airway management techniques in patients with respiratory failure.

Question 3

A 4-year-old child presents to the Emergency Department after a seizure at home. He remains confused and combative. A bedside glucose evaluation reveals a blood glucose of 25 mg/dl. The patient weighs 20 kg. What is the most appropriate dose of glucose to administer to this patient?

A. 10 ml of D10
B. 250 ml of D5
C. 25 ml of D50
D. 40 ml of D25
E. 100 ml of D50

Correct Answer: D

Initial dose of IV dextrose: 0.5–1 g/kg
Using rule of 50:

- 5 ml/kg of D10%
- 2 ml/kg of D25%
- 1 ml/kg of D50%

Acute hypoglycemia can manifest with a number of symptoms ranging from dizziness or hunger to neurologic deficits and seizures. Hypoglycemia can be missed quite easily in the pediatric population; thus, a child with altered mental status and/or head trauma should have a point-of-care glucose check on arrival. The differential for hypoglycemia is broad, and a child with unexplained hypoglycemia should have an appropriate workup done in the ED. After the bolus, plasma glucose should be maintained by an infusion of dextrose at 6–9 mg/kg per minute, and blood glucose should be monitored every 30–60 minutes. If the patient has mild symptoms and can tolerate oral feeding, then an oral load of glucose can be given. In the event that immediate IV access cannot be obtained, intramuscular glucagon can be used to release stores of glucose from glycogen in the liver.

Take-Home Message
Know the rule of 50 to calculate the appropriate bolus of glucose.

ABP Content Specification
- Know the role of crystalloid infusion in the management of shock.

Question 4

A 4-year-old child has been transferred to your Emergency Department from a rural hospital for an epidural hematoma. He was intubated for airway protection and ventilated en route to your hospital. On arrival, his initial vitals are as follows: heart rate 110 beats/minute, respiratory rate 16 breaths/minute, blood pressure 110/60 mm Hg, and oxygen saturation 85% on 100% FiO_2. You notice the tube is quite deep in the patient's mouth. Approximately how many centimeters deep the ET tube should be?

A. 12 cm
B. 13 cm
C. 14 cm
D. 15 cm
E. 16 cm

Correct Answer: C

The ideal location for the endotracheal tube tip is at the midpoint between the thoracic inlet and the carina. Some tools that help with appropriate depth placement include placing the double line on the uncuffed ET tube at the glottis, using the length-based tape, estimating the tube depth at three times the inner diameter of the ETT, or 12+ [age (years)/2]. Use the formula 12 + [age (years)/2]. Beware that formulas are less accurate for children under 3 years of age.

The medications can be administered via ETT including atropine, naloxone, lidocaine, and epinephrine; schedule of medication can be remembered by the mnemonic LANE.

Take-Home Message

ET tube depth estimation can be done using the formula 12+ [age (years)/2].

ABP Content Specification

- Know the use of advanced airway management techniques in patients with respiratory failure.
- Recognize the presentations of patients with hypoxia.

Question 5

A 5-year-old child is brought to the Emergency Department by ambulance. The patient is pulseless, apneic, and unresponsive. All basic life support (BLS) maneuvers are being done. The patient is placed on the monitor, and the following rhythm is obtained.

What is the most appropriate next intervention?

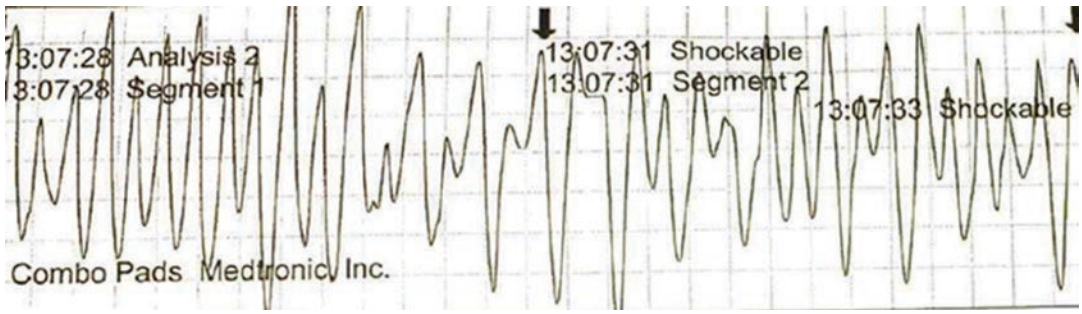
A. Defibrillation 4 J/kg
B. Intubate the patient
C. Give epinephrine 0.01 mg/kg IV/IO
D. Synchronized cardioversion
E. Defibrillation 2 J/kg

Correct Answer: E

This is an example of a patient with ventricular fibrillation (VF). Defibrillation is indicated for the treatment of VF; pulseless ventricular tachycardia, regardless of the waveform; and unstable, polymorphic (irregular) ventricular tachycardia with or without pulses. The recommendation is to defibrillate this patient at 2 J/kg after starting chest compressions and placing the patient on the monitor. CPR should be resumed immediately after the shock, and a rhythm check should occur 2 minutes later, at which point a 4 J/kg defibrillation dose can be given if the patient remained in VF.

In a patient without pulses, if a shockable rhythm is detected, then initiate CPR immediately and defibrillate. Once a shock has been delivered, chest compressions should be resumed immediately and continued for a period of 2 minutes. If no pulse is still detected, then an additional shock should be delivered while epinephrine is given every 3–5 minutes. Defibrillation should not be delayed for endotracheal intubation.

Synchronized cardioversion is used in the treatment of SVT and unstable monomorphic (regular) VT with pulses.



Take-Home Message
Defibrillation is the first step for the pulseless patient with a shockable rhythm such as VF and pulseless ventricular tachycardia.

ABP Content Specification
- Know the indications for and pharmacologic action of epinephrine in resuscitation.
- Know the indications for defibrillation in resuscitation.
- Recognize arrhythmias during cardiac arrest.
- Know techniques of pediatric advanced life support in cardiopulmonary arrest.

Question 6

A 10-year-old child has been struck by a vehicle at unknown speed. He is brought to the ED by paramedics. His initial vital signs are blood pressure 80/40 mm Hg, heart rate 130 beats/minute, respiratory rate 10 breaths/minute, and oxygen saturation 95% on non-rebreather face mask. His eyes open to painful stimuli, he cries to pain and making inappropriate sounds, and he withdraws to painful stimuli. What is his Glasgow coma scale score?

A. 6
B. 7
C. 8
D. 9
E. 10

Correct Answer: D

The Glasgow coma scale (GCS) is an objective method of following the patient's neurologic status. It assesses a patient's best eye, verbal, and motor response.

Eye Opening

Spontaneously	4
To verbal command	3
To pain	2
None	1

Best Verbal Stimuli

Oriented	5
Confused	4
Inappropriate words	3
Incomprehensible	2
No response	1

Motor Response

Obeys verbal commands	6
Localizes pain	5
Withdraw from the pain	4
Flexion to pain	3
Extension to pain	2
No response	1

- E2 V3 M4
- Eye opening (to painful stimuli) = 2
- Best verbal response (inappropriate words) = 3
- Best motor response (withdraws to pain) = 4

Take-Home Message
Glasgow coma scale is an objective way to assess the neurological condition of the patient and has implications for immediate intervention and prognosis. Therefore, it is important to document the score in all patients who present with head trauma or altered mental status.

ABP Content Specification
- Know the indications and procedures for transport to a higher-level facility.

Question 7

Which of the following is least likely to be present in a child with respiratory distress?

A. Use of accessory muscles and tripod position
B. Speaking in 1- to 2-word sentences
C. Muffled voice
D. Stridor
E. Speaking in full sentences

Correct Answer: E

Generally, the observations seen in a child who is in respiratory distress constitute the following: Mental status changes, (including somnolence or anxiety), changes in position to facilitate increased air movement ("sniffing position"), cyanosis, drooling, or dysphagia. Speaking in full sentences requires adequate respiration; thus, a child in respiratory distress would more often be able to use only one to two words at a time. A muffled voice or stridor would be evidence of upper airway obstruction, which could be associated with respiratory distress. Use of accessory muscles is common in cases of respiratory distress from many causes.

Take-Home Message
Inability to speak in full sentences in the setting of dyspnea or respiratory distress may indicate the onset or presence of respiratory failure and needs immediate intervention.

ABP Content Specification
- Understand the progression of respiratory failure to arrest.

Question 8

A 10-year-old boy with a history of asthma is brought to the Emergency Department for shortness of breath, cough, subjective fever, and rhinorrhea. His mother has been administering albuterol nebulizer treatments at home with little relief. His initial vital signs are as follows: heart rate 110 beats/minute, respiratory rate 15 breaths/minute, blood pressure 100/60 mm Hg, and oxygen saturation 93% on room air. On examination, the patient has intercostal and supra-costal retractions, poor inspiratory effort, and minimal wheezing in both lungs. He has a history of multiple hospitalizations for asthma exacerbation and has been intubated once for respiratory failure because of asthma exacerbation. What is the most appropriate intervention at this time?

A. Continue albuterol nebulizer treatments via nebulizer
B. Supplemental oxygen via nasal cannula
C. Noninvasive ventilation
D. Endotracheal intubation and mechanical ventilation
E. Discharge

Correct Answer: C

This is a case of severe respiratory distress in a patient with asthma exacerbation. Clinical signs for worsening respiratory distress include retractions, poor respiratory effort, and minimal wheezing, which could indicate fatigue and impending respiratory failure. Another sign of fatigue is his respiratory rate, which should normally be elevated in a child with respiratory distress. A normal respiratory rate in a patient with signs of respiratory distress indicates a patient with impending respiratory failure. Optimal treatment at this time would be initiation of noninvasive ventilation, while using albuterol and steroids to help treat the airway inflammation which has caused the impending respiratory failure. Indications for intubation in patients with acute severe asthma include hypoxemia despite high flow oxygen by noninvasive measures, increased work of breathing that does not improve with optimal medication delivery, altered mental status, and respiratory/cardiac arrest.

Take-Home Message
Use of noninvasive ventilation should be strongly considered initially for patients with severe distress, as it can at times prevent the need for endotracheal intubation. Ventilation of asthmatic patients through an endotracheal tube is associated with significant complications compared with other indications for respiratory failure and therefore should be used prudently.

ABP Content Specification

- Understand the progression of respiratory failure to arrest.
- Recognize the signs and symptoms of hypercarbia.
- Recognize the signs and symptoms of lower airway obstruction.

- Plan management priorities for patients in respiratory failure.
- Know the use of basic airway management techniques in patients with respiratory failure.
- Recognize the presentations of patients with hypoxia.

Question 9

Which of the following agents would be the best induction agent when intubating an asthmatic in severe respiratory distress?

A. Etomidate
B. Thiopental
C. Ketamine
D. Fentanyl and versed
E. Propofol

Correct Answer: C

Both ketamine and propofol have been found to have bronchodilatory properties and thus are suitable induction agents for the severe asthmatic. Ketamine is preferred over propofol due to the direct and indirect mechanisms for bronchodilation, as well as its vasoactive component. The downside of propofol is the potential to induce hypotension in the peri-intubation setting. Thiopental and other barbiturates are not preferred, as they can induce bronchospasm via histamine release. Fentanyl and *m*idazolam (versed) are not ideal agents for rapid sequence intubation. Indeed, if fentanyl is delivered inappropriately, then the patient's respiratory status may worsen significantly, and it may cause acute respiratory failure in an otherwise well patient. The dosage for ketamine in RSI is 1–2 mg/kg.

Take-Home Message
Ketamine is the preferred sedative in asthma patients that require rapid sequence intubation due to its ability to aid bronchodilation and maintain blood pressure.

ABP Content Specification
- Recognize the complications associated with rapid sequence induction for intubation.

Question 10

Which of the following agents is the best choice for induction when intubating a child in septic shock?

A. Etomidate
B. Thiopental
C. Ketamine
D. Fentanyl and midazolam
E. Propofol

Correct Answer: C

Ketamine is a good choice for intubation in septic shock as it maintains cardiovascular stability during intubation. The dose of ketamine in RSI is 1–2 mg/kg.

Propofol is a potent sedative agent that can cause respiratory depression and hypotension and therefore is not a good choice for the patient in shock. Fentanyl and Midazolam (versed) are good choices for conscious sedation, as together they provide pain control and sedation; they are not, however, good choices for intubation.

Etomidate is hemodynamically neutral agent. It is preferred in head-injured patients who have shock transient adrenocortical suppression following a single dose of etomidate has been demonstrated in adults in numerous small randomized trials. The 2015 PALS guidelines recommend that etomidate be avoided in patients with septic shock. Ketamine is the preferred rapid sequence intubation (RSI) induction agent for pediatric patients in septic shock (see the below references). Etomidate has a quick onset of action approximately 30 seconds and a short half-life resulting in an awake and alert patient within 5–15 minutes of drug discontinuation. The main side effects are myoclonus, nausea, vomiting, respiratory depression, and adrenocortical suppression. If etomidate must be

used in the setting of septic shock refractory to fluids and vasopressors, a stress dose of dexamethasone (0.1 mg/kg) should be administered.

In isolated head-injured children, propofol, etomidate, or thiopental can be used.

ABP Content Specification

- Know the use of advanced airway management techniques in patients with sepsis.
- Plan the key steps and know the potential pitfalls in performing rapid sequence induction for intubation.
- Recognize the complications associated with rapid sequence induction for intubation.

Take-Home Message

Ketamine may be preferred to etomidate due to less likely adrenal suppression. Ketamine's catecholamine effect might worsen hypotension in the peri-intubation period.

Question 11

When compared to the adult airway anatomy, the pediatric airway is as follows:

A. More anterior and superior
B. More posterior and superior
C. More posterior and inferior
D. More anterior and inferior
E. The same

Correct Answer: A

In adults, the vocal cords (or glottis) is the narrowest portion of the airway. The cricoid ring (below the vocal cord) is the narrowest portion of the pediatric airway. Therefore, once the endotracheal tube passes through the vocal cords, it is lodged at the level of the cricoid cartilage.

Also, pediatric airway is funnel shaped in children under 8 years of age and cylinder shaped in adults. The larynx is more anterior and superior, and trachea is short. The epiglottis in children is longer, narrower, and omega shaped than the adult epiglottis. Because the angle between the base of the tongue and the glottis opening is more acute, this may make direct laryngoscopy difficult in children.

These anatomical differences have practical implications with respect to ET tube placement and must be kept in mind during intubation. In addition to these anatomic factors, it is important to take into account the relatively large size of the tongue in children, as this can make pediatric intubation more difficult.

Take-Home Message

The anatomy of the pediatric airway differs from the adult, and awareness of these differences can improve chances of successful endotracheal intubation. The pediatric airway is funnel shaped (<8 years), larynx is located more anteriorly, and the cricoid ring is the narrowest portion of the pediatric airway.

ABP Content Specification

- Understand the anatomy of the respiratory system.

Question 12

A 7-year-old boy comes to the Emergency Department with a 1-week history of diffuse abdominal pain, weight loss, nausea, and vomiting. He also admits to polyuria and polydipsia, worsening over the past few days. His vital signs are as follows: heart rate 150 beats/minute, respiratory rate 30 breaths/minute, blood pressure 90/50 mm Hg, and oxygen saturation 99% on room air. A bedside glucose is 520 mg/dl. He appears lethargic and has dry mucous membranes. Which of the following is the most appropriate initial management after IV access has been obtained?

A. Insulin bolus 0.2 unit/kg
B. Insulin drip 0.1 unit/kg/hour
C. Normal saline bolus 20 ml/kg
D. IV antibiotics
E. D5NS at 150 ml/hour

Correct Answer: C

This is a case of diabetic ketoacidosis (DKA). DKA is a state of hyperosmolar hypovolemia. The patient becomes volume depleted through osmotic diuresis and gastrointestinal losses via vomiting, sometimes with diarrhea as well. Studies have shown that patients in moderate–severe DKA generally have about 30–100 ml/kg total body water loss and total body electrolyte disturbances (see below reference). An initial volume expansion should start with a normal saline bolus of 20 ml/kg administered over 60 minutes, with repeat boluses if the patient remains hemodynamically unstable. If the patient is stable after the initial bolus, maintenance fluids can be started with a goal of replacing fluid losses over the next 24–72 hours.

Take-Home Message

DKA is characterized by significant fluid deficit causing depleted circulatory volume, and thus the initial management strategy is fluid resuscitation to maintain tissue perfusion. This should be immediately followed by correction of hyperglycemia and electrolyte imbalance with insulin infusion and appropriate replacement electrolytes.

ABP Content Specification

- Plan the management of acute diabetic ketoacidosis.
- Understand the pathophysiology of hypovolemic shock.
- Recognize signs and symptoms of uncompensated shock.
- Know the role of crystalloid infusion in the management of shock.

Question 13

The incidence of septic shock in children in the United States is greatest in:

A. Infants
B. School-aged children
C. Pre-teens
D. Teenagers
E. Fetuses

Correct Answer: A

There are almost 47,000 cases of pediatric sepsis each year. Approximately, 10 times as many infants develop sepsis when compared with older children. Infants are at highest risk, with low and very low birth weight infants comprising more than 25% of cases. Therefore, early recognition and immediate treatment are essential in this age group.

Take-Home Message

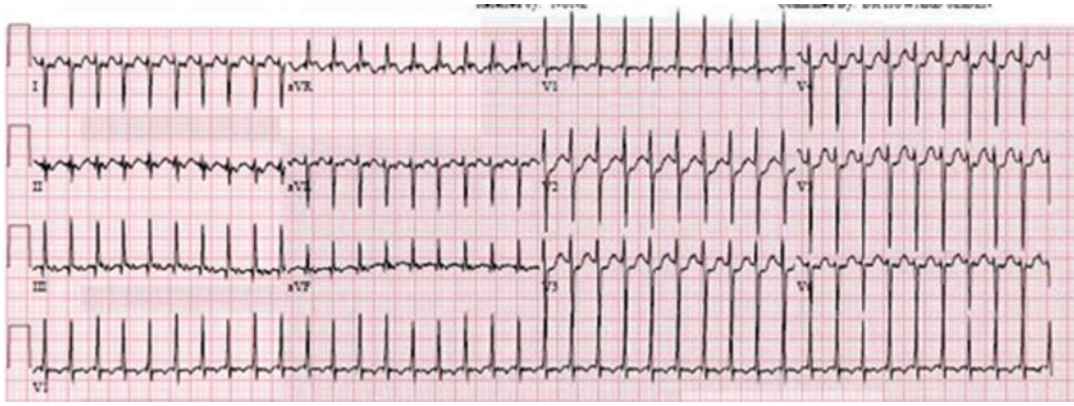
Infants are at higher risk for sepsis relative to other pediatric age groups, and majority occur in very low birth weight infants.

ABP Content Specification

- Differentiate the major causes of shock by age.
- Know major etiologies of circulatory failure/shock.

Question 14

An 11-month-old girl is brought to the Emergency Department for evaluation of fussiness and fever. She was taken to her primary care physician who diagnosed her with acute otitis media and started her on oral antibiotics. The patient has not been taking much in the way of oral fluids and has not eaten for the past day. She has had decreased wet diapers over the past 24 hours. Initial vital signs are as follows: temperature 102 °F, heart rate 240 beats/minute, respiratory rate 45 breaths/minute, blood pressure 90/50 mm Hg, and oxygen saturation 99% on room air. You administer a 20 ml/kg bolus and acetaminophen, but the heart rate remains at 240 beats/minute. A 12-lead electrocardiogram is obtained.



What is the most appropriate next intervention?

A. Cardioversion 1 J/kg
B. Amiodarone 5 mg/kg
C. Adenosine 0.1 mg/kg
D. Procainamide 15 mg/kg
E. Cardioversion 2 J/kg

Correct Answer: C

This is a case of supraventricular tachycardia (SVT). The initial hemodynamic assessment was normal – the patient is normotensive, and has no signs of acute heart failure, shock, or altered mental status. If the patient is deemed unstable, then he/she should be treated with synchronized cardioversion at 0.5–2.0 J/kg. EKG findings of SVT include absent P waves, tachycardia not consistent with sinus tachycardia, no variation of heart rate with activity, and heart rate >220 in infants or >180 in children. Vagal maneuvers are an appropriate initial intervention, or adenosine 0.1 mg/kg can be administered. Adenosine is the medical intervention of choice for SVT. Adenosine must be given as a rapid IV push over 1–2 seconds followed by a 5-ml normal saline flush. This measure is done because of its very short half-life. If no response is seen, then the dose can be increased to 0.2 mg/kg.

Take-Home Message
SVT is best treated first with vagal maneuvers and then adenosine in the hemodynamically stable patient. The first dose of adenosine is 0.1 mg/kg. A second dose of 0.2 mg/kg may be given if the first is unsuccessful.

ABP Content Specification
- Know the indications for and pharmacologic action of amiodarone.
- Know the indications for and pharmacologic action of adenosine.
- Know the indications for and pharmacologic action of procainamide.
- Know the indications for cardioversion in resuscitation.
- Know treatment of stable dysrhythmias.

Question 15

A 15-year-old boy is brought to the Emergency Department after sustaining a head injury while riding his bicycle. He was un-helmeted and sustained a loss of consciousness after his fall. EMS transported him after they placed a cervical collar on him and placed him on a backboard. His initial vital signs are as follows: heart rate 45 beats/minute, respiratory rate 11 breaths/minute, blood pressure 80/50 mm Hg, and oxygen saturation 97% on room air. The airway is patent, the patient is breathing well, but has diminished pulses in all 4 extremities. The patient is unable to move any of his extremities during the examination. Packed red blood cells are ordered, and 1 liter of 0.9% normal saline is given without improvement in the blood pressure. The most appropriate vasopressor for this condition is:

A. Epinephrine
B. Dopamine
C. Dobutamine
D. Milrinone
E. 2 units of packed red blood cells

Correct Answer: A

This is a case of spinal shock. Hypotension, which may be mild in these patients, results from the loss of peripheral vascular resistance, but tachycardia may not be present due to loss of sympathetic tone. Initial management should focus on increasing intravascular volume while closely monitoring for signs of hemorrhagic shock due to trauma. Neurogenic shock is generally seen with acute spinal cord injury above the level of T6. Epinephrine is the vasopressor of choice among those listed here. Vasopressors with alpha and beta activity should be initiated to counter the loss of sympathetic tone and provide chronotropic cardiac support.

Take-Home Message
For patients presenting with traumatic shock, spinal cord injury should always be in the differential diagnosis. Spinal shock is characterized by hypotension, bradycardia, and abnormal neurologic examination (mental status or motor dysfunction), often with some localization. Epinephrine infusions are necessary for their vasopressor effect to maintain blood pressure and tissue perfusion.

ABP Content Specification
- Understand the pathophysiology of neurogenic shock.
- Know the role of pharmacologic therapy for circulatory failure/shock.

Question 16

A 3-year-old boy is undergoing a CT scan with sedation due to agitation. What is the most sensitive method for detecting hypoventilation during the sedation?

A. End-tidal CO_2 monitoring
B. Continuous video EEG
C. Continuous pulse oximeter
D. Telemetry cardiac monitoring
E. Respiratory rate monitor

Correct Answer: A

$ETCO_2$ is more sensitive for detecting hypoventilation and apnea than clinical assessment and continuous pulse oximetry. There is no role for continuous vEEG in procedural sedation. Telemetry cardiac monitoring provides only late indicators for apnea. Studies have shown that $ETCO_2$ is an earlier indicator for apnea versus respiratory rate monitoring as well.

Take-Home Message
End tidal CO_2 is a valuable noninvasive tool that gives a very early indication of inadequate ventilation and is very useful to monitor sedation and can help identify respiratory failure.

ABP Content Specification
- Recognize and interpret relevant monitoring studies for respiratory failure.

Question 17

A 38-week newborn is delivered via spontaneous vaginal delivery in the emergency department. The amniotic fluid is dark and cloudy. You evaluate the infant under the warmer and note gasping, pale color, and a heart rate of 75 beats/minute. The best initial step is:

A. Immediate endotracheal intubation and suctioning of meconium
B. Bag-mask ventilation
C. Initiate chest compressions
D. Obtain vascular access and administer epinephrine
E. Vigorous drying and stimulation

Correct Answer: B

Positive pressure ventilation (PPV) should be provided to depressed infants born through meconium with a heart rate less than 100 breaths/minute. There is insufficient evidence to support intubation with tracheal suctioning, which inherently delays the initiation of oxygenation and ventilation. Neonatal guidelines for chest compressions specify chest compressions for a heart rate less than 60 beats/minute. Airway and breathing are the priority in this scenario, so vascular access and epinephrine administration should be after addressing airway and ventilation during resuscitation.

Take-Home Message
PPV via bag mask is the initial treatment to resuscitate unresponsive infants born to meconium stained amniotic fluid mothers. There is inadequate evidence for better outcomes with tracheal suctioning.

ABP Content Specification
- Recognize signs and symptoms of neonatal distress.
- Plan step-wise intervention in the treatment of neonatal distress.
- Plan management of meconium aspiration.

Question 18

A 2-year-old child presents with high fever, drooling, and mild respiratory distress. He is ill-appearing. The mother states they do not believe in immunizations. The child's neck radiograph is most likely to reveal:

A. Steeple sign
B. Thumbprint sign
C. Unilateral air trapping/hyperinflation of lung fields on expiratory chest X-ray
D. Widening of the retropharyngeal space
E. Radiopaque foreign body

Correct Answer: B

This is a typical presentation of acute epiglottitis. The incidence of epiglottitis has decreased due to widespread immunization against influenza type b (Hib). The thumbprint sign is indicative of an edematous epiglottis. HiB was associated with 90% of cases of epiglottitis prior to the advent of the HiB vaccination. The primary objective in the management of these cases is to secure the airway. These patients have a tendency to deteriorate quickly. Never place these patients in the supine position as it can cause upper airway obstruction due to the large epiglottis and subsequent respiratory arrest. ENT and/or anesthesia should be notified anticipating a difficult airway intervention in a controlled setting such as operating room.

Take-Home Message
Thumbprint sign in a child presenting with stridor and drooling is strongly suggestive of acute epiglottitis. Airway manipulation should be minimized to prevent rapid deterioration and progression to respiratory failure**.**

ABP Content Specification
- Recognize signs and symptoms of upper airway obstruction.
- Recognize and interpret relevant radiographic studies for respiratory failure.
- Know etiology of respiratory failure.

Question 19

An 11-year-old patient who was in a severe motor vehicle collision and sustained multiple fractures and a potential traumatic brain injury (TBI) presents to the ED. The GCS is 5. Multiple direct and video laryngoscopy intubation attempts with in-line cervical spine stabilization have been unsuccessful. What is the most appropriate next step for this patient?

A. Surgical cricothyrotomy
B. Needle cricothyrotomy
C. Insertion of LMA
D. Continue to use bag-valve mask
E. Chin lift to improve visibility

Correct Answer: C

The laryngeal mask airway (LMA) is a temporizing measure to ventilate in the setting of the difficult airway. After two to three attempts of endotracheal intubation, an LMA can be placed to continue ventilating and oxygenating the patient while an alternative plan for intubation is determined. The LMA is inserted into the mouth and blindly passed along the palate into the posterior pharynx until resistance is met. The cuff is then inflated, and the mask forms a partial seal around the larynx. The airway is not secured, and the patient remains at risk for aspiration if they vomit. The LMA can be used as a conduit for a fiberoptic bronchoscope or bougie.

Needle cricothyrotomy involves the insertion of a large needle through the cricothyroid membrane into the airway for transtracheal ventilation (TTV). This option is for "cannot intubate–cannot ventilate" situation when oral or nasal intubation is impossible or fails. This is a temporary measure to reestablish oxygenation until a definitive surgical airway such as tracheostomy can be established. The cricothyroid membrane can be identified as an indentation between the thyroid and cricoid cartilage.

Take-Home Message

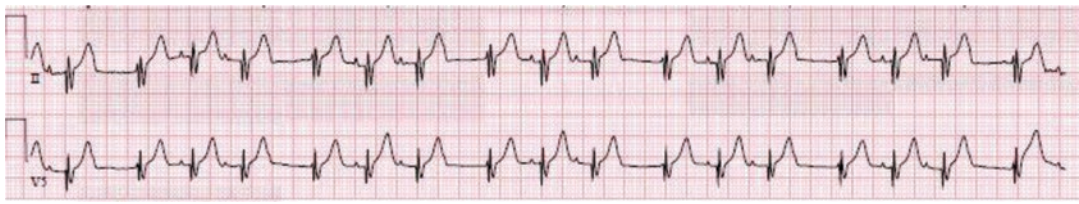
The LMA is a good alternative to enable ventilation in the setting of a difficult airway and can be used as a conduit to access a more secure airway.

ABP Content Specification

- Know the use of advanced airway management techniques in patients with respiratory failure.
- Know the use of surgical airway management procedures.
- Learning point – after multiple failed endotracheal intubation attempts, the next step is always LMA before a surgical airway.

Question 20

A 4-year-old boy is brought to the ED by EMS after he was found altered, minimally responsive with cool and clammy extremities. His heart rate is 45 beats/minute, and blood pressure is 50/20 mmHg. He is awake and has a pulse on your examination. The paramedics placed an IV and administered 0.01 mg/kg epinephrine without response. The strip from EMS is shown below.



What is the next treatment of choice?

A. Atropine 0.02 mg/kg intravenous
B. Atropine 0.1 mg/kg intravenous
C. Atropine 1 mg intravenous
D. Transvenous pacing
E. Amiodarone 5 mg/kg intravenous

Correct Answer: A

This patient has a second-degree (type 2) AV block. In this situation, chest compression should be initiated if the heart rate is less than 60 beats/minute and epinephrine 0.0.1 mg/kg is administered. If the bradycardia persists despite these efforts and the patient shows evidence of AV block, then atropine 0.02 mg/kg should be administered and can be repeated.

Take-Home Message

Severe bradycardia with second-degree heart block should be treated with IV epinephrine, and if not responsive, then atropine can be added.

ABP Content Specification

- Know the indications for and pharmacologic action of atropine in resuscitation.
- Know the indications for and pharmacologic action of epinephrine in resuscitation.
- Recognize unstable arrhythmias leading to cardiac arrest.

Question 21

You have just intubated a 5-year-old girl for acute respiratory failure due to multifocal pneumonia. The chest radiograph confirmed placement of the endotracheal tube. About 15 minutes later, you hear alarm bells and notice the blood pressure is 50/20 mm Hg, and the pulse oximeter shows 85% on FiO2 100%. Which of the following is a possible cause of the patient's current condition?

A. Dislodged or displaced endotracheal tube
B. Mucus plug
C. Pneumothorax
D. Ventilator malfunction
E. Any of the above

Correct Answer: E

This patient is showing signs of decompensation after being placed on mechanical ventilation post-intubation. The DOPE mnemonic is an easy way to remember the most likely causes of post-intubation deterioration.

- D- Dislodged/displaced endotracheal tube (main stem, esophageal, supraglottic)
- O- Obstructed endotracheal tube – kink, mucus plug
- P- Pneumothorax
- E- Equipment failure, including ventilator malfunction or no oxygen connection

Take-Home Message

Consider DOPE mnemonic to manage patients that are difficult to ventilate after successful endotracheal intubation.

ABP Content Specification

- Plan mechanical interventions during the postarrest period, including hypothermia.
- Know etiology of respiratory failure.

Suggested Reading

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Question 21

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Critical Care and Transport

2

Rohit Pravin Patel and Alicia Buck

Question 1

You receive a call from the hospital transfer system that a school bus has overturned in a nearby city which is 40 miles away. The transfer center is asking for your advice concerning transfer of these patients to your facility. Which of the following regarding regionalized systems in pediatric emergency mass critical care is accurate?

A. Pre-disaster/mass casualty planning is best left to the bureaucrats and politicians.
B. In rural regions, existing delivery systems are effective to deliver appropriate care.
C. In planning for response to mass critical care events, it is beneficial to use existing public health data to assess pediatric populations at risk based on patient volume and acuity.
D. States and regions should not provide special legal protection for those hospitals involved in mass critical care events to ensure standard medical practice.
E. Survival is not improved when children receive critical or trauma care at a pediatric trauma center.

Correct Answer: C. In planning for response to mass critical care events, it is beneficial to use existing public health data to assess pediatric populations at risk based on patient volume and acuity.

The Pediatric Emergency Mass Critical Care Task Force encourages states and regions to review emergency operations and to make plans to respond to the medical needs of children during disasters. Planning is not assigned to bureaucrats and politicians but rather to experts and with input from child health professionals. In many rural and even urban areas, existing systems are inadequate to manage pediatric mass casualties. Critical care resources must be capable to triple the numbers of available pediatric intensive care beds within each region and sustain this for up to 10 days. In natural disasters, terrorist attacks, pandemics, and other mass casualty events, outcomes may depend on the ability to increase intensive care resources to serve such surges in the number of patients. During a large mass casualty event involving children, the need for intensive care resources would far exceed the available resources at individual facilities. An organized approach that utilizes all resources available in a defined region can alleviate this problem. For

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_2

instance, acceptable care can be provided at the closest non-pediatric community hospitals for low-risk conditions, and care for patients with high acuity can be provided at regional pediatric hospitals. Survival is improved when infants and children receive appropriate pediatric critical care, neonatal critical care, or trauma care at pediatric or pediatric capable trauma centers. Even though distance may be greater, outcomes for the youngest and most severely injured children appear to be maximized in pediatric trauma centers.

All municipal levels (state, regional, and federal) should address legal, operational, and information systems to provide effective pediatric mass critical care by any of the following means:

1. Pre-disaster/mass casualty planning, management, and assessment along with input from child health professionals.
2. Close cooperation, service agreements, public-private partnerships, and unique delivery systems.
3. Use of existing public health data to assess pediatric populations at risk and to model graded response plans based on increasing patient volume and acuity.
4. Should facilitate care by providing the legal protection for those hospitals involved in a mass critical care event. States should plan to share scarce resources with neighboring states to meet the needs of a pediatric patient surge and optimize pediatric critical care capacity in a mass casualty event.
5. States should develop pediatric-specific performance criteria to hold regional systems accountable for mass casualty preparations and responses.
6. Practice employing full-scale simulation and/or tabletop exercises that involve all responding organizations and agencies.
7. Hazard vulnerability analysis for special populations such as children with chronic health conditions, non-English-speaking speakers, and uninsured persons and in facilities that serve large numbers of children (schools/daycare).

Take-Home Message

It is important to know your state or regional plans for emergency operations during mass casualty events. When critically ill patients are transferred to the appropriate facility such as designated pediatric trauma center, survival is improved.

ABP Content Specification

Know the purpose of regionalization of specialty-care hospitals, including pediatric trauma, burn, and critical care, and principles of field triage for pediatric illness and injury in mass critical care situations.

Question 2

Which of the following is correct regarding the scope of activities and responsibilities of the medical director for the emergency medical services system?

A. Medical licensure in any jurisdiction is adequate, in order to function as a medical director.
B. The medical director is responsible for educating the team, including team interactions and procedures, as well as the implementation of simulations as needed.
C. Safety and quality improvements are under the purview of individual ambulance units.
D. The medical director is solely responsible for the introduction of new technologies or treatments in the emergency department.
E. Protected administrative time consistent with volume, scope, and mission is generally unnecessary for the position of medical director.

Correct Answer: B. The medical director is responsible for educating the team, including team interactions and procedures, as well as the implementation of simulations as needed.

The responsibilities of the medical director include administrative/organizational, educational, safety and quality improvement, and operational.

These responsibilities are outlined in a consensus report by the American Academy of Pediatrics Committee on Transport Medicine. Medical directors should be licensed in the state of jurisdiction where the service operates. The medical director should also maintain a working knowledge of transport medicine and either be subspecialty trained or have access to subspecialists. The medical director must have protected administrative time consistent with volume, scope, and the mission of particular institutions or the region served.

Administrative duties include developing a mission statement, a strategic plan, team structure, financial and revenue generation plan, transport agreements, and marketing plan. The director should be able to serve as liaison for administrative staff and referral physicians and be responsible for advocacy issues, accreditation, legal and compliance issues. The medical director should play an important role in educating referring institutions and physicians about transport capabilities. These should include appropriate transport modalities, team composition, and patient stabilization strategies.

The medical director should oversee the education of all team members, including caregivers at referring and receiving hospitals and medical control physicians. These responsibilities should also include the establishment of transport standards, compliance with local/national standards, protocol/guideline design and review, determination of educational needs, and training plans (including simulation of team member interactions and procedures).

Other responsibilities include team development and supervision, online and off-line medical command, patient review provision, logistic review provision, ensuring clinical competence, ensuring efficient access, and quality assurance and improvement. Integral to this process is medical oversight of out-of-hospital care by using preexisting evidence-based patient care protocols or by online medical control via voice or video communication.

Take-Home Message

The role of the medical director has evolved into a significant leadership position encompassing multiple areas of responsibility that include developing and maintaining transport standards, ensuring adequate training of personnel, overall medical oversight, and leading quality improvement initiatives.

ABP Content Specification

Know the physician's role in medical direction for pediatrics, and differentiate between online (direct) and off-line (indirect) medical direction.

Question 3

You receive a call that a school bus has collided with a tractor-trailer. The estimated number of injured children is 20, with 5 recognized as unstable and including open lower extremity fractures, unresponsive with suspected traumatic brain injury, abdominal injuries of impalement, etc. Which of the following statements regarding field triage of pediatric trauma patients is accurate?

A. It is recommended that communities attempt to keep their under-triage rates between 25 and 30%.
B. In severely injured children, minimizing time to surgery has not been shown to improve outcomes.
C. The Pediatric Emergency Care Applied Research Network clinical decision rule that accurately identified children at low risk for clinically important traumatic brain injury has not been validated.
D. The Model Uniform Core Criteria is a checklist of criteria that addresses the dress code for prehospital providers.
E. The SALT Triage is a nonproprietary, freely available triage scheme that meets the Core Criteria.

Correct Answer: E. The SALT Triage is a nonproprietary, freely available triage scheme that meets the Core Criteria.

For severely injured children, early evaluation and prompt intervention at designated trauma centers results in better outcomes. Having a

trauma team in the ED upon arrival of a seriously injured child reduces the time to definitive treatment and hence improves outcomes. However, it is important for prehospital providers to recognize children's severity of injury to benefit from transport to a designated trauma center.

Field triage guidelines were developed to assist prehospital providers in the management of injured patients. However, under-triage was found to be a significant issue, when it involves injured children (rate 35%). This rate is much higher than the desired rate of 1–5%. This situation led to the development of Sort, Assess, Lifesaving Interventions, Treatment/Transport (SALT) Triage and the Model Uniform Core Criteria. The criteria include general considerations, global sorting, lifesaving interventions, and assignment of triage categories. These core principles promote interoperability and standardization of triage system during mass casualties. The Model Uniform Core Criteria is a set of guidelines that mass casualty triage systems should include. SALT Triage is a set of nonproprietary, freely available triage criteria that are compliant with the Model Uniform Core Criteria for Mass Casualty Triage.

Take-Home Message
Prehospital provider use of appropriate triage systems such as SALT Triage and Model Uniform Core Criteria in mass casualty incidents facilitates more effective strategy for identifying injured children that benefit from transport to trauma centers, hence helping to improve outcomes.

ABP Content Specification
Know principles in providing emergency care in disasters, multi-casualty events, and mass gatherings and the principles of field triage in a disaster.

Question 4

Which of the following medical equipment is required on an advanced life support (ALS) ambulance compared to a basic life support (BLS) ambulance?

A. Bag valve masks (manual resuscitator in adult, child, infant, or neonate sizes).
B. Cervical collar; rigid for children ages 2 years or older; child and adult sizes.
C. Intraosseous needles and/or intraosseous placement devices.
D. Nasopharyngeal airway.
E. Pediatric sphygmomanometer.

Correct Answer: C. Intraosseous needles and/or intraosseous placement devices.

The Emergency Medical Services for Children (EMSC) Stakeholder Group has developed a guideline outlining the essential pediatric equipment/supplies needed for basic life support and advanced life support patient care units. The goal for out-of-hospital care is to minimize the worsening of systemic injury and to appropriately manage life-threatening conditions. ALS ambulances must have all the equipment designated for BLS units and additional equipment to provide advanced airway and vascular access. Supplies and equipment to obtain intravenous access include the availability of intraosseous needles. Certain specialty transport teams, such as pediatric and neonatal teams, may include other personnel such as respiratory therapists, nurses, and physicians. Training and equipment needs may vary depending on the skills needed during the transport of these patients.

Take-Home Message
EMS personnel may have different resources available to them depending on the type of level of care unit that is dispatched. It is important to be aware of this information when making decisions regarding transport to other facilities. Specialty transport teams have training and equipment specific to their needs.

ABP Content Specification
Know essential pediatric equipment in the ambulances equipped for basic versus advanced life support.

Question 5

You are responsible for the online medical control EMS phone during your work shift and receive a phone call from a prehospital provider who is called in by a minor with no adult or legal guardian available to accompany this minor. In which of the following situations does the minor need consent for treatment from a legal guardian/parent?

A. A 16-year-old married female that lives with her spouse and works at a local grocery store.
B. A 15-year-old patient with leukemia who has a judicial determination as a mature minor and makes decisions about his chemotherapy.
C. A 14-year-old male asking for evaluation/treatment for a sexually transmitted disease.
D. A 15-year-old who presents for evaluation/treatment of a lip laceration and tooth injury pursuant to a fight after school.
E. A 16-year-old male who is depressed and wants mental evaluation.

Correct Answer: D. A 15-year-old who presents for evaluation/treatment of a lip laceration and tooth injury pursuant to a fight after school.

Children and adolescents might require evaluation and treatment for emergency medical conditions in situations in which a parent or legal guardian is not available to provide consent. In general, a medical screening examination and any medical care necessary to prevent harm should not be withheld or delayed because of problems obtaining consent. The ethical basis for this approach is based on the professional's duty to consider the best interest of the child. The legal basis for taking action in an emergency when consent is not available is known as the "emergency exception rule." The emergency exception rule is also known as the doctrine of "implied consent." This rule assumes that reasonable persons would consent to emergency care if able to do so. Also, if the legal guardian knew the severity of the emergency, he or she would consent to the medical treatment for the child. Under this rule, a medical professional may presume consent and proceed with appropriate treatment or transport if the following conditions are met:

1. The child is suffering from an emergent condition that places his or her life or health in danger.
2. The child's legal guardian is unavailable or unable to provide consent for treatment or transport.
3. Treatment or transport cannot be safely delayed until consent can be obtained.
4. The professional administers only treatment for emergent conditions that pose an immediate threat to the child.

In certain situations, a minor has the legal authority to make decisions regarding own health care: emancipation, the mature minor exception, and exceptions based on specific medical conditions. Most emancipated minor laws recognize marriage, economically self-supporting and not living at home, or those on active military duty status to qualify for "emancipated status." In some states, a minor who is a parent or who is pregnant might also be considered emancipated. Most states also recognize mature minor exception where a minor, usually 14 or older, displays maturity and intelligence to understand risks and alternatives. States vary in terms of whether a physician can make this determination or whether a judicial determination is required. Most states allow certain conditions for a minor to consent to evaluation and treatment, including mental health conditions, treatment for drug and alcohol addiction, pregnancy-related care, contraceptive services, and testing for and treatment of sexually transmitted diseases. The specific nature of these exceptions and age at which they apply vary from state to state.

If the child's legal guardian possesses medical decision-making capacity, he or she has the right to refuse medical care for the child. The guardian

is required to act in the best interest of the child. If a legal guardian refuses to consent to medical care or transport that is necessary and likely to prevent death, disability, or serious harm to the child, law enforcement officers may intervene under local and state child abuse and neglect laws. The medical professional should attempt to negotiate with the legal decision-maker and attempt to achieve an agreeable plan for safely managing the child's medical condition. Medical control should be involved early in these situations, and law enforcement resources should be used as necessary to ensure that the patient receives the necessary emergency stabilization and transport.

Take-Home Message

In situations where a minor has a condition that represents a threat to life or health and where a parent or legally authorized decision-maker is not readily available to provide consent, health care professionals may provide necessary medical treatment or transport the child for more definitive evaluation and stabilizing treatment.

ABP Content Specification

Know the special medicolegal problems faced by prehospital personnel caring for the minor patient, including consent and treatment refusal.

Question 6

You are working at a small rural hospital. You receive a call from your 911 call center for medical advice regarding a 9-year-old girl who was thrown off of her all-terrain vehicle during an accidental collision. On initial assessment, she has a GCS of 7 with a moderate right-sided scalp hematoma and palpable skull deformity. The child has been intubated for airway protection at the scene. The EMS crew is trying to decide between ground transport and helicopter transport to a level 1 pediatric trauma center for neurosurgical intervention. The pediatric center is 45 minutes away by ground. What factors lead you to recommend helicopter transport vs ground EMS in this patient?

A. GCS < 8.
B. Child's age.
C. Type of insurance coverage.
D. Isolated scalp injury.
E. Unavailability of legal guardian.

Correct Answer: A. GCS < 8.

The selection of vehicle for transport of critical patients is multifactorial. In general, it depends on the child's emergency needs, distance, traffic patterns, ground or air ambulance availability, helicopter landing pad and/or airport access, weather conditions, as well as expense. Air medical transport is important for the transfer of patients in the event of a trauma or medical condition that requires specialized care.

Air ambulance services consist of fixed-wing and rotary-wing aircraft. Fixed-wing air ambulances are preferred for longer transports. The advantages include greater speed, absence of weight limitations, and a pressurized cabin. Also, this may be able to fly, particularly when weather precludes the use of a helicopter. However, their inability to land in close proximity to hospitals and their dependence on ground ambulances to transfer patients are some of the limitations of a fixed-wing aircraft.

In the Elswick study, helicopter transport was used for patients whose GCS is 3–8 or who had radiographic evidence for the need for acute neurosurgical intervention. It has been suggested that outcomes were better comparing helicopter vs ground EMS transport. However, the survival benefit may be related to advanced provider care. In the Starnes study, increased distance (odds ratio [OR] = 6.1–18.6), lower Glasgow Coma Scale (OR = 2.5), multisystem injury (OR = 1.5), intubation (OR = 2.7), motor vehicle collision-related injuries (OR = 2.1), and elevated heart rate (OR = 1.8) were all associated with helicopter EMS transport. Furthermore, the type of insurance and unavailability of guardian have no effect

on mode of transport, since the situation described pertains to a life-threatening emergency.

However, air transportation has certain challenging characteristics versus ground transport. These may include vibration, turbulence, thermal changes, decreased humidity, forces of acceleration and deceleration, hypoxia, gas volume changes, and high noise level. These factors must be considered when deciding the mode of transportation for a critically ill patient.

Take-Home Message
Air ambulance transport is required for patients with low GCS and who require urgent neurosurgical intervention.

ABP Content Specification
Know resources available for transport including availability of ground, helicopter, and stiff wing transport for critical patients.

Question 7

You receive a call from an ambulance crew who was dispatched to a respiratory distress call from a caregiver. Upon arrival, the crew found an underweight, syndromic child with agonal breathing and exhibiting a pulse rate of 42 beats/minute. No legal guardians were present. But the child has a medical facility bracelet that states "Do Not Resuscitate." The provider calling you is asking for advice on advanced airway placement. What should you recommend?

A. Respect facility bracelet stating DNR.
B. Ask for the wishes of the caregiver while attempting to reach the legal guardian.
C. Start resuscitation efforts including airway protection and ventilation.
D. Provide blow-by oxygen and chin lift while transporting the subject to the nearest pediatric facility.
E. No intervention pending the procurement of DNR documentation.

Correct Answer: C. Start resuscitation efforts including airway protection and ventilation.

Advance directives are common among adult patients and in some states such as Wisconsin. A DNR bracelet is adequate for the EMS personnel to not start resuscitation. However, this directive is not applicable for children less than 18 years of age. The EMS Committee of the American College of Emergency Physicians has published guidelines for Do Not Resuscitate (DNR) orders in the prehospital setting. This emphasized that all necessary resuscitative efforts should be provided unless a valid DNR document is presented at the scene. Providing intermediate resuscitation efforts, e.g., blow-by oxygen and airway opening, is not appropriate. However, if appropriate state-specific paperwork is presented, providers should abide by the pre-stated wishes unless they are revoked by the legal guardian.

Take-Home Message
Pediatric patients can have advanced directives, and providers should honor and carry out those directives unless specifically revoked by the legal guardian.

ABP Content Specification
Know the use and guidelines for advanced directives in your state.

Question 8

Your hospital is preparing to obtain a level 1 pediatric trauma center designation and is currently reviewing their resources. Your center admits about 200 injured children below the age of 15 annually. It has one board-certified pediatric surgeon, 24-hour subspecialty coverage for neurosurgery, plastic surgery and PICU. It has a PED, pediatric acute care unit, rehabilitation services, a pediatric social worker and a child-life program. The hospital has a respectable teaching and research program. What

additional resources does your center need for a successful designation?

A. 24/7 coverage by orthopedic surgery
B. More than four pediatric emergency medicine physicians.
C. More than a five-bed pediatric ICU.
D. An additional board-certified pediatric surgeon.
E. A child abuse specialist.

Correct Answer: D. An additional board-certified pediatric surgeon.

Pediatric Trauma Center Designation Criteria

Level 1: Provides resources for care ranging from prevention to rehabilitation. 24-hour coverage of pediatric surgery and the availability of both neurosurgery and plastic surgery. Two board-certified pediatric surgeons. >200 encounters with patients aged less than 15 years admitted for trauma each year. Provides leadership and operates organized teaching and research efforts to improve traumatic care. A pediatric social worker and both child-life and family-support programs, as well as Injury Prevention and Outreach Programs.

Level 2: Provides resources to initiate care for all injured patients. One board-certified pediatric surgeon. >100 encounters with patients aged less than 15 years admitted for trauma each year. Pediatric emergency department, an ICU, and an acute care unit.

Take-Home Message

The major difference between level 1 and level 2 pediatric trauma centers is the availability of board-certified pediatric surgeons (i.e., they need two surgeons for level 1 trauma center designation), the ability to conduct research to develop field innovations, and the number of patients seen for traumatic injuries.

ABP Content Specification

Know pediatric trauma center designation requirements.

Question 9

In your role as medical director, you are preforming a quality improvement project on pain management. You are reviewing charts evaluating for factors associated with inadequate pain management in pediatric trauma patients. What factors would you expect are associated with suboptimal pain control in pediatric trauma patients?

A. Intravenous access.
B. Longer transport time.
C. Adolecent age.
D. Undocumented pain score.
E. Low GCS.

Correct Answer: D. Undocumented pain score.

Analgesia for pediatric trauma patients in the prehospital setting remains a topic of research. Despite implementing policies and provider education, research has shown little improvement in providing adequate pain control for pediatric patients. The following factors have been reported to be associated with administration of analgesia: longer transport time, presence of IV access, patient's age, and documentation of pain score. Factors associated with decreased likelihood of analgesia administration include younger age, lack of IV access, high GCS, systolic blood pressure < 100 mm Hg, low initial pain score, and failure to document a pain score.

Take-Home Message

Inadequate pain management in children is quite common. Physicians should be aware of contributing factors which include lack of documentation of pain score or not having IV access.

ABP Content Specification
Know pain control continues to be underutilized in pediatric trauma patients.

Question 10

You are reviewing the protocols implemented during your department's care for pediatric trauma patients. You would like to standardize the process your ambulance crews use to determine which facility to go to. You have one local level 2 pediatric trauma center that is relatively distant from your area and one local and much closer adult trauma center. What is of paramount importance when you recommend patient transport?

A. All severely injured pediatric patients should be sent to a pediatric trauma center.
B. All stabilized pediatric trauma patients should preferably be taken to a pediatric capable trauma facility for further care.
C. High mechanism injuries should be transported to the nearest appropriate age trauma center.
D. Children should be transported to the trauma facility their parents are taken to.
E. Patients should be alternated between the pediatric and adult trauma center based on current census in the individual ED.

Correct Answer: B. All stabilized pediatric trauma patients should preferably be taken to a pediatric capable trauma facility for further care.

The published guidelines recommend specialty specific trauma evaluation due to the improved outcomes when a child is resuscitated and subsequently managed at a pediatric trauma center. It should be noted that stabilized pediatric patients had better long-term outcomes from pediatric-specific hospitals. However, if the pediatric-specific trauma center was distant and the patient was hemodynamically unstable, all efforts to initiate resuscitation should be attempted at the nearest facility. Once stabilized, the patient should then be transported to a pediatric-specific facility.

Take-Home Message
Injured children that are appropriately triaged in the field and transported to pediatric trauma centers have a better survival rate and reduced morbidity. However, unstable patients should be transported to the nearest facility for resuscitation and stabilization.

ABP Content Specification
Know appropriate facility destinations for pediatric trauma patients.

Question 11

An advanced life support EMS crew arrives at your facility with a pediatric patient whose chief presentation is anaphylaxis. Throughout the evaluation and transport, they have administered subcutaneous 0.01 mg/kg epinephrine, intravenous 2 mg/kg methylprednisolone, and 1 mg/kg diphenhydramine according to their protocols. Under what form of medical command were these actions taken?

A. In-line command.
B. Off-line command.
C. Scope of practice.
D. Provider expertise.
E. Online command.

Correct Answer: B. Off-line command.

Each EMS system has a medical director who is ultimately responsible for the care of all patients. Each prehospital provider is considered to be under the licensure of the medical director.

Online or direct medical direction occurs when a qualified physician gives direct patient care orders, typically via phone or radio. Typically, the individual giving direction is either the medical director or a qualified physician designated by the medical director. Off-line or indirect medical direction occurs by means of several different auspices—training, chart review, quality assurance, protocol development, etc. Protocols are sets of procedures and policies for all components of the EMS system and provide a blueprint for providers to approach common problems and provide standard medical care. A subset of protocols may include standing orders or preauthorized treatment procedures. The medical director is responsible for developing, standardizing, and implementing these protocols, as well as reviewing them from time to time. While giving these medications is within the scope of practice, the decision to give is based on protocol and not related to provider expertise.

Take-Home Message
EMS field responses to common presentations utilize established standardized protocols and may be further supported, if needed by online medical direction as provided by a qualified physician.

ABP Content Specification
Know the principles of medical control and direction.

Question 12

You receive a call from the 911 call center regarding ongoing resuscitation efforts for a pediatric trauma. The patient and his family were in a MVC rollover on a rural highway. Resuscitation efforts have been in progress for 45 minutes on a pulseless 3-year-old boy with diffuse abdominal bruising who appeared to have been an unrestrained backseat passenger and who was ejected from the vehicle in which he had been riding. The patient's location is 90 minutes from the nearest facility. What are your recommendations for the EMS crew?

A. Continue resuscitation measures and transport to the nearest facility.
B. Terminate resuscitation.
C. Discuss the likelihood of a poor outcome or death with family members in order to decide a further plan of care.
D. Continue one more additional round of ATLS, and if no ROSC or improvement, terminate care.
E. Perform a pericardiocentesis and continue resuscitation.

Correct Answer: C. Discuss the likelihood of a poor outcome or death with family members in order to decide a further plan of care.

The American College of Surgeons, American Academy of Pediatrics, and American College of Emergency Physicians published a policy statement in 2014 regarding resuscitation efforts and poor prognostic indicators for traumatic arrests in children. In most states, resuscitation should be initiated and continued until arrival to the appropriate facility. In this statement, it was noted that patients in traumatic arrest who require >30 minutes of resuscitation and those whose nearest facility is >30 minutes away may suggest inevitable poor outcome or death. Additional recommendations are to withhold resuscitation in the presence of obvious signs of death—rigor, dependent lividity, and decapitation. Any doubt regarding the timing of the arrest should prompt additional resuscitation and transport to an appropriate facility. In this vignette, there is cardiopulmonary arrest with a known downtime of at least 45 minutes, and an appropriate facility is 90 minutes away.

Take-Home Message
A case of a traumatic out-of-hospital cardiac arrest, a downtime greater than 30 minutes, and a caregiving facility greater than 30-minute distance are poor prognostic indicators. Withholding

resuscitation is considered reasonable, when there are obvious signs of death (lividity, rigor, decapitation) and injuries incompatible with life.

ABP Content Specification
Know poor prognostic indicators for traumatic pediatric arrests.

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Emergency Medical Services

3

Cristina M. Zeretzke-Bien, Usha Avva, and Fernando Jara

Question 1

You are working in the pediatric emergency room when you get an emergency medical services (EMS) notification about a bus accident. EMS reports an 18-wheeler truck collided with a school bus carrying second grade students. The exact number of victims is unknown. The charge nurse asks you to activate mass casualty incident (MCI) system. In preparation for the incoming injured, what triage tool/guidelines can be used to field triage?

A. START as a triage tool, to handle multiple patients and to allocate resources appropriately.
B. JumpStart is a pediatric algorithm that incorporates a child's vital signs to facilitate decision-making.
C. There is no need to activate a MCI system at this time. Await further information.
D. SALT is an effective triage tool/guideline that can accommodate the pediatric population.
E. All of the above.

Correct Answer: E

JumpSTART is a tool for rapid pediatric multicasualty field triage. The goal is to do the best for the most with the least.

JumpSTART's objectives are as follows:

- To optimize the primary triage of injured children in the MCI setting
- To enhance the effectiveness of resource allocation for all MCI victims
- To reduce the emotional burden on triage personnel who may have to make rapid life-or-death decisions about injured children in chaotic circumstances

JumpSTART is a pediatric triage algorithm used by first responders during an MCI. JumpSTART provides an objective framework that helps to assure that injured children are triaged by first responders without the emotional burden they face in a mass-causality setting. It reduces over-triage that might siphon resources from other patients who need them more. This tool recognizes the key differences between adult and pediatric physiology, using appropriate

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_3

pediatric physiologic parameters at decision points. It was first developed in 1995 and later modified in 2001.

JumpSTART is used by EMS agencies across the United States and Canada. The tool is easy to teach and is useful, and both prehospital personnel and school nurses found it easy to learn. Currently, various groups such as National Disaster Medical System's federal medical response teams and EMS providers in the National Park Service have adopted it.

START (simple triage and rapid treatment) is an adult triage tool used by first responders to quickly classify victims based on severity of injury during an MCI. The algorithm is *not* adaptable to the pediatric population. START requires a sequential evaluation of mental status, respiration, and perfusion that could be difficult to adapt for children.

The START/JumpSTART triage tool merges pediatric and adult pathways into one algorithm. However, JumpSTART is more appropriate for children, and START should be used for adults.

SALT triage is the product of a CDC-sponsored working group to propose a standardized triage method. The guideline, entitled SALT (sort, assess, life-saving interventions, treatment, and/or transport) triage, incorporates aspects from all the existing triage systems to create a single overarching guide for unifying the mass casualty triage process across the United States.

Another method uses a color-coded triage system.

- *Red* = life-threatening injury requiring immediate intervention.
- *Yellow* = patient may deteriorate to "Red" if immediate intervention is not provided.
- *Green* = minor injuries.
- *Black* = deceased/dead (Fig. 3.1).

ABP Content Specification

- Know principles in providing emergency care in disasters, multi-casualty events, and mass gatherings.
- Know the principles of field triage in a disaster.

Question 2

EMS is transporting a patient that is actively seizing despite administration of protocol medications. EMS calls ahead, speaks with the ED physician, and requests medical direction. The ED physician directs EMS to administer additional IV meds, specifying the amount and rate. The physician then notifies nursing and quickly prepares the resuscitation area for their arrival. Which of the following statement is correct?

A. This is an example of combined medical direction, offline protocol, and online medical direction.
B. This is an example best described as offline medical direction only.

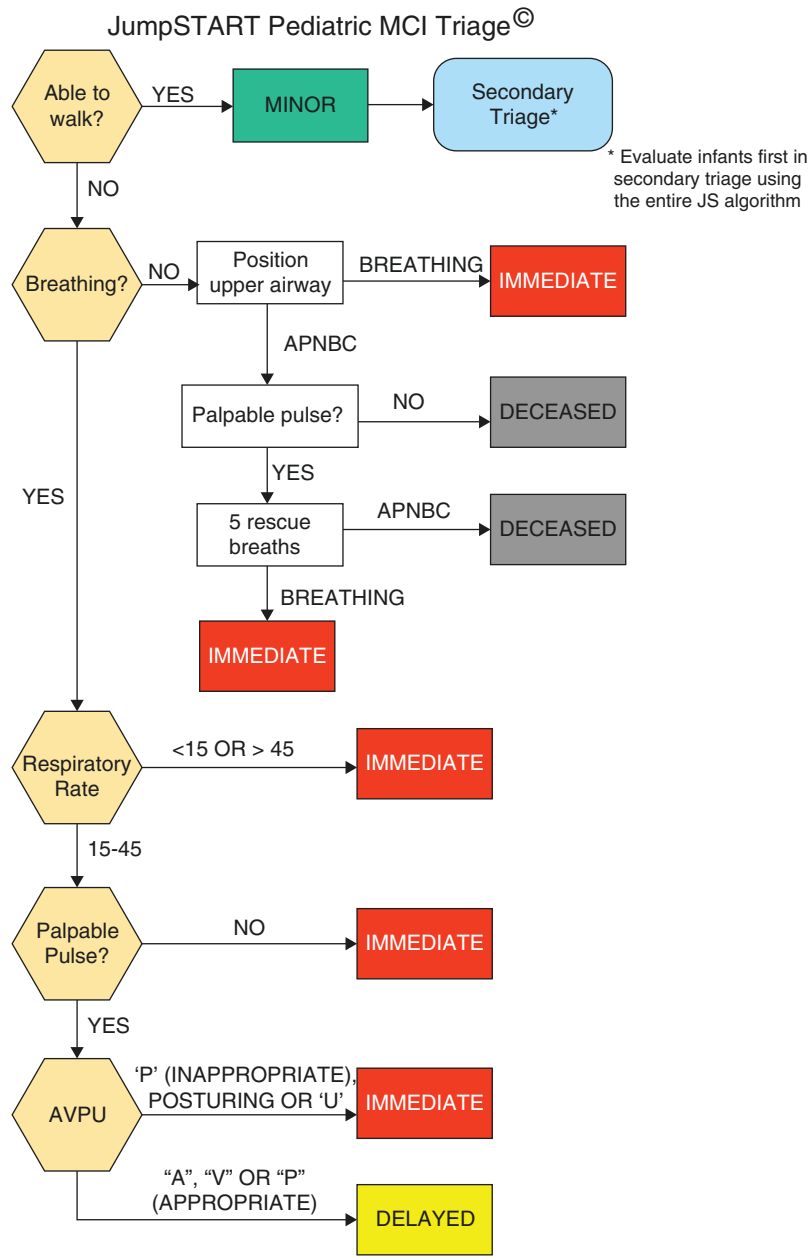

Fig. 3.1 JumpSTART, a pediatric version of START, was developed at the Miami, Florida Children's Hospital in 1995 by Dr. Lou Romig. U.S. Department of Health & Human Services. Adapted from https://chemm.nlm.nih.gov/startpediatric.htm

C. This is an example of direct online medical direction only.
D. This is an example of medical oversight, of which only offline medical direction was implemented.
E. EMS has called for directions from the physician, which in this case is often known as offline medical direction.

Correct Answer: A

Medical oversight is the medical authority and responsibility for all medical care provided in the prehospital setting. This inclusion covers both online (direct) and offline (indirect) medical direction.

Moreover, this scope includes an active day-to-day role in the function and management of

the service as it relates to patient care and activities. It can be offline or online or a combination of the two.

Online medical direction is the medical direction provided directly to out-of-hospital providers by the medical director or designee, generally in an emergency, either on scene or by direct voice communication. The mechanism for this contact may be radio, telephone, or other means as technology develops, but must include person-to-person communication of patient status and orders to be carried out. Ultimate authority and responsibility for concurrent medical direction rest with the medical director.

Off-line medical direction includes those activities performed by the medical director that do not occur during actual transport. These duties are usually performed before transport. Standing orders allow uniformity and streamline care during emergency situations.

ABP Content Specification

- Distinguish between online (direct) and offline (indirect) medical direction.
- Understand the role of field policies in managing emergency medical services for children (EMSC).
- Understand the role of the base hospital.
- Know the pediatrician's role in medical direction for pediatrics.

Question 3

EMS is called to the home of a 3-year-old child with a past history of asthma who developed sudden onset of respiratory distress. This child is at home with the babysitter who started a breathing treatment for a suspected asthma attack. She felt the child was worsening and tried to call the parents without success, then called 911.

EMS noted the child to have significant retractions, diffuse wheezing, and oxygen saturation of 89%. Which of the following is true regarding transport by EMS?

A. The babysitter can provide consent and authorize the child's transfer to the ED
B. Even if the parents can be contacted by phone, they cannot provide verbal consent
C. The police should be notified, and they can call parents and obtain consent for transport
D. EMS can provide treatment and the transport without consent, due to the emergent needs of this child
E. EMS can continue to give breathing treatments at home until parental consent is obtained.

Correct Answer: D

The emergency exception rule is also known as the doctrine of "implied consent." This emergency exception rule assumes that reasonable persons would consent to emergency care if able to do so. It further assumes that if the legal guardian knew the severity of the emergency, he or she would consent to medical treatment for the child. Under the emergency exception rule, a medical professional may presume consent and proceed with appropriate treatment and transport if the following 4 conditions are met:

1. The child is suffering from an emergent condition that places his or her life or health in danger.
2. The child's legal guardian is unavailable or unable to provide consent for treatment or transport.
3. Treatment or transport cannot be safely delayed until consent can be obtained.
4. The professional administers treatment only for emergent conditions that pose an immediate threat to the child.

Any time a minor is treated without consent, the burden of proof falls on the professional who is evaluating, treating, or transporting the child to justify and document that the emergency actions were necessary to prevent imminent and significant harm to the child. In addition to actions necessary to save a person's life and prevent permanent disability or harm, the treatment of fractures, infections, pain, and other conditions may broadly be considered as emergent conditions that require treatment. As a rule, healthcare

professionals should always do what they believe to be in the best interest of the minor. The emergency exception exists to protect healthcare professional from liability with the assumption that if the parents were present, then they would consent to treatment. The professional must clearly document in the child's record the nature of the medical emergency and the reason the minor required immediate treatment and/or transport, and the efforts made to obtain consent from the patient's legal guardian, if unavailable.

ABP Content Specification

- Know the special medicolegal problems faced by prehospital personnel caring for the minor patient, including consent, treatment refusal, and do-not-resuscitate orders.

Question 4

EMS is dispatched to the scene of an MVA where a 6-year-old boy was ejected from the vehicle. The details of the collision are unclear, but the driver was reportedly inebriated. You are told by transport that the child has a GCS of 8, with concerns for a distal extremity fracture. He has multiple contusions on his face. Cervical spine immobilization was performed and a paramedic intubated the child with a 5.0 ETT after bag-mask ventilation failed. Blood pressure was only 60 by palpation, with a heart rate of 160 beats/minute, and a respiratory rate of 16 breaths/minute. The patient is now being transferred to your facility, as a Level 1 trauma activation by flight. This situation is an example of:

A. A paramedic who has practiced outside of his scope, by providing a definitive airway, with direct laryngoscopy intubation on the scene.
B. Poor utilization of resources, by direct transport by helicopter to a Level 1 trauma center, as most regional ED centers should be able to provide services and the level of care warranted by this patient presentation.
C. This is an example of appropriate field triage and allocation of resources and appropriate regionalization of care under the EMSC program and the American College of Surgeons Trauma criteria.
D. This patient was appropriately cared for by the EMS team dispatched, including the paramedic who provided the airway, but this method was not an appropriate use of regionalization of care.

Correct Answer: C

In this case, paramedics instituted appropriate field triage and airway intervention. Regionalization of care was developed so that children who need transport to a specialized regional trauma center are transported without delays. EMS on the scene can make this trauma designation and institute transport to that designated facility. EMSC is a program within the Department of Health and Human Services designed to ensure that pediatric care is integrated into the EMS system.

ABP Content Specification

- Know the purpose of regionalization of specialty-care hospitals, including pediatric trauma, burn, and critical care.
- Know the principles of field triage for pediatric illness and injury.

Question 5

Choose the statement that best defines the roles of Emergency Medical Services for Children (EMSC):

A. EMSC is primarily a Data Analysis Resource Center, which assists EMS in research development.
B. EMSC functions mainly as a state system without federal regulation.
C. The EMSC program serves primarily to enhance and standardize the delivery of prehospital care. EMSC components include prevention programs, equipment guidelines, and treatment protocols.
D. Clinical features, such as injury prevention, transportation, pediatric rehabilitation, and

pediatric equipment, are not incorporated into the services provided by EMSC.

E. The primary focus of EMSC is national standardization of a curriculum for EMTs (emergency medical technicians) and is sponsored by NHTSA (National Highway Traffic Safety Administration) and the Maternal and Child Health Bureau.

Correct Answer: C

EMSC is a program administered by the US Department of Health and Human Services. EMSC serves to ensure that all children receive appropriate emergency medical care with the goal of reducing child and youth morbidity and mortality caused by severe illness and trauma. EMS for Children aims to ensure that:

1. State-of-the-art emergency medical care is available for the ill and injured child or adolescent.
2. Pediatric service is well integrated into an emergency medical service system backed by optimal resources.
3. The entire spectrum of emergency services, including primary prevention of illness and injury, acute care, and rehabilitation, is provided to children and adolescents as well as adults, no matter where they live, attend school, or travel.
4. Regionalization of services is integrated into acute care. These services include emergency healthcare delivery to patients in rural and tribal communities.

The EMSC program helps fund and support pediatric emergency care improvement initiatives and various educational projects throughout the United States and territories.

EMS for Children also supports:

- National Resource Center at Children's National Medical Center, which maintains the program's professional partnerships, disseminates information, and supports a special collaboration with the Family Advisory Network (FAN)
- National EMS for Children Data Analysis Resource Center (NEDARC), which assists grantees in data collection, analysis, and dissemination

ABP Content Specification

- Know EMS system organization and administration.
- Know the components of emergency medical service (EMS) systems.
- Know the functioning of emergency medical services for children (EMSC) within the EMS system and the unique problems in delivering prehospital care to children.

Question 6

Which of the following statements best summarizes pediatric patients requiring transport?

A. Protocols and equipment on any EMS transport can be applied to pediatric populations.

B. Children in need of special healthcare do not have access to the EMS system.

C. Pediatric patients can be transported without special attention as most EMS transport can handle these patients without any additional clinical components.

D. EMSC (Emergency Medical Services for Children) allows for specific mandates and regulates all staff treating children.

E. EMSC includes treatment policies, protocols, and pediatric equipment. EMSC also includes prevention programs and education to ensure optimal pediatric prehospital care.

Correct Answer: E

Emergency Medical Services for Children (EMSC) is a national initiative designed to reduce childhood death and disability due to severe illness or injury. Now in its 30th year, EMSC has successfully raised awareness among healthcare professionals, EMS, and trauma system planners, and the general public.

EMSC grant funds have enabled the development of prehospital and acute care provider

training; the establishment of EMS guidelines and protocols, equipment lists, and other clinical care resources; the formation of advisory committees and national/federal partnerships; and identification of strategies for improving the EMS system for children. The EMSC performance measures have set goals for states that will help develop more consistency in the EMS and trauma systems of care for children across the nation.

The readiness of general emergency departments (EDs) is crucial for the care of children. It has been shown in the past that EDs may not have all the equipment needed to care for children. In partnership with AAP, ACEP, and ENA, the EMSC Program implemented the National Pediatric Readiness project, a national continuous quality improvement initiative.

ABP Content Specification

- Know the functioning of emergency medical services for children (EMSC) within the EMS system and the unique problems in delivering prehospital care to children.
- Recognize the unique problems of rural emergency medical services for children.

Question 7

Inter-facility transport is an important concept to understand as a pediatric emergency medicine physician because:

A. Inter-facility transport includes stabilization, need for transport, selection of the appropriate method, communication with the receiving hospital, and maintenance of monitoring during transport.
B. The best mode of transport can be determined by factors such as the condition of the patient but does not rely on specific conditions such as the weather.
C. During transport, receiving hospitals are able to operate without application of EMTALA if the hospital is funded through a private source.
D. Physicians do not need to explain to families regarding transport (risks/benefits) if the physician has determined a higher level of care is necessary.
E. EMTALA regulations do not require the transferring hospitals and physicians to provide detailed patient-specific information and records.

Correct Answer: A

Pediatric transport has benefited and grown from its roots in the emergency medical system (EMS) and the inter-facility transport of adult patients. Transport medicine received section status within the AAP in 1990 and is dedicated to people who have an interest in pediatric and neonatal transport.

It is critical that the patient be stabilized (best possible state) before the transfer, establish communication with the receiving hospital with an appropriate mode (ground vs. air), and monitored. The transport team upon arrival to the referring hospital should establish medical control and further ensure stabilization of the patient prior to transfer. If a medical conflict in stabilization occurs while at the referring institution, then resolution by direct communication between the referring and receiving or medical control physicians is recommended.

Mode of transport is best determined by the patient's condition, distance, and duration of transportation and weather conditions. All patient transports must conform to the EMTALA law regardless of funding of institutions and must include appropriate documentation and transfer of appropriate information and relevant records. Risk benefits of transfer must be discussed with patients and families, and written informed consent should be obtained for the transfer.

Options B and C are not true, as weather is a factor in determination of transport and EMTALA is applied to all hospitals both publicly and privately funded. Option D is incorrect, as physicians should always explain to why transport is necessary to families. Option A is the best response.

ABP Content Specification

- Know the indications for ground versus air transport of ill/injured children triage/receiving hospitals.
- Know the role of field policies in the prehospital care of children, including policies specific to intubation, inter-facility transport, unexplained infant death, and physician-on-scene.

Question 8

You recently had several pediatric orthopedic emergencies requiring consultation. You receive a call from an outside hospital requesting transfer. The transfer center has contacted you and the orthopedic surgeon on call to accept the patient. The patient is a 6-year-old boy with a forearm injury, which may require surgical intervention. The orthopedic surgeon denies the request for transfer of the patient as the patient does not have insurance. He suggests you recommend transport to another facility. Choose your best response:

A. You can recommend transport to another institution.
B. Tell the outside hospital to send the patient to the closest hospital without an accepting physician.
C. Inform the consultant that he is in violation of EMTALA; this patient cannot be refused on basis of insurance status.
D. The Model Uniform Core Criteria (MUCC) is a national guideline, useful in a mass casualty triage system. It uses a checklist of core criteria to increase interoperability between various existing MCI triage systems as well as providing guidelines for MCI triage.
E. Tell the county physician to instruct the parents of the child to put the patient in his/her own private vehicle and drive to the closest facility to seek care.

Correct Answer: C

Congress enacted EMTALA in 1986 as part of the Consolidated Omnibus Budget Reconciliation Act (COBRA) of 1985 (42 U.S.C. §1395dd). Its original intent and goals are consistent with the mission of ACEP and the public trust held by emergency physicians.

1. Referred to as the "anti-dumping" law, it was designed to prevent hospitals from transferring uninsured or Medicaid patients to public hospitals without, at a minimum, providing a medical screening examination to ensure they were stable for transfer. As a result, local and state governments began to abdicate responsibility for charity care, shifting this public responsibility to all hospitals. EMTALA became the de facto national healthcare policy for the uninsured.
2. EMTALA requires Medicaid-/Medicare-participating hospitals with EDs to screen and treat the emergency medical conditions of patients in a nondiscriminatory manner to anyone, regardless of their ability to pay, insurance status, national origin, race, creed or color.

ABP Content Specification

- Know the physician's role in medical direction for pediatrics.

Question 9

Please select the correct scope of practice for the EMS personnel involved with the following three scenarios:

1. A 2-year-old boy is being transported to the hospital with an albuterol nebulizer treatment, which is actively being administered in route.
2. An EMS provider responds to a call for a motor vehicle accident, where a 10-year-old boy is noted to be hypotensive with a complaint of abdominal pain. No IV access has been obtained on the scene. An IO was placed en route to an activated level 1 trauma center. RSI is likely to be needed but cannot be performed by this EMS provider, if he is to stay within the scope of practice.
3. At the same scene, an 8-year-old girl has an obvious leg deformity and complains of leg pain. The leg is splinted and the cervical spine is immobilized.

A. The scope of practice in each of these listed scenarios is within the scope of practice of an EMT-B (basic).
B. The scope of practice within the scenarios listed above is consistent with an EMT-I (intermediate).
C. The scope of practice in the scenarios above is consistent with an EMT-P (paramedic).
D. The scope of practice in each of these listed scenarios is within the scope of practice of an EMT-D (defibrillation).
E. None of the above.

Correct Answer: B

EMS personnel have four levels of categories based on their proficiency: First responder (FR), emergency medical technician basic (EMT-B), or advanced providers (EMT-I or intermediate), or EMT paramedic (EMT-P).

The EMT-basic curriculum is a core curriculum of minimum required information, to be presented within a 110-hour training program. It is recognized that there is additional specific education that will be required of EMT-basic who operates in the field (i.e., ambulance driver training, heavy and light rescue, basic extrication, special needs, and so on).

Advanced life support models provide a more comprehensive level of service by highly trained personnel usually certified at the paramedic level (EMT-P). The main distinction is the knowledge and skills to perform invasive therapeutic procedures during a medical emergency. EMT-I or intermediate is also an ALS provider, whose scope of practice is more limited compared with the paramedics. EMT-P is the most advanced prehospital provider. There are different models for paramedic training and certification. Training and certification will depend on the countries' regulatory and credentialing process. In the United States, there is a national standard curriculum for training that consists of 1200 educational hours including didactic, clinical, and a field practicum.

EMT basic can open and maintain the airway, perform ventilation with a bag-mask device, perform CPR, obtain consent and refusal, and conduct fundamental extrication. They can also stabilize the entire spinal column, perform burn management and fundamental newborn delivery, control hemorrhage, and stabilize injuries including neck and extremity injuries. Medications that can be delivered include oral glucose administration, bronchodilators, preloaded epinephrine, and nitroglycerin.

In addition to the parameters of basic practice, intermediate providers may perform intubation without medications (without RSI), chest decompression such as needle thoracotomy, vascular access (IV/IO), fundamental rhythm interpretation, administer albuterol, and transport level 1 trauma patients.

Paramedics, in addition to EMT-intermediate skills, may administer medications and perform nasotracheal intubation, orotracheal intubation (with RSI), surgical airway, advanced rhythm interpretation, and manual defibrillation.

ABP Content Specification
EMS personnel: Differentiate between major levels of prehospital providers by training background and scope of practice, including first responders, EMT-B, EMT-I, EMT-D, and EMT-P.

Question 10

You are working in the pediatric ED at a tertiary care academic center and receive a phone call "warning" from the hospital transfer system that a school bus has overturned in a nearby city 40 miles away. The transfer center is asking for your advice concerning the transfer of these patients to your facility. Which of the following regarding regionalized systems in pediatric emergency mass critical care is *incorrect*?

A. Pre-disaster/mass casualty planning, management, and assessment with input from child health professionals is recommended.
B. Close cooperation, agreements, public–private partnerships, and unique delivery systems help provide effective care.
C. Use of existing public health data to assess pediatric populations at risk and to model graded response plans based on increasing

patient volume and acuity would benefit patients during mass critical care events.

D. States and regions should facilitate care by providing the legal protection for those hospitals involved in a mass critical care event.

E. Survival is not improved when infants and children receive critical care at a pediatric or pediatric capable adult trauma center.

Correct Answer: E

The Pediatric Emergency Mass Critical Care Task Force encourages states and regions to review emergency operations and make plans to respond to disasters to meet the medical needs of infants and children. Critical care resources must be structured to surge to at least three times the number of available intensive care unit beds for infants and children within each region for up to 10 days without assistance. In natural disasters, terrorist attacks, pandemics, and other mass casualty events, outcomes may depend on our ability to increase intensive care resources to serve surges of patients. The needs in a large emergency situation would exceed the resources of individual facilities, whereas using all resources across a region would help alleviate this problem. Acceptable care can be provided for patients with low-risk conditions at the closest nonpediatric community hospitals. High acuity patients' care should be provided at regional pediatric hospitals. Survival is improved when infants and children receive appropriate pediatric critical care, neonatal critical care, or trauma care at pediatric or pediatric capable adult trauma centers. Even though distance may be increased, outcomes for the youngest and most severely injured children appear to be maximized in pediatric trauma centers.

All levels (state, regional, and federal) should address legal, operational, and information systems to provide effective pediatric mass critical care through the following:

1. Pre-disaster/mass casualty planning, management, and assessment with input from child health professionals.
2. Close cooperation, agreements, public–private partnerships, and unique delivery systems.
3. Use of existing public health data to assess pediatric populations at risk and to model graded response plans based on increasing patient volume and acuity.
4. Providing legal protection for those hospitals involved in a mass critical care event. (For more information on this, refer to a report by the Institute of Medicine in the article, "Legal considerations during pediatric emergency mass critical care events.")
5. Planning to share scarce resources with neighboring states to meet the needs of a pediatric patient surge and optimize pediatric critical care capacity in a mass casualty event.
6. Developing pediatric-specific performance criteria to hold regional systems accountable for mass casualty preparations and responses.
7. Practicing full-scale simulations and/or tabletop exercises. Responses should be practiced within and across responding organizations and agencies.
8. Analysis of hazard vulnerability for populations such as children with chronic health conditions, non-English speakers, and those who are uninsured and in facilities that serve large numbers of children such as schools, daycare, and recreational facilities.

Take-Home Message

It is important to know your state or region's plan for emergency operations during mass casualty events. When critically ill patients are transferred to the appropriate facility, survival is improved.

ABP Content Specification

- Know the purpose of regionalization of specialty-care hospitals, including pediatric trauma, burn, and critical care centers, and principles of field triage for pediatric illness and injury in mass critical care situations.

Question 11

You recently took a new position at a hospital as a faculty member for the pediatric ED. Your department chair makes the suggestion that she is looking for a pediatric medical director for the

EMS system. Which of the following is *not* correct regarding the role and responsibilities of the medical director for the EMS system?

A. Administrative/organizational leadership including the role in educating referring institutions and physicians about transport capabilities; this would include appropriate modes, team composition, and patient stabilization.
B. Education including simulation of team interaction and procedures.
C. Safety and quality improvement including supervision of online and off-line medical control.
D. Operational responsibilities, which may include an introduction of new technologies or treatments.
E. The medical director does not have to have protected administrative time consistent with volume, scope, and mission.

Correct Answer: E

Over the past 10 years, the responsibilities of the medical director have been expanded and modified. The four areas of responsibility are administrative/organizational, educational, safety and quality improvement, and operational. The medical director should be licensed in the state or jurisdiction where the service operates, maintain a working knowledge of transport medicine, and either be subspecialty trained or have access to subspecialists. The medical director must have protected administrative time consistent with volume, scope, and mission of the institution/region served.

Administrative duties include the mission statement and strategic plan development, team structure, advocacy, development of transport agreements, accreditation issues, financial planning, and revenue generation, service as a liaison for administrative staff, and referral physicians. The medical director should have knowledge in legal awareness and compliance and plan development and supervision of marketing (including outreach and visibility). The medical director should play a role in educating referring institutions and physicians about transport capabilities, including appropriate modes of transportation, team composition, and patient stabilization.

The medical director should oversee education to include all team members, caregivers at referring and receiving hospitals, and medical control physicians. Responsibilities include the establishment of transport standards, compliance with local/national standards, protocol/guideline design and review, determination of educational needs, and training plans (including simulation of team interaction and procedures).

Even though the aviation and ground vehicle safety issues are the responsibility of the program or operations director, the medical director should understand the safety structure. Responsibilities include team development and supervision, online and off-line medical command, patient review provision, logistic review provision, ensuring clinical competence, ensuring efficient access, and quality assurance and improvement. Integral to this process is medical oversight of out of hospital care by using preexisting patient care protocols (off-line medical control or indirect medical oversight), which are evidence-based when possible, or by medical control via voice and/or video communication (inline medical control or direct medical oversight).

The offline medical control is established under the auspices of the local EMS medical director.

Operational activities incorporate establishment of an appropriate managerial structure, including a program director to oversee the multidisciplinary team. Personnel selection, medical command development, communications management, vehicle selection, and the introduction of new technologies or treatments are other various operational activities.

Take-Home Message

The medical director has many roles, including administrative, education, safety, quality, and operational directives.

ABP Content Specification

- Know the physician's role in medical direction for pediatrics and differentiate between online (direct) and off-line (indirect) medical direction.

Question 12

As you are about to leave your shift after signing out to your colleague, a call is received from the 911 call center that a bus carrying children has been in an accident with a semi-truck. The estimated number of injured children is 20. Of these, five are recognized as unstable (open lower extremity fractures, unresponsive with suspected traumatic brain injury, impalement into the abdomen, etc.). Which of the following regarding field triage of pediatric trauma patients is *incorrect*?

A. The American College of Surgeons Committee on Trauma recommends communities attempt to keep their under-triage rates between 1% and 5%.
B. In severely injured children, minimizing time to surgery has not been shown to improve outcomes.
C. A study published in 2009 by the Pediatric Emergency Care Applied Research Network successfully identified a clinical decision rule that accurately predicted children at low risk for clinically important traumatic brain injury.
D. The Model Uniform Core Criteria (MUCC) is a national guideline, useful in a mass casualty triage system. It uses a checklist of core criteria to increase interoperability between various existing MCI triage systems as well as providing guidelines for MCI triage.
E. SALT triage is a nonproprietary, freely available triage scheme that meets the core criteria.

Correct Answer: B

When children are severely injured, minimizing time to surgery will increase the likelihood of a good outcome. Most regions meet this need by developing trauma systems where specialty care providers and equipment are located in designated trauma centers. A total of 17.4 million children in the United States do not have access to a pediatric capable trauma center within 60 minutes of travel time from their home.

EMS is challenged with identifying those patients in need of transfer to designated specialty centers. Implementing a statewide trauma system has been shown to improve clinical outcome. Having a trauma team in the ED upon arrival of a seriously injured child ensures immediate access to definitive care and improved expected outcome.

Implementing a statewide trauma system has been shown to improve clinical outcomes, and having a trauma team in the ED upon arrival of a seriously injured child has been shown to reduce the time to definitive treatment and improve expected outcomes. Over-triage can also have significant negative effects on the EMS and trauma systems in general.

Prehospital guidelines are established to minimize time to definitive care. Over-triage occurs when a minimally injured patient is initially thought to have critical injuries. Under-triage is when a critically injured patient is thought to have minor injuries. Under-triage results in delay in definitive care which impacts adversely on morbidity and mortality. Over-triage does not impact outcome but can tax the trauma system and result in excessive cost and burden.

Use of clinical tools such as the Pediatric Emergency Care Applied Research Network (PECARN) standardizes prehospital assessment of patients with head injury. This process allowed both prehospital and ED care providers to risk stratify children with head injuries and determine the most appropriate clinical care, including mode and urgency of transport and destination hospital.

Most evidence used to improve field triage is in the adult populations, although smaller studies have evaluated field triage guidelines or its components in pediatric populations. In 2006, a national workgroup was convened to improve the system for mass casualty triage. This measure led to the development of SALT Triage and the Model Uniform Core Criteria (MUCC).

The MUCC published by the National Highway Traffic Safety administration (US Department of Transportation) is a group of 24 criteria that have been recommended as essential elements of an MCI triage system.

SALT triage is a nonproprietary, freely available triage scheme that meets the MUCC. EMS-C was the first government agency to accept the MUCC concept, leading the way to the recent approval of a MUCC Implementation Plan by all members of the Federal Interagency Committee on EMS.

Take-Home Message
In a severe injury, minimizing time to interventions of surgery will increase the likelihood of an improved outcome.

ABP Content Specification
- Know the principles in providing emergency care in disasters, multi-casualty events, and mass gatherings and the principles of field triage in a disaster.

Question 13

Which of the following medical equipment is not required on a basic life support (BLS) ambulance, but is required on an advanced life support (ALS) ambulance?

A. Bag valve mask (manual resuscitator) (adult, child, infant, neonate sizes)
B. Cervical collar; rigid for children ages 2 years or older; child and adult sizes
C. Intraosseous needles and/or intraosseous placement devices
D. A length-based resuscitation tape or reference material that provides appropriate guidance for pediatric drug dosing and equipment sizing based on length or age
E. Pediatric sphygmomanometer

Correct Answer: C

EMS providers care for patients of all ages. The goal of out of hospital care is to minimize further systemic injury and manage life-threatening conditions through a series of well-defined and appropriate interventions and to embrace principles that ensure patient safety. With this goal in mind, the Federal EMSC Stakeholder Group and endorsed by the American Academy of Pediatrics developed performance measures to evaluate the availability of essential pediatric equipment and supplies for BLS and ALS patient care units. ALS ambulances must have all the equipment on the required BLS list and the equipment on the required ALS list. ALS providers (paramedics) are trained to administer certain medications and fluids through IV/IO as needed with the help of preexisting protocols. Specialty transport teams, including pediatric and neonatal teams, may include other personnel such as respiratory therapists, nurses, and physicians. Training and equipment need may be different depending on the skills needed during transport of these patients.

Take-Home Message
EMS personnel may have different resources available to them depending on the level of care unit dispatched, and this information is important to know when making consulting decisions as a clinician from the receiving facility. Specialty transport teams may have training and equipment specific to their needs.

ABP Content Specification
- Know essential pediatric equipment in ambulances equipped for basic versus advanced life support.

Question 14

You are responsible for the online medical control EMS phone during your work shift and receive a phone call regarding consent for a minor. The "minor" called 911, and the EMS provider wanted clarification regarding the decision-making ability because the parent or legal guardian is not immediately available to provide consent. Which of the following situations does not allow the minor to have the legal authority to make decisions regarding his/her own healthcare?

A. A 16-year-old girl married, lives with the spouse, and has a job at a local grocery store

B. A 15-year-old leukemia patient who has a judicial determination as a mature minor and frequently makes decisions about his chemotherapy
C. A 14-year-old boy asking for evaluation/treatment for a sexually transmitted disease
D. A 15-year-old here for evaluation/treatment of a small lip laceration and tooth injury secondary to fight after school
E. A 16-year-old boy for evaluation/treatment of a mental health condition such as depression

Correct Answer: D

Children and adolescents might require evaluation and treatment for emergency medical conditions in situations in which a parent or legal guardian is not available to provide consent or conditions under which an adolescent patient might possess the legal authority to provide consent. In general, a medical screening examination and any medical care necessary and likely to prevent harm to the pediatric patient with an emergency medical condition should not be withheld or delayed because of problems with obtaining consent. The legal basis for taking action in an emergency when consent is not available is known as the "emergency exception rule." The emergency exception rule is also known as the doctrine of "implied consent." This rule is based on the assumption that reasonable persons would consent to emergency care if able to do so and that if the legal guardian knew the severity of the emergency, he or she would consent to the medical treatment for the child. Under this rule, a medical professional may presume consent and proceed with appropriate treatment and transport if the following four conditions are met:

1. The child is suffering from an emergent condition that places his or her life or health in danger.
2. The child's legal guardian is unavailable or unable to provide consent for treatment or transport.
3. Treatment or transport cannot be safely delayed until consent can be obtained.
4. The professional administers only treatment for emergent conditions that pose an immediate threat to the child.

Three situations in which a minor, rather than his or her parents, has the legal authority to make decisions regarding his or her healthcare are as follows: emancipation, the mature minor exception, and exceptions based on specific medical conditions. Most emancipated minor laws recognize marriage, economically self-supporting and not living at home, or on active duty status in the military. In some states, a minor who is a parent or who is pregnant might also be considered emancipated. Most states also recognize the mature minor exception where a minor, usually 14 or older, displays maturity and intelligence to understand risks and alternatives. States vary in terms of whether a physician can make this determination or whether a judicial determination is required. Most states allow certain conditions for a minor to consent to evaluation and treatment, including mental health conditions, treatment for drug and alcohol addiction, pregnancy-related care, contraceptive services, and testing for and treatment of sexually transmitted diseases. The specific nature of these exceptions and age at which they apply vary from state to state.

If the child's legal guardian possesses medical decision-making capacity, then he or she has the right to refuse medical care for the child. The guardian is required to act in the best interest of the child. If a legal guardian refuses to consent to medical care or transport that is necessary and likely to prevent death, disability, or serious harm to the child, then law enforcement officers may intervene under local and state child abuse and neglect laws. The medical professional should attempt to negotiate with the legal decision maker and attempt to achieve an agreeable plan for safely managing the child's medical condition. Medical control should be involved early in these situations, and law enforcement resources should be used as necessary to ensure that the patient receives the necessary emergency stabilization and transport.

Take-Home Message
In situations where a minor has a condition that represents a threat to life or health and a parent or legally authorized decision maker is not readily available to provide consent, healthcare professionals may provide necessary medical treatment or transport the child for more definitive evaluation and stabilizing treatment.

ABP Content Specification
- Know the special medicolegal problems faced by prehospital personnel caring for the minor patient, including consent and treatment refusal.

Question 15

A 7-year-old boy with a history of asthma has a progressive cough and shortness of breath that is worsening despite multiple albuterol nebulizer treatments. He is breathing very fast, and his mother is concerned that he is becoming tired and confused. She dials 911 for an ambulance. Which of the following is true regarding EMS capabilities?

A. Advanced life support (ALS) ambulances are equipped for intubation, vascular access, and portable monitor defibrillators.
B. Basic life support (BLS) ambulances are equipped for intubation, vascular access, and automatic external defibrillators.
C. In a tiered EMS system, the highest-level provider is dispatched to all calls.
D. Enhanced 911 systems are unable to provide dispatchers with the address of the caller.
E. ALS ambulances are equipped with obstetric kits, while BLS ambulances are not.

Correct Answer: A

This child has impending respiratory failure and needs immediate transport to a hospital via EMS, specifically an ALS unit. BLS units are equipped with ventilation and noninvasive airway equipment, an automated external defibrillator (AED), immobilization devices, bandages, two-way communication equipment, obstetric kits, a length-based resuscitation tape or similar guidance material, and other miscellaneous items. BLS units are not equipped with intubation or vascular access equipment; thus, answer choice B is incorrect. ALS units carry the same items as BLS units with the addition of intubation and vascular access equipment, a portable monitor–defibrillator, and a variety of medications, as described in the correct answer choice A. Both ALS and BLS are equipped with obstetric kits, making answer choice E incorrect.

Enhanced 911 systems have the capability to provide dispatchers with the address and location of the caller. This development is useful in situations when the caller, such as a young child, cannot give an address.

New systems are even able to locate calls from cellular phones using global positioning satellite (GPS) technology. In a tiered system, a set of criteria is available that determine whether an ALS or BLS response is indicated and dispatched, based on dispatcher's interrogation of the caller. In a nontiered system, the highest level of provider is dispatched to all calls. Based on local policies, other resources such as police and fire units may be dispatched along with EMS.

Take-Home Message
ALS ambulances have intubation and vascular access capabilities, and enhanced 911 systems can provide dispatchers with caller locations.

ABP Content Specification
- Know prehospital provider and ambulance dispatch through the 911 system.
- Know out-of-hospital BLS procedures.
- Know pediatric out-of-hospital treatment protocols for BLS and ALS personnel.
- Know the differences between 911 and enhanced 911 systems.

Suggested Reading

Question 1

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Environmental Emergencies

4

Waleed Awad Salem and R. J. Hoffman

Question 1

Which of the following statements regarding pediatric drowning is TRUE?

A. Sudden immersion of young children in cold water (<20 °C) leads to apnea, reflex tachycardia, and vasodilation.
B. Clinically significant hyponatremia is caused by ingestion of large volumes of freshwater.
C. Survivors of swimming pool drowning should receive prophylactic antibiotics because pneumonia is the most common sequelae of aspiration.
D. Primary CNS injury is worse among children with hypothermia.
E. Drowning occurs due to reflex laryngospasm when water contacts the lower respiratory tract.

Correct Answer: E. Drowning occurs due to reflex laryngospasm when water contacts the lower respiratory tract.

There is a predictable physiologic response in drowning. First, there is panic to stay afloat and alteration in breathing pattern with breath holding, subsequent reflex breathing and causes laryngospasm and/or aspiration. It was previously thought that significant electrolyte disturbances, such as hyponatremia, resulted from ingestion of large volumes of freshwater (rather than aspiration). However, more recent studies have shown this phenomenon to be untrue. Patients with submersion injury develop hypoxia and organ damage due to reduced lung compliance, ventilation–perfusion mismatch with intrapulmonary shunting. Sudden immersion of young children in cold water (<20 °C) leads to apnea, bradycardia (not tachycardia), and vasoconstriction of nonessential vascular beds with shunting of blood to the coronary and cerebral circulation. Chemical pneumonitis is a more common sequela than infectious pneumonia, especially if the submersion occurs in a chlorinated pool or in a bucket containing a cleaning product.

CNS injury remains the major determinant of survival and long-term morbidity in cases of drowning. Around 2 minutes after immersion, a child will lose consciousness. Irreversible brain damage usually occurs after 4–6 minutes. Most children who survive are discovered within 2 minutes of submersion. Most children who die are found 10 minutes or later after submersion.

Primary CNS injury is initially associated with tissue hypoxia and ischemia. If the period of

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_4

hypoxia and ischemia is brief or if the person rapidly develops core hypothermia, then primary injury may be limited, and the patient may recover with minimal neurologic sequelae, even after more prolonged submersion.

Take-Home Message
Patients with submersion injury develop hypoxia and organ damage due to reduced lung compliance and ventilation–perfusion mismatch with intrapulmonary shunting

ABP Content Specification
- Understand the pathophysiology of drowning/submersion injuries.

Question 2

Five children were brought to the Emergency Department with a history of having been struck by lightning while playing soccer during a rainy day. Which patient's management is CORRECT?

A. Patient A – fixed and dilated pupils: presume brain death and stop resuscitation attempts
B. Patient B – cold and pulseless extremities: focus on treating hypothermia
C. Patient C – new QT prolongation on ECG: immediate cardiology consultation and urgent transfer to cardiac catheterization laboratory for electrophysiological studies
D. Patient D – fern-like skin marks: test for urine myoglobin and serum creatinine kinase
E. Patient E – prolonged paresis on presentation: obtain MRI to evaluate for spinal cord injury

Correct Answer: E. Prolonged paresis on presentation: obtain MRI to evaluate for spinal cord

Paresis that persists should mandate further radiological assessment for spinal cord injury. Though paresis may be associated with high-voltage electrical injury without any CNS injury, this scenario is typically transient. If paresis persists, then spinal cord imaging is warranted.

Fixed and dilated pupils are more typically a result of transient autonomic disturbances, not necessarily serious head injuries or death. Hence, in this setting, resuscitation should be continued regardless of the pupillary findings.

Cold and pulseless extremities may occur with vasomotor instability, common after lightning strike. Nonetheless, hypothermia should be checked for and managed accordingly.

QT prolongation is the most common electrocardiogram (ECG) abnormality, and it tends to resolve spontaneously over several months without treatment. Other ECG abnormalities should receive standard treatments.

The fernlike Lichtenberg/keraunographic marks are pathognomonic of lightning strike, probably related to the flashover phenomenon, from the transmission of electricity along the superficial vasculature. The erythema begins to fade in 4–6 hours with no residual skin changes, and the fernlike marks usually disappear after several days. Because the electrical current is presumed to have passed on the surface of the skin, assessing urine myoglobin and serum creatinine kinase is unnecessary.

Take-Home Message
A *lightning strike* is both a serious medical and *traumatic* event. Strongly consider spinal immobilization in the management of *lightning strike victims*.

ABP Content Specification
- Recognize the signs and symptoms of potentially life-threatening electrical injuries.

Question 3

A 15-year-old boy was brought to the Emergency Department after an episode of electrical shock. He was fixing his computer at home when he accidentally touched a live wire from the main supply. There was no loss of consciousness nor seizures observed, and his vital signs are heart rate 98 beats/minute, respiratory rate 12 breaths/minute, blood pressure 116/68 mmHg, and oxygen saturation 99%. Physical examination reveals no burn marks and no neurological deficit. The statement which BEST describes appropriate management is:

A. If his ECG is normal, then he can be safely discharged home to his parents.
B. Initiate IV fluids according to the Lund and Browder chart.
C. If it had been a high-voltage exposure, then he is almost certain to develop rhabdomyolysis.
D. Admit to the observation unit for regular hemodynamic monitoring overnight.
E. Refer for out-patient neurological follow-up.

Correct Answer: A. If his ECG is normal, then he can be safely discharged home to his parents.

Admission for cardiac monitoring is not needed for asymptomatic patients with normal ECG on presentation after a low-voltage electrical injury; household electricity is in fact low voltage. Patients can be safely discharged, and admission for monitoring is unnecessary in this scenario.

The Lund and Browder chart is used for calculation of burns surface area, hence not applicable here. High-voltage exposures may result in rhabdomyolysis, but this case is not universal. Multivariate modeling revealed that high-voltage exposure, prehospital cardiac arrest, full-thickness burns, and compartment syndrome were associated with myoglobinuria. Defining "positive" as ≥2 of these findings has a sensitivity of 96% and negative predictive value of 99%.

There is no indication for referral to neurological follow-up.

Take-Home Message

Electrical injuries are typically divided into high-voltage and low-voltage injuries, using 500–1000 V as the cutoff. High morbidity and mortality have been described in 600 V direct current injury associated with railroad "third rail" contact.

Typical household electricity provides 110 V for general use and 240 V for high-powered appliances, while industrial electrical and high-tension power lines can have more than 100,000 V.

ABP Content Specification

- Plan the management of pediatric patients with electrical injuries.

Question 4

A 16-year-old schoolboy is brought to your Emergency Department during a summer football game. He was noted by the athletic staff to be shaking before he passed out on the field. He has moist skin and his vital signs are temperature 41.2 °C (106.1 °F), heart rate 135 beats/minute, respiratory rate 16 breaths/minute, blood pressure 108/62 mm Hg, and oxygen saturation 100%. His teachers and friends are not aware of any significant medical or medication history, and there are no obvious signs of trauma. His ECG reveals sinus tachycardia, but otherwise no abnormalities are detected. After placing the patient on a monitor and giving oxygen, the next immediate management is:

A. IV loading dose of phenytoin
B. Brain CT scan
C. Cold IV fluids, external fans, and cover with cold water-soaked sheets
D. Neurology consult
E. Toxicology screen including amphetamines and cocaine

Correct Answer: C. Cold IV fluids, external fans, and cold sponging

Hyperthermia with CNS manifestations are the hallmarks of heatstroke, which must be immediately recognized and promptly treated. The exertional-type of heat stroke is characterized by hyperthermia, diaphoresis (or cessation of diaphoresis) and altered sensorium, which may manifest suddenly during extreme physical exertion in a hot environment.

Heat stroke is particularly problematic in high school athletes and is the third leading cause of death after traumatic and cardiac arrest. The American College of Sports Medicine recommends that cooling be initiated at the scene, before transporting the patient to an Emergency Department for further evaluation and treatment. Given the persistent hyperthermia, management should focus on cooling while resuscitation is

on-going. The other investigation and treatment measures do not take priority and can be considered at a later stage. If treatment is rapidly initiated and aggressive enough to rapidly reduce the core body temperature, complications (including multisystem organ failure) may be averted, and the patient may have a much better prognosis. The aim is to reduce the temperature by at least 0.2 °C/min to approximately 39 °C. Active external cooling generally is halted at 39 °C to prevent overshooting and after-drop to prevent iatrogenic hypothermia. Removal of restrictive clothing and spraying water on the body, covering the patient with cold water-soaked sheets and exposure to external fans can reduce the patient's temperature significantly.

There is no role for a loading dose of phenytoin at this point. If seizing, the medication of choice would be a benzodiazepine, but a loading or prophylactic dose is not indicated at this time. Because of the global nature of the CNS insult, phenytoin would not be the optimal medication for these seizures. There is no need for neurology consult, and screening for stimulants will not alter the patient's management.

Take-Home Message

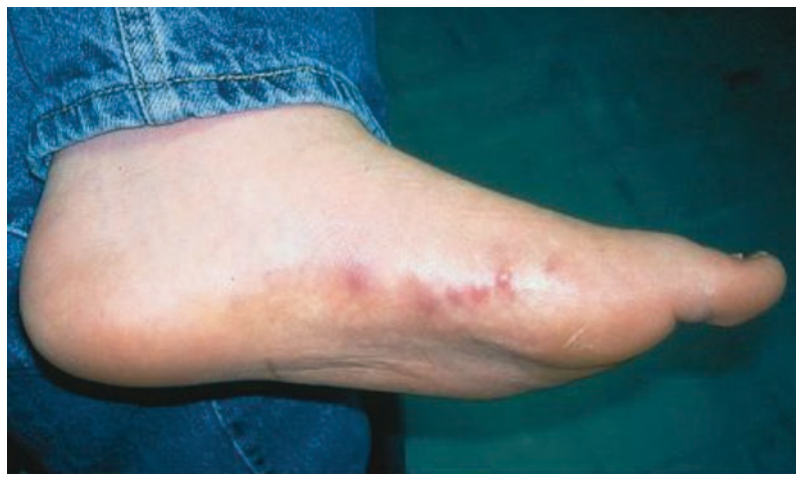
Hyperthermia is a medical emergency and rapid cooling result in improved prognosis.

ABP Content Specification

- Plan the management of severe hyperthermia.

Question 5

A teenage girl presents to your Emergency Department with painful toes. She had just returned from a college camping trip (month of January) where the temperature was 3 °C–5 °C and the ground was wet. She is otherwise fit and healthy, and her vital signs are within normal range. Foot examination reveals the finding below:



Source: Knoop KJ, Stack LB, Storrow AB, Thurman RJ: *The Atlas of Emergency Medicine, 3rd Edition*: http://www.accessmedicine.com.

The statement which BEST describes your management is:

A. Rewarm with a dry bar heater.
B. Local heat and lubricants to keep the skin supple.
C. Nifedipine should be avoided.
D. Gentle rewarming via air-drying, bed rest, extremity elevation, and early physical therapy.
E. Reassurance, discharge on analgesics.

Correct Answer: B. Local heat and lubricants to keep skin supple.

Chilblains, or pernio, is characterized by a chronic, recurrent vasculitis. Physical examination manifestations include red-to-violaceous raised lesions in unprotected extremities (see picture above). It is caused by exposure to nonfreezing temperatures and damp conditions. Blisters, erosions, and ulcers may also develop. Treatment involves local heat, gentle massage, and lubricants to keep the skin supple. Lesions usually resolve in 1–3 weeks.

Calcium channel blockers, such as nifedipine, may be used to reduce pain and speed healing. This is most useful in young- to middle-aged women with Raynaud's phenomenon.

Response (D) is recommended therapy for immersion/trench foot, which is not for her condition. This condition is a disease of the sympathetic nerves and blood vessels in the feet. It occurs in individuals whose feet have been wet, but not freezing, for prolonged periods of time. Patients typically report numbness, tingling pain with itching, and cramps.

Response (E) would be appropriate treatment for cold panniculitis, which is an inflammation of the subcutaneous adipose tissue after exposure to cold temperatures, most commonly seen in children and obese women. It typically develops 48 hours after cold exposure to a poorly protected area.

Take-Home Message
Chilblain or pernio presents as red to violaceous lesions seen usually in extremities caused by exposure to cold temperatures and damp conditions and treated with local heat, gentle massage, and lubricants.

ABP Content Specification
- Plan the management of local and systemic injuries due to hypothermia.

Question 6

After a potential leakage at a local nuclear power station, a family presents to you with worries about the detrimental effects to them and their children. Which component of a complete blood count (CBC) initially becomes abnormal, indicating early damage from radiologic exposure?

A. Platelets
B. Hemoglobin
C. Lymphocytes
D. Neutrophils
E. Eosinophils

Correct Answer: C. Lymphocytes

Acute radiation syndrome occurs when the body absorbs high radiation doses, injuring rapidly proliferating cells first (e.g., hematopoietic, reproductive, and gastrointestinal systems). The earliest adverse effects may be detected at 8 hours postexposure, when lymphocytes and the stem cells (lymphopenia) may have been destroyed. Hence, lymphocyte count (at 48 hours after an acute exposure) of >1000/mm^3 suggests an exposure of <2 Gy and carries a good prognosis.

Ultimately, pancytopenia may occur, but later. The importance of recognition of hematopoietic effects from radiation exposure is to permit vigilance for infection. These patients are similar to neutropenic patients undergoing chemotherapy and are susceptible to opportunistic infection.

Other radiation effects include mucositis, which results in toxicity to the GI tract, and in high-dose exposures, CNS toxicity, and rapid death.

Take-Home Message
Acute radiation syndrome initially presents with lymphopenia that progresses to pancytopenia. Additionally, it can cause mucositis and CNS toxicity.

ABP Content Specification
- Understand the pathophysiology and differentiate between stages of acute radiation sickness/syndrome.

Question 7

A group of school students aged 6 years and 7 years old present at your Emergency Department after an inhalational exposure to some white powder believed to be highly suspicious for anthrax. Guidelines for management include:

A. Amoxicillin should be given as postexposure prophylaxis (PEP) for 60 days if used alone in unvaccinated victims.
B. If asymptomatic, stable, and with normal baseline blood chemistry and hematology, then they can be treated as an outpatient with oral doxycycline.
C. Raxibacumab should be used for cutaneous disease.
D. Strict barrier nursing with negative pressure in a dedicated isolation room should be applied to victims confirmed to have inhalational anthrax.
E. Assessment of chest imaging to detect apical infiltrates, consolidation, and occasionally cystic lesions.

Correct Answer: A. Amoxicillin should be given as PEP for 60 days if used alone in unvaccinated victims.

The Centers for Disease Control and Prevention (CDC) recommend postexposure antimicrobial prophylaxis for 60 days if used alone for PEP of unvaccinated exposed persons. The suggested antimicrobials are ciprofloxacin, doxycycline, or amoxicillin for children and pregnant or breastfeeding women exposed to strains susceptible to penicillin.

Oral doxycycline is used for cutaneous exposure to anthrax. While the majority of anthrax is cutaneous (95%), the remaining cases are inhalational (5%) and gastrointestinal (<1%). Inhalational cases are usually fatal, with symptoms noted days after exposure. Hence, bioterrorism must be suspected in all cases of inhalational anthrax and the relevant authorities informed.

Raxibacumab is available from the CDC for treatment of inhalational anthrax or as prophylaxis when other therapies are not available or appropriate.

Patients can be admitted to a normal hospital room with barrier nursing procedures (i.e., gown, gloves, and mask) and secretion precautions (i.e., special handing of potentially infectious dressings, drainage, and excretions).

In inhalational anthrax, the chest X-ray (CXR) typically shows widening of the mediastinum and pleural effusions, whereas the parenchyma may appear normal. Chest CT may detect hemorrhagic mediastinal and hilar lymph nodes and edema, peribronchial thickening, and pleural effusions.

Take-Home Message
Amoxicillin for 60 days is the treatment of choice for children exposed to anthrax.

ABP Content Specification
- Plan the management of biologic exposures (i.e., chemoprophylaxis) and the treatment of acute illness due to biologic agents in children.

Question 8

Which of the following statements concerning botulism is CORRECT?

A. Typical symptoms include ascending paralysis, paralytic ileus, and blurred vision.

B. Stool samples for toxin analysis should not be refrigerated.
C. A heptavalent antitoxin is available and can neutralize all seven known botulinum nerve toxin serotypes.
D. Foodborne botulism should be treated with penicillin G.
E. In severe constipation, administer magnesium to minimize absorption of gastrointestinal toxin.

Correct Answer: C. A heptavalent antitoxin is available and can neutralize all seven known botulinum nerve toxin serotypes.

On March 22, 2013, the FDA approved the first botulism antitoxin that can neutralize all seven known botulinum nerve toxin serotypes (types A, B, C, D, E, F, and G). The heptavalent antitoxin is derived from horse plasma and is the only drug available for treating botulism in patients over 1 year of age, including adults. It is also the only available drug for treating infant botulism that is not caused by nerve toxin type A or B. A different medication used for infants is available from the California Department of Health.

Botulism can manifest with various neurological signs and symptoms. For this reason, most cases of botulism in children are initially misdiagnosed. Early symptoms are often nonspecific and relate to feeding. These may include the mother's complaints that the child is feeding less, has a weaker suck, or even of mastalgia resulting from breasts not being relieved of their milk as usual. Other potential symptoms include cranial nerve paralysis, which may present with blurred vision, diplopia, ptosis, extraocular muscle weakness or paresis, fixed/dilated pupils, dysarthria, dysphagia, and/or suppressed gag reflex. Symmetrical descending paralysis or weakness and autonomic nerve dysfunction may occur. Respiratory muscle weakness may be subtle or progressive, advancing rapidly to respiratory failure. Deep tendon reflexes are also diminished. Autonomic nervous system dysfunction may include paralytic ileus, constipation, urinary retention, orthostatic hypotension, reduced salivation, and reduced lacrimation.

Clostridium botulinum may be grown on selective media from samples of stool or foods. Note that the specimens for toxin analysis should be refrigerated, but culture samples should not be refrigerated.

Antibiotic therapy is useful in wound botulism, but has no role in foodborne botulism. Magnesium salts, citrate, and sulfate should not be administered because magnesium can potentiate the toxin-induced neuromuscular blockade.

Take-Home Message
The heptavalent botulism antitoxin is the only drug available for treating all seven botulinum nerve toxin serotypes.

ABP Content Specification
- Plan the management of biologic agents in children.

Question 9

A 12-year-old girl is brought to the Emergency Department by her uncle, who works as a farmer. She had been playing around his barn the whole morning but returned to the house complaining of abdominal cramps, vomiting and diarrhea after she sipped liquid from a bottle of pesticide. Her vital signs are temperature 36.4'C heart rate 62/minute, respiratory rate 32/minute, blood pressure 108/64 mmHg, and oxygen saturation 92%. She is sweaty, has small pupils, and wheeziness on auscultation of her chest. The rest of her examination is unremarkable. After initiating 100% oxygen and IV access, your NEXT BEST action is:

A. Send her to the decontamination room before proceeding with other measures.
B. Prepare for endotracheal intubation.
C. Use succinylcholine for paralysis of her vocal cords in RSI.
D. Order oral activated charcoal.
E. Administer atropine.

Correct Answer: E. Administer atropine

This patient has muscarinic symptoms of organophosphate toxicity, and treatment would be to administer atropine which antagonizes the central and muscarinic effects by blocking these receptors. It is recommended that the anticholinergic is repeated until atropinization occurs, which is clinically detected by pupillary dilation.

Muscarinic symptoms are "wet" symptoms such as salivation, lacrimation, urinary incontinence diarrhea, and emesis. The mnemonic DUMBELS not only covers the same symptoms as SLUDGE but also has miosis and most importantly bradycardia, bronchorrhea, and bronchospasm. These three symptoms beginning with the letter "b" are the only muscarinic symptoms that are truly life threatening; thus, DUMBBBELS is a better mnemonic. Nicotinic symptoms are primarily symptoms of muscular involvement or "weak" symptoms. They include weakness, fasciculation, and paralysis. Patients with nicotinic symptoms should be treated with pralidoxime. Atropine does not play a role in treatment of nicotinic toxicity.

This patient has probably been exposed to organophosphate insecticide at her uncle's farm. Symptoms vary depending on age. Any patient may have the typical SLUDGE and DUMBELS signs and symptoms, though young children may present with isolated seizure and coma.

Decontamination is very important, but it is not clear that she has any external contamination, as the exposure is reported to be by ingestion. If a patient does have external contamination, they should not be brought into the clean or "green" zone of the ED until decontamination is completed.

The girl does not require urgent intubation, and even if she does, succinylcholine worsens the toxicity.

Take-Home Message

The specific antidote for organophosphate poisoning is pralidoxime, but atropine is essential to reverse the muscarinic effects of the toxin.

ABP Content Specification

- Plan management of non-accidental chemical exposures in children.

Question 10

Your pediatric Emergency Department has appointed you to brief the staff on chemical weapon agents (CWAs) in the wake of terrorist incidents in the area. Which of the following statements is CORRECT?

A. Double-layer latex gloves should be worn while handling victims of blistering agent such as mustard.
B. A 0.5% hypochlorite solution should be avoided when decontaminating victims of sarin exposure.
C. In the event of exposure to nerve agent tabun at a tower block apartment, tenants should move to floors lower than the floor with the tabun contamination.
D. Of the nerve agents, VX is comparatively very toxic, and dermal contact at small doses can be lethal.
E. Victims of phosgene exposure who are asymptomatic have a normal ECG and CXR, and baseline blood investigations can be safely discharged after a 4-hour observation period.

Correct Answer: D. Of nerve agents, VX is relatively more toxic by dermal exposure.

List of CWAs includes:

- Nerve agents (e.g., sarin, soman, cyclosarin, tabun, VX)
- Vesicating or blistering agents (e.g., mustards, lewisite)
- Respiratory agents (e.g., chlorine, phosgene, diphosgene)
- Cyanides
- Antimuscarinic agents (e.g., anticholinergic compounds)
- Opioid agents (opioid derivatives)
- Riot control agents (e.g., pepper gas, cyanide, CS)
- Vomiting agents (e.g., adamsite)

The least volatile agent, VX, has the consistency of motor oil. The consistency and high

lipophilicity make VX 100–150 times more toxic than sarin when victims sustain dermal exposure. A 10-mg dose applied to the skin is lethal to 50% of unprotected individuals.

CWA can either be in liquid aerosols or vapors and absorbed via three routes: skin (liquid and high vapor concentrations), eyes (liquid or vapor), and respiratory tract (vapor inhalation). Their volatility (i.e., tendency of liquids to vaporize, which directly increases with temperature) and persistence (i.e., tendency of liquids to remain in a liquid state) determine their characteristics. In general, volatile liquids pose the dual risk of dermal and inhalation exposure, while persistent liquids are more likely to be absorbed across the skin. Vapors are largely influenced by ambient wind conditions; even a slight breeze can blow nerve agent vapor away from its intended target, and the exposure is prolonged when deployed within an enclosed space.

Large inhalational exposures to nerve agents or mustards are likely to be lethal immediately. Small dermal exposures to nerve agents and mustards are particularly insidious and generally require expectant observation for variable periods because of possible delayed effects.

Adequate PPE is a must for all rescuers and staff treating the victims, the levels of which vary with the agents. Double layers of latex gloves are useless against liquid nerve and blistering agents, and surgical masks and air-purifying respirators are inadequate against nerve agent vapors. A solution of 0.5% hypochlorite used as a rinsing agent will chemically neutralize most CWAs (e.g., nerve agents, mustards). This solution can be conveniently prepared by mixing 1 part 5% hypochlorite (household bleach) with 9 parts water.

All nerve agents rapidly penetrate the skin. Their vapors are heavier than air and tend to sink into low places (e.g., trenches, basements).

The highly toxic substance phosgene exists as a gas at room temperature. In view of its poor water solubility, one of the hallmarks of phosgene toxicity is an unpredictable asymptomatic latent phase before the development of noncardiogenic pulmonary edema. Respiratory manifestations, which can develop relatively early with exposures to a concentration greater than 4.8 ppm, may not develop until 4–24 hours post-exposure with lower concentrations. Therefore, a 24-hour period of observation is recommended.

Take-Home Message

CWAs can either be in liquid aerosols or vapors and absorbed via the skin (liquid and high vapor concentrations), eyes (liquid or vapor), and respiratory tract (vapor inhalation). Large inhalational exposures to nerve agents or mustards are likely to be lethal immediately, and PPE is necessary to protect rescuers and staff.

ABP Content Specification

- Plan triage decontamination and healthcare worker protection in chemical exposures.

Question 11

After a college diving trip, an otherwise fit young man presents to the medical center with paresthesia in his legs and dyspnea, which he attributes to the "fright of his life" on seeing some sharks during the dive and swimming up fast for safety. He denies any alteration in mental status, ear symptoms, or chest pains. Clinical examination reveals no evident abnormalities while ECG and bedside thoracic ultrasound are normal. Your NEXT action would be to organize:

A. Cranial CT
B. Transthoracic echocardiogram for patent foramen ovale (PFO)
C. Chest CT and CXR to rule out pneumothorax
D. Referral for urgent hyperbaric oxygen therapy
E. MRI of the spine

Correct Answer: D. Referral for urgent hyperbaric oxygen therapy.

The history is highly suggestive of decompression sickness myelopathy. This scenario is spinal cord dysfunction that manifests with deep sea diving. Gas bubbles in the venous plexus of the spinal cord is the postulated mechanism of injury. Symptoms typically develop during or

immediately after ascent, but they can be delayed for hours or even days. Hyperbaric therapy typically reverses symptoms, though injury can persist for weeks to months and may be permanent.

Decompression that occurs during ascent from diving, if occurring too rapidly, may result in liberation of gas bubbles in the blood which can be distributed in any location in the body. Most commonly, decompression sickness presents as skeletal pain or arthralgia, commonly referred to as "the bends."

Barotrauma resulting from gas expansion may have different presentations. Sinus, ear, and dental barotrauma result from gas expansion in the sinuses, middle ear, or dental cavity. More dangerous forms of barotrauma include pneumomediastinum, pneumothorax, and arterial gas embolism. A chest image would be appropriate in this patient, but only using US or X-ray; there is no indication for a chest CT at this time.

Likewise, there is no indication for a cranial CT or spinal MRI at this time. A PFO can contribute to decompression sickness, but detection of a PFO is non-emergent and should be carried out at a later time.

Ultrasound is highly sensitive (>95%) in picking up a pneumothorax; hence, a CXR is not indicated at this stage.

Take-Home Message

Hyperbaric oxygen therapy is effective in the management of decompression sickness myelopathy that can occur after deep sea diving.

ABP Content Specification

- Understand the pathophysiology of barotrauma and differentiate according to severity and type of exposure.
- Recognize the signs and symptoms of each type of barotrauma in children.
- Plan the management of barotrauma.

Question 12

You are accompanying a group of teenagers who are on their first skiing trip to a mountain resort. At the second station, 3000 m above sea level, an otherwise healthy 16-year-old boy complains of headaches and mild shortness of breath. No other abnormalities are found on examination. Presuming all treatments below are possible, which is likely to bring the fastest symptomatic relief?

A. Rest and acclimatize
B. Administer acetazolamide
C. Descent to lower altitude
D. Give supplemental oxygen by nasal cannula
E. Administer IM dexamethasone

Correct Answer: D. Give supplemental oxygen by nasal cannula

Acute mountain sickness (AMS) is defined as "in the setting of a recent gain in altitude, the presence of headache and at least one of the following symptoms: gastrointestinal (anorexia, nausea or vomiting), fatigue or weakness, dizziness or lightheadedness, or difficulty sleeping." Symptoms may start at elevations above 1500–2000 m, and at greater than 2500 m, they become more noticeable. Though the precise pathophysiology is not fully clear, hypoxia is believed to be the primary insult on ascent to high altitudes.

When severe, serious complications may ensue, which include high-altitude pulmonary edema (HAPE) and high-altitude cerebral edema (HACE), they will require rapid descent, and, if available, hyperbaric oxygen therapy (e.g. the portable Gamow bag). Management of AMS includes no further ascent until symptoms resolve, descent to a lower altitude if medical therapy shows no improvement, and if HACE/HAPE appears, then immediate descent is required. Descent to below the altitude where symptoms started is the goal, which may not be practically possible in certain circumstances.

Treatment for mild AMS symptoms may include rest and waiting at that same altitude for acclimatization. Often this process takes 24–48 hours, and it is common that climbers or their group will want to ascend without waiting for this period of time. Resuming ascent too early may result in more severe symptoms and result in HACE or HAPE.

Though acetazolamide has been a traditional therapy taken prophylactically, its adverse side-

effect profile often limits use. Relatively recently, ibuprofen has also been demonstrated to be effective to prevent headache associated with ascent.

Decent to lower altitude is always an appropriate treatment for any degree of AMS, but is only absolutely necessary in the most severe cases, particularly for HACE/HAPE. In this case, descent will take a significant amount of time, and if the patient were to choose this option, then he should still receive oxygen therapy because it will bring symptomatic relief sooner.

Dexamethasone is the drug of choice for treating HACE. It swiftly reverses symptoms (2–4 hours) and hence should be given early, but it does not improve acclimatization. It should be used in conjunction with descent.

Oxygen is extremely effective treating AMS and is always an appropriate treatment regardless of the severity. Users typically respond very quickly to treatment, though after discontinuation the symptoms will return in 12–24 hours. Oxygen is now used prophylactically to prevent AMS in travelers who rapidly ascend to high altitude and commonly used in travelers who reach altitude by aircraft.

Take-Home Message

AMS and HAPE are seen in personnel exposed to high altitude that are not adequately acclimatized. Therapy consists of immediate descent and in some cases acetazolamide and hyperbaric oxygen.

ABP Content Specification

- Plan the management of each type of high-altitude illness.

Question 13

Concerning animal exposures, which of the following is TRUE?

A. Dog bite wounds should never be primarily closed in view of infection risks.
B. Rabies does not occur with cat bites.
C. Children are most commonly bitten by stray dogs in unprovoked attacks.
D. Rabies from a bat may occur even without a known bite.
E. Rabies postexposure vaccine is best given intradermal.

Correct Answer: D. Rabies from a bat may occur even without a known bite.

Based on epidemiology of rabies cases, Postexposure prophylaxis (PEP) is recommended for persons exposed to bats in settings where a bite or scratch may have occurred, even if it is unclear that the event did occur. The common setting for this scenario is a patient or family who discovers a bat in their home, and they were asleep during the bat's presence. In such cases, PEP is recommended due to the possibility that a bite or scratch unknowingly occurred. Similarly, for children who are preverbal or unable to communicate, if it is discovered that they have had exposure to a bat, then PEP is indicated.

A study of dog bites showed improved cosmetic scores and no increased risk of infection with primary closure of wounds in multiple anatomic locations with provision of prophylactic antibiotics. Facial wounds have a low risk of infection even when closed primarily due to their increased blood supply. A randomized clinical trial showed no increased risk of infection (without the use of prophylactic antibiotics) and improved wound healing times with primary closure of facial wounds from dog bites. Given the cosmetic implications of facial wounds, primary closure is therefore advisable.

Anti-rabies treatment may be indicated for bites by dogs and cats whose rabies status cannot be obtained or in foxes, bats, raccoons, or skunks in the United States.

Bite wounds from cats and dogs can occur without provocation, but provoked bites, such as those that occur when an animal is disturbed while eating, are more common. Older animals often are less tolerant of disturbances, especially by children. Most dog bites involve a dog that belongs to

the family or friend of the victim, and approximately half occur on the pet owner's property.

Rabies is spread via the animal's saliva. Though a bite would be the most expected mode of transmission, it is not a necessity as the saliva may be spread by other means. In the United States, the CDC recommends rabies PEP with intramuscular (IM) cell-cultured vaccines. Prophylaxis includes injection of the rabies IG into the wound itself, and if there is any left, the remainder is injected into the same limb or area. The vaccine is given on the contralateral side – as far from the wound as possible. For example, if bitten in the left hand, then the rabies IG would be administered to the left hand and arm, and the vaccine would be administered to the right thigh or buttock. The reason for this action is that the rabies IG can potentially neutralize the rabies vaccine.

Take-Home Message
PEP for rabies is indicated after bat exposures even when uncertain if there was a bite or a scratch.

ABP Content Specification
- Know the risk factors and indications for prophylaxis, and plan the management of potential rabies exposure.

Question 14

A 16-year-old boy presents with a puncture wound over the fourth metacarpophalangeal joint of his right hand after a fist fight an hour earlier. The statement which BEST describes your management is:

A. Cephalexin should be prescribed for the skin flora.
B. Ampicillin/sulbactam should be prescribed for anticipated *Pasteurella multocida* infection.
C. Amoxicillin/clavulanic acid is effective for suspected *Eikenella corrodens* contamination.
D. Thorough irrigation and debridement is all that is required if the wound looks clean.
E. All such wounds will require surgical exploration.

Correct Answer: C. Amoxicillin/clavulanic acid is effective for possible *Eikenella corrodens* contamination.

This boy most probably sustained the injury by punching his clenched fist into the mouth of his opponent, sustaining a bite wound. This case is sometimes referred to as a "fight bite." Human bite wounds are at high risk for infection. *Eikenella corrodens* is the most common bacterial species implicated in human bite infections, although *Staphylococcus aureus* is the most commonly isolated organism; treatment includes amoxicillin/clavulanic acid or ampicillin/sulbactam.

Pasteurella multocida is treated with amoxicillin/clavulanic acid or ampicillin/sulbactam. This organism is commonly associated with cat bites rather than human bites.

An adequate inspection will determine the need for further exploration.

Take-Home Message
Human bite wounds are at high risk for secondary infection and should be treated with amoxicillin/clavulanic acid.

ABP Content Specification
- Understand the pathophysiology and plan the management of human bites.

Question 15

During a walk along an outdoor school trek, a boy heard a rattling sound and suddenly felt pain in his leg. His teacher managed to take a picture of the snake with her smart phone that is clearly a viper with a rattle (rattlesnake).

The BEST statement which explains his condition or your management is:

A. Non-envenomation (dry bite) occurs in majority of cases (>80%).
B. Use of a negative-pressure venom extracting device greatly reduces chances of envenomation.

C. In the presence of compartment syndrome, fasciotomy is never necessary if antivenom is available.
D. Administration of diphenhydramine is indicated in the treatment of envenomation.
E. CroFab antivenom should be given for even mild signs of envenomation.

Correct Answer: E. CroFab antivenom should be given for even mild signs of envenomation.

CroFab has been available for nearly 2 decades and has improved treatment of rattlesnake bites tremendously. As a Fab antivenom, it has minimal side effects and is extremely safe. The previously used antivenom was a polyvalent antivenom derived from horses exposed to venom from rattlesnakes and similar venomous snake relatives. As a horse-derived antidote, various allergic reactions, ranging from anaphylaxis to serum sickness, were common. Polyvalent antivenom treatment for rattlesnake bites is no longer recommended because CroFab is available.

Dry bites by rattlesnakes occur in 10% and 50% of bites, so envenomation should be anticipated in most cases. To date, there is no strong evidence to support the benefits of venom extracting devices with regards to envenomation. When compartment syndrome is present, antivenom becomes the first-line treatment as it may even resolve the compartment syndrome. CroFab is safe and indicated even if the envenomation is minimal or mild.

If any signs of rattlesnake envenomation exist, CroFab should be given as a preventative measure. There is no consensus on the routine use of CroFab for asymptomatic bites from less toxic snakes such as cottonmouth and copperhead snakes.

Antihistamines (e.g., diphenhydramine) are used to treat the allergic reactions of antivenom use.

Take-Home Message

Antivenom CroFab is effective against envenomation by rattlesnakes and has fewer side effects compared with previous horse serum-derived antitoxin.

ABP Content Specification

- Plan the management of snake envenomation by type and severity.

Question 16

An otherwise healthy 5-year-old boy was immediately brought by the mother after he was stung by an insect. She described it as a fly with yellow and black stripes. The boy looks irritable, weeping in pain, and his vital signs are temperature 36 °C (axilla), heart rate 168/minute, respiratory rate 28/minute, blood pressure 60/46 mm Hg, RR 28/minute, and oxygen saturation 95%. There are wheezes heard on auscultation of his chest, and you notice puffiness to his face and neck. On examining his right hand, there is a small wound with a tiny black foreign body and surrounding inflammation. After initiating 100% oxygen via non-rebreather mask, your NEXT action would be:

A. Administer topical lidocaine gel to the right hand and acetaminophen suppository.
B. Request the nurse to get a suture set and other instruments that could be used to attempt to remove the foreign body.
C. Immediately administer IM epinephrine.
D. Give nebulized salbutamol with the oxygen.
E. Order for diphenhydramine IV.

Correct Answer: C. Administer IM epinephrine.

The patient appears to be having a type I hypersensitivity reaction to a wasp sting. He already has hypotension, wheezing, and dermal findings; thus, multiple organ systems are involved. His severe reaction could be fatal, even with appropriate treatment. Immediate treatment with IM epinephrine is indicated.

Immediately discontinuing the exposure that is causing this reaction, which could be the presence of a stinger and venom sac, is important, but, given the impending cardiovascular collapse, is not the first thing to do.

Nebulized albuterol could be used to treat wheezing, but it may be unnecessary because all the symptoms of anaphylaxis may resolve after

treatment with epinephrine. Nebulized albuterol administration is lower priority than epinephrine administration in this case.

An H1 and H2 blocker as well as a corticosteroid should all be administered, but the time for these medications to take effect is much longer than that for epinephrine, and these do not have the immediate usefulness and lifesaving effect of epinephrine.

Take-Home Message
Bee or wasp stings cause type I hypersensitivity reaction including anaphylaxis and should be treated with IM epinephrine.

ABP Content Specification
- Plan the management of bites/stings by type, including scorpions, spiders, ticks, and insects.

Question 17

Which of the following statements regarding arthropod bites and stings is CORRECT?

A. Most symptomatic exposures to tarantulas result from allergic response to its hairs rather than venomous bites.
B. The black widow is recognized by its violin-like pattern on the thorax.
C. Black widow spider venom is cytotoxic and hemolytic.
D. Systemic envenomation by the brown recluse is more frequent in adults than in children.
E. Application of warm compress deactivates the brown recluse venom.

Correct Answer: A. Most symptomatic exposures to tarantulas result from allergic response to its hairs rather than venomous bites.

Both tarantulas and centipedes have "urticating hairs" that may cause severe allergic reactions. Though not true hairs, as hair only grows in mammals, tarantulas grow hairlike bristles that are highly irritating. Exposure may occur passively, but the tarantula may also use these hairs defensively. When threatened, tarantulas may flick or kick these hairs off the body toward a threatening animal. Most commonly, the tarantula pulls a hair off the abdominal area and flicks it using two legs.

These urticating hairs usually cause dermal or ocular symptoms with occasional respiratory symptoms. The urticating hairs are irritants even after the tarantula is dead, and handling a live or dead tarantula may result in symptoms.

The black widow typically has a red hourglass on its black body, while the violin-like pattern on the thorax belongs to the brown recluse spider. The venom is neurotoxic.

Brown recluse spider bites can cause significant cutaneous injury with tissue loss and necrosis. Less frequently, more severe reactions develop, including systemic hemolysis, coagulopathy, renal failure, and, rarely, death.

Brown recluse venom, like many of the other brown spider venoms, is cytotoxic and hemolytic. Systemic involvement, although uncommon, occurs more frequently in children than in adults. Because the activity of sphingomyelinase D (one of the enzymes in its venom) is temperature dependent, application of local cool compresses is helpful and should be continued until progression of the necrotic process appears to have stopped.

Take-Home Message
Urticating hairs are responsible for most of the allergic reactions caused by tarantulas and centipedes.

ABP Content Specification
- Plan the management of bites/stings by type, including scorpions, spiders, ticks, and insects.

Question 18

A 16-year-old boy presents with severe pain in his left foot while out snorkeling. He thinks that he stepped on a fish and has something in his foot. His vital signs are normal. Which of the following statements would BEST describe your initial therapy?

A. Give supplemental oxygen and observe the patient for signs of respiratory failure.
B. Recommended initial therapy is immersion in cold water to soothe the pain.
C. Envenomation stops after the spine is broken off the fish.
D. Ultrasound can detect if the fish spine is still in his foot.
E. Prophylactic antibiotics are recommended.

Correct Answer: D. Ultrasound can detect if the fish spine is still in his foot.

This patient has probably been envenomated by a fish. Although the spines rarely break off into the skin, debridement of loose spines should be undertaken promptly, because retained spines continue to envenomate. Embedded structures should be pulled straight out with forceps to avoid breaking them.

The Scorpaenidae family represents a large array of fish characterized by the ability to envenomate with various types of specialized spines. Potency of the venom is highest in the stonefish, which can be fatal, followed by the scorpionfish and then the lionfish.

The most commonly recommended therapy is immersion in non-scalding hot water (upper limit of 114 °F or 45 ° C) after removal of visible spines and sheath, in order to inactivate the heat-labile components of the venom that might otherwise cause a severe systemic reaction.

With the exception of persons with deep puncture wounds and those who are immunocompromised, prophylactic antibiotics generally are not indicated. Once infection is established, however, prompt therapy must be instituted with emphasis on coverage for potential marine pathogens. Especially in cases where x-ray of the foot shows no abnormality, ultrasound of his foot can very helpful in locating the foreign body.

Take-Home Message

The treatment for exposure to fish from the Scorpaenidae family is similar to that for jellyfish envenomation, that is, to immerse the affected area in non-scalding hot water (about 114 °F) to inactivate the heat labile componets of the venom, and removal of any visible (or sonogram detected) spines.

ABP Content Specification

- Plan the management of acute marine bites, punctures, and envenomation.

Question 19

Three teenagers present to the Emergency Department after having just returned from a camping trip in the desert during a cold winter night. They say they skinned and cooked a wild rabbit, over a portable stove for dinner the night before. They also used the stove to heat the tent. They awoke with headaches, nausea, and malaise they describe as "flu." There is no fever, vomiting, or diarrhea, and they give no significant past medical history. The action that would most likely be helpful in this situation is to:

A. Initiate non-rebreather oxygen therapy and obtain carboxyhemoglobin levels.
B. Do brucellosis titres.
C. Order a CXR to evaluate for anthrax.
D. Expose and examine the skin for rashes and bite marks.
E. Prescribe oseltamivir to each of them and advise to quarantine themselves at home.

Correct Answer: A. Initiate high FiO2 oxygen therapy and obtain carboxyhemoglobin levels.

The most probable diagnosis here would be carbon monoxide poisoning. The clinical presentation of CO poisoning is highly variable, which leads to misdiagnosis in many cases. Clinical scenarios range from that of an unconscious patient pulled from a house fire or from a running car in a closed garage, to the patient with "flu-like" symptoms, or the elderly person presenting with syncope and ischemic ECG changes. Given the lack of any fixed set of signs or symptoms for carbon monoxide poisoning, a strong clinical suspicion remains the best initial method of detection.

Brucellosis may be a systemic or localized infection and has many different possible presentations. When systemic, it occurs after a 1- to 4-week incubation period, after which fever, malaise, arthralgia, myalgia, back pain, headache, and loss of appetite are common. Abdominal pain and cough may be present, and hepatomegaly/splenomegaly also may be part of the clinical picture. It is diagnosed by blood culture, serology, or PCR. Localized brucellosis may involve osteoarticular, genitourinary, pulmonary, neurologic, cardiac, or ophthalmologic symptoms.

Inhalational anthrax has in recent times become a focus of interest due to malicious mailing of anthrax as an act of terrorism in the United States, but inhalational and cutaneous anthrax occur naturally. Particularly in the setting of persons who handle animals, anthrax may occur. Fortunately, it is rare and usually manifests as cutaneous anthrax, which is not typically life-threatening. Inhalational anthrax may cause mediastinal widening, but it is not a consideration in this case.

Oseltamivir may be used to prophylaxis or treat viral infections such as influenza.

Take-Home Message

CO poisoning can present with vague symptoms, and one must have a high index of suspicion. The most important initial therapy for carbon monoxide poisoning is administration of supplemental oxygen.

ABP Content Specification

- Know the common etiologies of fatal or disabling inhalation injuries and carbon monoxide and cyanide poisoning.

Question 20

Which of the following statements is typically TRUE concerning cyanide toxicity?

A. Treatment is with sodium nitroprusside.
B. The poison or the patient may smell like garlic.
C. Oxygen saturation is low.
D. Cherry red skin may be seen.
E. Oral cyanosis is severe.

Correct Answer: D. Cherry red skin may be seen.

Cyanide toxicity, which occurs most commonly after exposure to closed-space fires that release cyanides, results in inhibition of mitochondrial oxidative phosphorylation. The mitochondria cannot use oxygen and, therefore, arterial and venous blood are highly oxygenated; therefore, the skin (in fair skinned persons) is cherry red due to abnormal saturation of venous hemoglobin. Diagnosis is suspected based on syncope, shock, or cardiac arrest after a closed-space fire and is corroborated by elevated serum lactate levels. Elevated lactate results from anaerobic cellular respiration.

Sodium nitroprusside is one of the iatrogenic causes of cyanide toxicity. Cyanide is a component of nitroprusside, and patients on nitroprusside infusions may develop metabolic acidemia and tachycardia. They may decompensate if the infusion is not discontinued and antidote administered.

The typical odor is of bitter almonds, though this is noted in only about 40% of patients exposed to cyanide. Garlic smell is associated with sulfur mustard, heavy metals such as arsenic or arsine gas, and organophosphorus agents.

High, falsely reassuring pulse oximetry occurs as oxygen cannot be effectively used in oxidative phosphorylation, though the blood is saturated with oxygen.

Cyanosis occurs with prolonged respiratory failure and shock, but it is not a typical feature of cyanide poisoning.

Take-Home Message

Cyanide toxicity should be considered in patients after exposure to fire in closed spaces.

ABP Content Specification

- Recognize the signs and symptoms of life-threatening inhalation injuries and carbon monoxide and cyanide poisoning.

Question 21

An 18-year-old male presents complaining of fever and muscle aches. He was diagnosed to have mild acute gastroenteritis four days earlier and given chlorpromazine parenterally and discharged with a prescription for oral use. There is no significant other past medical or drug history. On examination, his vital signs are temperature 101.1 °F (38.4 °C), heart rate 112 beats/minute, respiratory rate 16 breaths/minute, and blood pressure 145/91 mm Hg. He has rigid limbs, and on reassessment a while later, his blood pressure is 168/99 mm Hg with a WBC count of 19,000. The statement which BEST describes your management is:

A. Chlorpromazine should be avoided in the future.
B. His presentation is much more expected to be in the cold winter months.
C. Serum myoglobin levels are characteristically low.
D. No specific medication would be indicated at this time, just discontinuation of antiemetics.
E. Metoclopramide is not associated with this condition.

Correct Answer: A. Chlorpromazine should be avoided in the future.

This patient appears to have neuroleptic malignant syndrome (NMS), which is an idiosyncratic reaction to a neuroleptic medication. NMS involves elevation of body temperature, muscular rigidity, altered mental status, and autonomic dysfunction. Although potent neuroleptics (e.g., haloperidol, fluphenazine) are most commonly associated with NMS, all antipsychotic agents, typical or atypical, may precipitate the syndrome. For example, these agents have been associated with NMS: promethazine (Phenergan®), metaclopropamide (Reglan), prochlorperazine (Compazine®), clozapine (Clozaril®), and risperidone (Risperdal®). After developing NMS, the medication that precipitated it should be avoided in the future. Treatment of NMS includes discontinuing the offending medication, ensuring adequate hydration by giving IV fluids and use of bromocriptine and possibly dantrolene. NMS would be more severe in summer, rather than winter months. Rhabdomyolysis does not frequently occur, but if it does, serum myoglobin levels are elevated. Rhabdomyolysis management includes maintaining vigorous hydration and alkalization of the urine with intravenous NaHCO3 to prevent renal failure.

Take-Home Message
NMS is an idiosyncratic reaction, often to a neuroleptic medication which presents with muscle rigidity, altered mental status, and elevated body temperature. Treatment of NMS includes discontinuing the offending medication, ensuring adequate hydration by giving IV fluids, and use of bromocriptine and possibly dantrolene.

ABP Content Specification
- Differentiate the most common causes of fatal hyperthermia by age group.

Question 22

You have been given the task of educating a group of new residents in your ED. Which of the following management statements below is correct?

A. A jagged teeth-mark wound with very small puncture of the skin over the dorsal fifth MCP joint of the hand should undergo x-ray; if negative, then administration of tetanus booster is the primary treatment.
B. The black widow spider venom causes necrotizing ulceration at the bite area, often requiring skin debridement.
C. A 17-year-old boy with scorpion sting to the hand 5 hours before admission should be observed for another 7–19 hours (so 12–24 hours after envenomation) before discharge.
D. A teenage girl who developed fever, headache, and fatigue plus an expanding circular rash 3 weeks after a camping trip into the forest will require 10-21 days of of doxycycline.

E. The primary consideration in managing a teenage boy with abrasion marks on ankles after feeling scratching across both legs while cave exploration should be evaluation for snakebite.

Correct Answer: D. A teenage girl who developed fever, headache, and fatigue plus an expanding circular rash after camping trip into the forest will require 10-21 days of doxycycline.

The rash described is ECM (erythema chronicum migrans), which is typical of Lyme disease. Oral antibiotics are used unless there is a specific complication such as meningoencephalitis. Doxycycline is recommended for children older than 8 and adults, but amoxicillin may also be used and is often better tolerated. A 14- to 21-day course of antibiotics is usually recommended, but some studies suggest that courses lasting 10 to 14 days are equally effective.

Response A describes a "fight bite" which has a high likelihood for infection. Besides x-ray, the wound should be thoroughly cleaned and the patient treated with prophylactic antibiotics, typically amoxicillin/clavulanic acid.

Response B is incorrect: Black widow envenomation includes muscle cramping, abdominal pain, weakness, and in severe cases, nausea, vomiting, faintness, dizziness, chest pain, and respiratory difficulties. Brown recluse bites, however, cause necrotizing ulceration. It is unclear if black widow antivenom administration is of value in black widow envenomation, and there is no brown recluse antivenom in the United States.

Response C is incorrect because scorpion envenomation does not result in delayed onset of effects; after 5 hours, the patient is not expected to have any exacerbation of symptoms or increase in severity of disease. There are several species of related scorpions in the United States that most commonly cause symptomatic envenomation by stings, but these symptoms are usually limited to local pain in the extremity that is stung. More severe poisoning will also include remote pain and paraesthesia, and the most severe envenomations result in cranial nerve dysfunction such as nystagmus, tongue fasciculation, or slurred speech. Skeletal neuromuscular dysfunction that occurs may include restlessness, fasciculation, involuntary movement of extremities, or opisthotonos.

For Answer E, the primary concern would be treatment for rabies prophylaxis with the presumption that the patient may have been exposed to bats.

For Answer E, numerous cases of rabies presumably contracted from bats occurred with no knowledge of a bite by the victim. Therefore, any exposure with disruption of skin integrity or of patients who have been sleeping in the presence of bats should be treated as a presumed bat bite. Healthcare providers are reminded to take notice of new Advisory Committee on Immunization Practices (ACIP) recommendations for rabies PEP that reduces the number of vaccine doses in the series from 5 to 4 doses. The new recommendations for PEP reduce the number of human rabies vaccine doses to 4 given on days 0, 3, 7, and 14 by eliminating the previously recommended fifth dose on day 28. Human rabies immune globulin (HRIG) continues to be recommended (20 IU/Kg) on day 0 for persons not considered previously immunized for rabies.

Take-Home Message

Lyme disease should be a strong consideration among patients with history of a tick bite in an endemic area and report developing a rash suggestive of ECM, and treatment with antibiotics such as doxycycline and amoxicillin are indicated.

ABP Content Specification

- Recognize the signs and symptoms of complications of bites and stings.

Question 23

You are the team doctor of a mountain climbing expedition. On reaching Camp Zulu 5, a team member complains of dyspnea on exertion. He had been having headaches since the day before after the team left Camp Zulu 4. On examination, he is alert and oriented but short of breath on exertion, and his vital signs are heart rate 130/minute, respiratory rate 20/minute, and oxygen

saturation 70%. He requires assistance to walk because of fatigue, but heel-to-toe walking is normal. There are bibasilar crackles on lung examination, but no peripheral edema detected. Which of the following statements is MOST accurate?

A. Camp Zulu 5 must be at least 6000 ft. above sea level.
B. The patient likely has High Altitude Cerebral Edema (HACE) as his primary medical issue.
C. Use portable hyperbaric chamber to avoid descent.
D. Nifedipine may be used as medical treatment.
E. If he had been regularly taking acetazolamide from base camp, then he should be able to rest in the current location and begin ascent when symptoms resolve.

Correct Answer: D. Nifedipine may be used as medical treatment.

High-altitude illness refers to clinical conditions associated with ascent to high elevations that can cause reduction in partial pressure of oxygen (depending on the degree of elevation) with resultant in hypoxia.

These primarily include HACE and High Altitude Pulmonary Edema (HAPE). Acute Mountain Sickness (AMS) is a mild, commonly encountered illness that may include headache, malaise, anorexia, nausea/vomiting, and difficulty sleeping. Symptoms are usually delayed 6–12 hours after arriving at high altitude, but onset may be as soon as one hour or as late as 24 hours after arrival. Symptoms are typically most severe the first night and then progressively resolve if there is no further ascent while symptomatic. AMS symptoms may be treated or prevented using ibuprofen, acetazolamide, and possibly antiemetics such as ondansetron.

HACE is more severe and rapidly fatal if not treated. Symptoms include encephalopathy, including ataxic gait and progressive decline of mental function and consciousness.

HAPE is an uncommon problem that occurs days after arriving at high altitude, usually 2500 m (8200 feet) or greater. It usually begins with cough and progresses to dyspnea on exertion. Expectoration of frothy pink sputum is expected with pulmonary edema. On examination, crackles and hypoxia are evident. Pulse oximetry is very useful to distinguish HAPE from other altitude-related conditions.

The scenario described above is a very straightforward case of pure HAPE. Besides the overall signs/symptoms and examination, hypoxia detected by pulse oximetry strongly corroborates the diagnosis. HAPE treatment considerations include the following: oxygen, nifedipine, sildenafil, albuterol, and dexamethasone. Hyperbaric treatment also helps to treat the condition, but descent is mandatory in both HAPE and HACE.

Take-Home Message

High-altitude pulmonary edema requires administration of oxygen, immediate descent, and in some cases hyperbaric oxygen and other medications.

ABP Content Specification

- Plan the management of each type of high-altitude illness.

Question 24

While retrieving a football from the bushes, a teenager was bitten by a snake on his right hand. He describes the snake as having red bands bounded by yellow bands. He has no pain or swelling but looks very anxious. Which of the following would best describe your management?

A. Irrigate bite wound, apply a venous pressure tourniquet, use sterile suction catheter to remove venom, and administer anti-tetanus toxoid and antibiotics.
B. Prepare Crotalidae polyvalent immune fab ovine (CroFab) antivenin to administer if any signs or symptoms of envenomation appear.

C. Observe in short stay unit for 6 hours, and if asymptomatic, discharge.
D. Locate and prepare for use of coral snake antivenom.
E. Do elective intubation and prophylactic ventilation in anticipation of respiratory paralysis.

Correct Answer: D. Locate and prepare for use of coral snake antivenom.

Coral snake venom is neurotoxic and may result in paralysis and apnea. Onset of symptoms may be late, as late as 24 hours. The coral snake antivenom stock in the United States is extremely low, making decisions regarding antivenom use difficult. Generally, if a patient has symptoms after coral snake envenomation, then antivenom administration is recommended. Some clinicians advocate the use of antivenom for any credible coral snake bite, though that is not universal. In this situation, determining the location of and preparation for the possible need of antivenom is recommended. Usually, contacting your local poison control center is the most appropriate first step.

Coral snakes have a characteristic band pattern for which there are several mnemonics: Red touches black venom lack, red touches yellow, kills a fellow. Basically, red/yellow band contact is specific to coral snakes. In the United States, coral snakes are primarily dominant in the South, including Florida, Arizona, Texas, and California, but they exist throughout the Americas as well as in Asia and Southern Africa.

Option A is incorrect as venous tourniquets and suction are not advised. Although devices such as a Sawyer extractor are sometimes used in the field, but found to be ineffective and should be avoided.

CroFab is a Fab antibody for crotalids, which include rattlesnakes, cottonmouths, and copperheads. It is typically administered based on symptomatology.

Answer E is completely inappropriate. A detailed neurologic examination done every 1–2 hours is recommended to detect the onset of neurotoxicity and paralysis, but elective intubation is not a consideration in the scenario described.

Take-Home Message
Coral snake venom is neurotoxic and can cause paralysis and apnea, and antivenom should be strongly considered for those with progressive neurological symptoms.

ABP Content Specification
- Plan the management of snake envenomation.

Question 25

EMS brings in an school boy who was trapped in a burning factory during a school trip. The patient is unconscious. Initial laboratory investigations reveal an arterial blood gas of pH 7.01, PCO_2 28, PO_2 250, carboxyhemoglobin level is 10%, and lactate is 12 mmoL/L. The statement which BEST describes appropriate management is:

A. Hyperbaric oxygen therapy will improve his clinical status.
B. Increased arteriovenous oxygen saturation difference (>10%) almost confirms the diagnosis.
C. He requires immediate and large doses of sodium nitroprusside.
D. Presence of neurological signs requires immediate MRI assessment.
E. Give hydroxycobalamin and/or sodium thiosulphate immediately.

Correct Answer: E. Give hydroxycobalamin and/or sodium thiosulfate immediately.

This patient has cyanide poisoning resulting from being in a closed-space fire. He requires immediate treatment with cyanide antidote, which may be hydroxycobalamin (Cyanokit) or the older Lilly Cyanide Antidote kit. Cyanide is released from numerous cyanogenic compounds such as plastics and clothing that are typically consumed in closed space fires. There are numerous labora-

tory indicators that can be considered highly suggestive or even pathognomonic of cyanide poisoning. Because cyanide blocks oxidative phosphorylation, oxygen will not be consumed normally, and a lactic acidemia will develop. A serum lactate level greater than 10 mmoL/L, irrespective of the percentage of body surface area burn or carboxyhemoglobin level, should be considered diagnostic of cyanide poisoning. Increased pO2 resulting from inability of the mitochondria to use oxygen appropriately is highly suggestive of cyanide poisoning, and comparison of an arterial and venous blood gas drawn at the same time may be used for this purpose. A low methemoglobin level is also suggestive of cyanide poisoning, due to cyanide binding with methemoglobin to form cyanomethemoglobin.

Treatment of cyanide poisoning may be carried out using hydroxycobalamin, which directly binds cyanide. There are few significant side effects, but the orange/red hue of this medication will derange pulse oximetry readings, so this scenario must be taken into consideration. A Lilly antidote kit includes sodium nitrite, sodium nitroprusside, and sodium thiosulfate. The nitrates are administered to develop methemoglobinemia. Their use in fire victims is controversial because methemoglobin does not carry oxygen; in cases of carbon monoxide poisoning, there is great concern that use of nitrates will further reduce oxygen carrying capacity of the blood. It is common for poison control centers or toxicologists to recommend empirical use of sodium thiosulfate alone without the nitrate portions of the kit in patients who have been in a closed space fire. Sodium thiosulfate has no effect on oxygen carrying capacity of the blood and has few side effects; therefore, it is considered very safe. Thiosulfate binds cyanide to form thiocyanate, and it is excreted.

Response B is incorrect. A difference of <10%, not >10%, would be indicative of lack of oxygen extraction between arterial and venous blood.

Response C is incorrect because large doses of nitroprusside would simply induce methemoglobin, which would decrease the oxygen carrying capacity of blood and likely cause severe hypotension.

Response D is incorrect. MRI may be used in inpatients with carbon monoxide poisoning to determine injury to specific areas of the brain, but there is no role for this method in the emergency department.

Take-Home Message

Serum lactate levels in cyanide poisoning can be very high (>10 mmol/L). The antidote for cyanide toxicity is sodium thiosulfate and hydroxycobalamin, both directly bind to cyanide.

ABP Content Specification

- Plan the management of inhalation injuries and carbon monoxide and cyanide poisonings, and know the indications for hyperbaric oxygen therapy.

Question 26

Which of the following concerning electrical injuries is CORRECT?

A. Alternating current has a higher predisposition to ventricular fibrillation than direct current.
B. Compartment syndrome occurs in high-voltage shocks of long duration, typically >5 seconds.
C. Even for low-voltage injury, admission for cardiac monitoring is necessary regardless of initial ECG.
D. CK-MB level is more specific for cardiac injury than skeletal muscle injury from electrical injury.
E. In managing rhabdomyolysis, maintenance fluids should be administered.

Correct Answer: A. Alternating current has a higher predisposition to ventricular fibrillation than direct current

Standard household electricity is AC. Electricity in batteries and lightning is DC. Low-frequency (50 to 60 Hz) AC can be more dangerous than similar levels of DC because the alternating current fluctuations can result in

ventricular fibrillation. The identification of electric shock as due to AC or DC is also important to reconstruct the mechanism of injury. AC current can produce tetany, and if this is involved in a hand grasping an electrified object, then the victim cannot let go of the electrical source. Both AC and DC current can hurl the victim away from the current source, which results in severe blunt force injury.

Patients with high-voltage shocks are at significant risk for development of compartment syndrome, even if the contact (or arcing) lasted <1 second. Compartment syndrome has also been noted in patients with injuries from 120-V AC or higher, who sustain contact for longer than a few seconds. Patients typically exhibit ongoing muscle pain with movement.

Cardiac arrhythmias can be treated according to accepted ALS guidelines. ED cardiac monitoring should be instituted for patients with high-voltage injuries and all symptomatic patients. Cardiac complications are more common in patients with high-voltage injuries and in those with loss of consciousness and include ventricular and atrial dysrhythmias, bradydysrhythmias, and QT-interval prolongation. Admission for cardiac monitoring is not needed for asymptomatic patients with normal ECG on presentation after a low-voltage electrical injury.

Elevation of creatine kinase MB isoenzyme in the face of electrical injury correlates more strongly with skeletal muscle injury than with cardiac injury and is therefore not helpful in determining the extent of cardiac damage. Patients should be monitored for the onset of compartment syndrome, rhabdomyolysis, and renal failure.

If myoglobinuria is suspected, then aggressive IV fluid resuscitation to maintain a urinary output of between 1 and 2 mL/kg/h and correction and prevention of electrolyte abnormalities with sodium bicarbonate and mannitol therapy should be initiated. Lack of large randomized controlled studies concerning the benefits of bicarbonate therapy makes it difficult to make strong recommendations for or against its use in the treatment of rhabdomyolysis. Initial IV rate in the adult is up to 1.5 L/h (more if there is hypotension or obvious blood loss). Maintain a high urine output until serum creatine kinase level is less 1000u/L or urine myoglobin measurements return to normal.

Take-Home Message
AC current has higher predisposition to cause tetany and ventricular fibrillation.

ABP Content Specification
- Plan the management of pediatric patients with electrical injuries.

Question 27

Concerning management of burn patients, which of the following is correct?

A. Circumferential neck burns without signs of inhalational injury is an absolute indication for definitive airway (endotracheal intubation).
B. The half-life of carbon monoxide in smoke inhalation is reduced to approximately 1 hour with 100% oxygen therapy at 1 atmospheric pressure.
C. A burn causing painful erythema but no blisters requires analgesics and IV fluid therapy.
D. In small children <30 kg, fluid therapy should be carefully controlled with non-glucose solutions to achieve urine output of 0.5 ml/kg/hr.
E. Major thermal burns (>10% BSA) which are painful will benefit from the analgesic effect of cold sterile water application.

Correct Answer: B. Half-life of carbon monoxide in smoke inhalation is reduced to approximately 1 hour with 100% oxygen therapy at 1 atmospheric pressure.

Circumferential neck burns can compromise the airway rapidly from edema and thus MAY require early ETT, regardless of inhalational inju-

ries; however, a circumferential burn is not an absolute indication for endotracheal intubation. Carbon monoxide has approximately 240× more affinity for Hb than oxygen. On room air, the approximate carboxyhemoglobin half-life is 4 hours, which decreases to 1 hour on 100% oxygen. This half-life further decreases to approximately 30 minutes in hyperbaric oxygen (3 atm).

First-degree burns (sunburn) do not have loss of the skin barrier; and hence, do not need IV fluids. Small children (<30 kg) will require maintenance fluid therapy containing glucose in addition to the fluids calculated based on the percentage of burn to sufficiently produce UO of at least 1.0 ml/kg/hr. Cold water should be avoided in extensive burns (>10%) to avoid hypothermia.

Take-Home Message

The half-life of carboxyhemoglobin is affected by the concentration of inhaled oxygen, hyperbaric oxygen causes the steepest decline, followed by 100% oxygen, both of which are standard therapeutic interventions based on carboxyhemoglobin levels.

ABP Content Specification

- Plan the management of inhalation injuries and carbon monoxide and cyanide poisonings, and know the indications for hyperbaric oxygen therapy.

Question 28

During a summer marathon event, an otherwise healthy young teenager who has been drinking Red Bull containing caffeine and taurine presents having fainted toward the end of the race. He complains of a bad headache, is confused, and has dry skin. His vitals are as follows: HR 138/min, BP 92/46 mmHg, RR 28/min, T 40.8 °C, and SpO_2 96%. No other abnormal clinical findings are noted. Your management would BEST follow treatment protocols for which of the following:

A. Heat exhaustion
B. Heat stroke
C. Rhabdomyolysis
D. Stimulant toxicity
E. Severe dehydration

Correct Answer: B. Heat stroke

What is described in this scenario is heat stroke. Heat stroke is defined as a core temperature ≥ 40 °C (104 °F) accompanied by central nervous system dysfunction in patients with environmental heat exposure. Absence of sweating is common, though not part of the diagnostic criteria. Heat stroke may be further differentiated as classic versus non-exertional and exertional heat stroke. The scenario described here is exertional heat stroke.

Other heat-related illnesses include the following:

- Heat exhaustion is a milder problem associated with heat exposure and body temperature less than 40 °C (104 °F). Additional symptoms may include tachycardia, sweating (typically absent in heat stroke), headache, nausea/vomiting, dizziness/syncope, and confusion. There is some overlap between heat exhaustion and heat stroke. If there is any doubt as to which condition is present, then it should always be presumed that it is heat stroke and managed accordingly, due to the high morbidity and mortality.
- Heat syncope is dizziness, orthostatic hypotension, and syncope that occur in patients with heat-related peripheral vasodilation and venous pooling. Syncope often occurs in patients who remain standing after significant exertion or who rapidly change position during exertion. These patients have a normal core body temperature and a rapid return to normal mental status once they are supine.
- Heat cramp is painful muscular cramping that may occur during or after exertion in hot environments. Cramping commonly involves the large muscle groups of the legs, abdomen, or arms. Patients may have a normal or elevated core body temperature that does not exceed 40 °C (104 °F).

Rhabdomyolysis could occur with any intense sports such as marathon running, but it would be

suspected based on symptoms of myalgias, serum and urinary findings. If there were a clinical scenario involving muscle pain, then one would also consider the possibility of rhabdomyolysis.

Stimulant toxicity could cause confusion, tachycardia, and elevated temperature, but would likely cause a widened pulse pressure. It is a likely contributor to the development of heat stroke, but in itself is unlikely to cause such an elevated temperature. Furthermore, the treatment would be primarily supportive care.

The clinical scenario above is not expected to result from severe dehydration, though dehydration may be an associated problem.

Take-Home Message
Sweating is often absent in heat stroke but present in heat exhaustion.

ABP Content Specification
- Differentiate the most common causes of life-threatening hyperthermia in children.

Question 29

Which one of the following types of radiation is LEAST likely to cause radiation sickness?

A. Alpha
B. Beta
C. Neutron
D. X-ray
E. Gamma

Correct Answer: A. Alpha

Alpha radiation possesses a significant biological hazard only when internalized. Alpha particles are very weak. Alpha radiation is easily shielded and cannot penetrate paper or the keratin layer of the skin.

Beta particles can cause significant skin burns and, such as alpha particles, are hazardous if internally deposited, but beta particles are easily blocked by clothing. Neutron radiation, gamma radiation, and x-rays all pose significant whole-body irradiation hazards.

Take-Home Message
Alpha particles are least likely to cause radiation sickness unless internalized.

ABP Content Specification
- Plan Emergency Department preparation, healthcare worker protection, and patient decontamination in radiation exposure.

Question 30

You are the emergency physician of a medical mobile team, responding to an incident of a bomb explosion at the city mall. Which of the following statements is true?

A. Safety of trapped victims is the topmost priority during the evacuation process.
B. Permission for entrance into the hot zone is the prerogative of the medical staff.
C. Incident Command Centers are established for each agency independently.
D. Usual cell phone use is encouraged to facilitate communications.
E. There may be a mixture of both trauma and medical emergencies.

Correct Answer: E. There may be a mixture of both trauma and medical emergencies

In any disaster response, the safety and welfare of the rescuers is always the topmost priority, followed by that of the survivors and the surrounding people. A bomb explosion usually demands special bomb disposal squads from the military, hence, their authority to advise other agencies on issues of security and safety. Incident command centers (as part of the IC System) are standards of disaster response management and should be within agencies and between them. As in any radio-communication practice, call signs and codes are utilized to facilitate communications. A bomb explosion is anticipated to cause cases of blast lung, burns, ruptured globe, or tympanic membrane and also possibly angina or myocardial infarct, exacerbation of asthma, COPD, smoke inhalation, etc.

Take-Home Message
In mass disaster scenarios, it is important to anticipate both trauma and medical emergencies.

ABP Content Specification
- Plan Emergency Department preparation for mass casualty incidents.

Question 31

A 17-year-old boy presents to your Emergency Department after being found obtunded. In his workup, a brain CT is done; bilateral globus pallidus low-density lesions are reported. What MOST likely diagnostic possibilities would you consider?

A. Methanol, hydrogen sulfide, or CO poisoning
B. CO_2 poisoning
C. Chlorine gas poisoning
D. Ethanol or ethylene glycol poisoning
E. Methane or butane gas toxicity

Correct Answer: A. Methanol, hydrogen sulfide, or CO poisoning

CT of the brain in patients with severe CO exposure may show signs of cerebral infarction secondary to hypoxia, ischemia, and hypotension. However, a well-reported finding is bilateral globus pallidus low-density lesions. The development of this lesion has been correlated with low local blood flow to the globus pallidus, metabolic acidosis, and hypotension during CO poisoning in animal models. Globus pallidus lesions may be delayed several days after initial presentation and may resolve with time. Concomitant white matter lesions also may be seen. Although globus pallidus lesions are not pathognomonic for CO poisoning and may be seen in other intoxications, such as methanol or hydrogen sulfide poisoning, their presence should alert the clinician to the possibility of CO exposure. MRI in patients with CO exposure may show diffuse, symmetric white matter lesions, predominantly in the periventricular areas, although the centrum semiovale, deep subcortical white matter, thalamus, basal ganglia, and hippocampus also may be affected.

Take-Home Message
Globus pallidus low-density lesions seen on CT head often suggest CO poisoning.

ABP Content Specification
- Understand the pathophysiology of inhalation injuries and carbon monoxide and cyanide poisoning in infants and young children.

Question 32

You have been recruited to be on your hospital's emergency response team for radiation disasters in the city. Apart from individual exposure time and presence of intervening shielding, what other factor is most important in determining the radiation dose received?

A. Season of the year
B. Activity of the individual during exposure
C. Presence of comorbidities
D. Distance from the source
E. The age of the patient

Correct Answer: D. Distance from the source

The individual's exposure time, any intervening shielding, and distance from the source are most important in determining the dose of radiation received. The other factors may influence the effect of the exposure to a small degree; these factors may include what sort of clothing is worn and duration of exposure due to what they are doing at the time and what tissues are most sensitive.

Take-Home Message
An individual's radiation exposure time along with actual distance from the radiation are the most important determinants of radiation dose received.

ABP Content Specification
- Plan Emergency Department preparation, healthcare worker protection, and patient decontamination in radiation exposure.

Question 33

A teenager presents to the Emergency Department with a swollen painful left lower leg, aggravated on walking. His vital signs are temperature 36 °C (Oral), heart rate 99 beats/minute, respiratory rate 20 breaths/minute, blood pressure 104/51 mm Hg, and oxygen saturation 100% on room air. The lower leg is tender to palpation, and passive movements inflict further pain. Intra-compartmental pressure registers 45 mmHg on the Stryker™ device. After starting a normal saline bolus, which of the following statements BEST describes your management?

A. If the compartment syndrome is due to snakebite, then fasciotomy might not prevent myonecrosis.
B. His measured intra-compartmental pressure is NOT a strong indication for fasciotomy.
C. Mannitol should be initiated early as an evidenced-based treatment for compartment syndrome.
D. Administer strong analgesics and elevate his leg for pain relief.
E. Supplemental oxygen therapy will be redundant given his pulse oximetry reading.

Correct Answer: A. If the compartment syndrome is due to snakebite, then fasciotomy might not prevent myonecrosis.

It appears that myonecrosis associated with compartment syndrome after envenomation is multifactorial and that fasciotomy may not prevent myonecrosis. Myonecrosis is thought to be due to a direct toxic effect of the venom and the inflammatory response. Therefore, these patients should be aggressively treated with antivenom if available because this method has been shown to decrease limb hypoperfusion.

Compartment pressures of 30 mmHb are typically considered to be the appropriate threshold for performing fasciotomy, and in this case the pressure is high enough to warrant fasciotomy. There is some evidence that mannitol may be useful in treating compartment syndrome, but this remedy is not definitive, and mannitol is not a standard component in treatment of compartment syndrome. Elevation of the legs will not decrease intra-compartmental pressure, but will work to decrease perfusion pressure. Supplemental oxygen is indicated in treatment of compartment syndrome, as is IV fluid therapy.

Take-Home Message
The mechanism for compartment syndrome after snake bite is multifactorial, and fasciotomy alone may not prevent myonecrosis.

ABP Content Specification
- Plan the management of snake envenomation.

Question 34

A 13-year-old boy is winter camping with his family when he is caught in a blizzard and gets lost. He is rescued the next day, found wandering in subzero temperatures. He is brought to the Emergency Department where he complains of foot numbness. The toes on both feet are dry and appear pale and waxy with mild swelling. He has sensation over the dorsum of both feet but not at the toes.

What is true regarding this condition?

A. Does not require actual tissue freezing to occur.
B. Most common presenting symptom is pain.
C. Tetanus booster is not required.
D. Requires rapid rewarming by immersion in warm water.
E. Presence of hemorrhagic blebs would be reassuring.

Correct Answer: D. requires rapid rewarming by immersion in warm water.

Frost bite occurs when tissues are exposed to subfreezing temperatures and ice crystals form, resulting in cellular damage and microvascular thrombosis. A common symptom is numbness and a “dead weight” feeling of hands or feet. Clear vesicles can form early and are similar to second-degree burns involving the dermis.

Hemorrhagic blebs develop late and indicate subdermal vascular injury, akin to third-degree burns and associated with poorer outcome. The treatment is rapid rewarming with warm water immersion, which will result in hyperemia, edema, and pain. After rewarming, frostbite is treated like a burn with elevation and sterile dressings. Clear vesicles can be debrided to prevent thromboxane-mediated tissue injury. Hemorrhagic blisters should be left intact to reduce risk of infection. Tetanus booster should be given if not up to date.

Take-Home Message
Treatment of frostbite is to rapidly rewarm the affected extremity with warm water immersion.

ABP Content Specification
- Plan the management of local hypothermia.

Question 35

A group of children got into a construction site, and one of them presents to the ED after getting hot tar spilled on his right arm. The safety manger on the scene immersed his arm in a pail of cold water. The tar is currently solidified and cool. Which of the following do you want to use to remove the tar?

A. Naphthalene (aromatic hydrocarbon)
B. Normal saline
C. Viscous lidocaine
D. Bacitracin ointment
E. None, to prevent further injury

Correct Answer: D. Bacitracin ointment

Hot tar burns should be managed by first using cold water until the tar is hardened and cool. The tar should then be removed to prevent bacterial growth at the site of injured skin. Organic solvents can theoretically be useful for this purpose, but can be systemically absorbed and cause their own ill effects. Bacitracin ointment does not cause systemic or local toxicity but allows for tar removal due to its petrolatum ointment component, while also providing antibacterial effects.

Normal saline will not assist in removing tar and neither will viscous lidocaine.

Take-Home Message
Hot tar burns should be managed by first using cold water until the tar is hardened and cool and then application of bacitracin that facilitates removal.

ABP Content Specification
- Plan the acute management of burns.

Question 36

A 17-year-old boy complains of pain and swelling in his right hand and forearm, perioral numbness, and vomiting after being bitten by a rattlesnake. His vital signs are temperature 36.2 °C (oral), heart rate 112 beats/minute, respiratory rate 20 breaths/minute, blood pressure BP 90/61 mm Hg, RR 20, and oxygen saturation 98% on room air. His arm looks swollen with numbness up to the elbow and finger movements aggravated by pain, but pulses are intact and equal. At this stage, you would manage him with the following:

A. Maintenance fluids
B. Administration of 10 vials of antivenom
C. Measurement of electrolytes
D. Urgent fasciotomy of the hand and forearm
E. Supplemental oxygen

Correct Answer: B. Administration of 10 vials of antivenin

The mainstay of treatment after rattlesnake bites is neutralization of the venom with antivenin. Large amounts of antivenin may be required. Crotalid antivenom currently used in the United States is CroFab, which is a Fab product that does not cause any anaphylactic reaction and is very safe. Coagulation factors and platelets should be checked in all snakebite victims to help determine the severity of envenomation, but electrolytes are not expected to be altered. Supportive care, including fluid resuscitation, is important

for all patients with pit viper envenomation. If compartment syndrome is suspected, then pressures should be measured. In this case, there is some concern about a condition that may be developing into compartment syndrome, but no measurement of compartment pressures has taken place; at this point, there is no diagnosis of compartment syndrome.

Ideally, fasciotomy should be performed when compartment pressures remain above 30 mm Hg *AND* after "failed" medical treatment. Though some toxicologists and emergency physicians prefer treatment with antivenom as first-line therapy for compartment syndrome associated with rattlesnake envenomation, medical treatment alone without fasciotomy is not standard of care. In this case, it is irrelevant because the patient does not have compartment syndrome.

Take-Home Message

Crotalid antivenom (CroFab) is an effective and safe antidote for bites from rattlesnakes.

ABP Content Specification

- Plan the management of snake envenomation.

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Asthma and Other Emergencies Treated Medically

5

Khalid Al Ansari and R. J. Hoffman

Question 1

While receiving an intravenous (IV) dose of ceftriaxone, a 5-year-old girl with sickle cell disease and fever develops rash, wheezing, and laryngospasm with an episode of vomiting. Which is the most important immediate action to take?

A. Order epinephrine for prompt IV administration.
B. Discuss with the patient's mother that a medication error has occurred, what you expect the possible adverse effects to be, and answer any questions she may have.
C. Discontinue the IV infusion of ceftriaxone.
D. Administer IM epinephrine in a dose of 0.01 mg/kg.
E. Advise the nurse to begin giving standard oral medications for allergy, including diphenhydramine, famotidine, and dexamethasone.

Correct Answer: C. Discontinue the IV infusion of ceftriaxone

The patient has developed an anaphylactic reaction to ceftriaxone. Anaphylaxis is an Ig-E-mediated reaction. It should be considered when any of the following three criteria exists.

1. Acute onset of an illness (minutes to hours) involving skin/mucosa and either respiratory compromise or hypotension (associated symptoms)
2. Two or more of the following that occur rapidly after exposure (minutes to hours) to a likely allergen for that patient: skin/mucosal involvement, respiratory compromise, hypotension and associated symptoms, and persistent gastrointestinal symptoms
3. Hypotension after exposure to known allergen for that patient (minutes to hours)

This reaction can be severe, progress to anaphylactic shock, and even be fatal. The first critical action is to immediately discontinue administration of the agent (drug) causing this reaction. Initial management priorities should include the following:

- Ensuring a patent airway and adequate oxygenation
- Establishing of IV access for circulatory support
- Early administration of epinephrine

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_5

Epinephrine is the drug of choice for anaphylaxis, and it should be administered immediately. The recommended dose is 0.01 mg/kg (1:1,000 solution, now this concentration is referred to as 1 mg/ml) intramuscularly, with a minimum of 0.1 mg/dose and a maximum of 0.3 mg/dose. This process can be repeated every 5–10 minutes depending upon the response.

It has both α_1- and β-receptor agonist properties.

- The α_1-receptor stimulation decreases mucosal edema.
- The β1-receptor stimulation increases heart rate and myocardial contractility.
- The β_2-receptor stimulation results in bronchodilation and reduces further mediator release.

IV administration is not the first-line route for epinephrine in the absence of cardiovascular compromise or collapse. Intramuscular administration is preferred over the subcutaneous as it provides higher, more consistent, and more rapid peak blood epinephrine levels. H_1 and H_2 blockers and corticosteroids are considered second-line therapy.

Take-Home Message

Recognize that immediate removal of the offending agent is important in an anaphylactic reaction. Epinephrine is the treatment of choice for anaphylaxis.

ABP Content Specification

- Recognize the signs and symptoms of hypersensitivity.
- Know the appropriate treatment regimen and appropriate order of medications to be administered under each circumstance.

Question 2

A 14-year-old African-American asthmatic boy presents to the pediatric emergency department due to severe dyspnea, coughing, and wheezing that began 6 hours earlier. Prior to these symptoms, the boy had been experiencing URI symptoms with fever. He has previously been prescribed metered-dose inhalers for albuterol and fluticasone along with a spacer.

At the time of presentation, the patient is able to speak in sentences and appears to have labored breathing. His vital signs are as follows: temperature 99 °F, heart rate 120 beasts/minute, respiratory rate 24 breaths/minute, blood pressure 110/74 mmHg, and oxygen saturation 94% on room air. He has mild retractions, decreased air entry bilaterally, and minimal wheeze. Based on this, you determine the patient is having a moderate (not life threatening) asthma exacerbation and begin therapy. Which of the following would be *inappropriate* as part of your initial treatment of this patient?

A. Oral prednisone
B. Nebulized ipratropium
C. IV magnesium sulfate
D. Nebulized albuterol
E. Subcutaneous terbutaline

Correct Answer: C. IV magnesium sulfate

The NAEPP (National Asthma Education and Prevention Program) recommends magnesium sulfate for severe exacerbations that have not responded to standard treatments. Magnesium sulfate is recommended as an add-on for severe asthma exacerbation, but as described the patient was not having a life-threatening attack. Magnesium relaxes bronchial smooth muscle. The mechanisms include calcium channel-blocking properties, inhibition of cholinergic neuromuscular transmission, stabilization of mast cells, and others. The potential side effects of magnesium infusion are dose related. They include warmth, flushing, sweating, vomiting, muscle weakness and loss of deep tendon reflexes, and hypotension. Therefore, when administered, blood pressure and deep tendon reflexes should be monitored.

Albuterol should be used as the first-line bronchodilator. In the absence of good air movement as described, subcutaneous terbutaline can be used as initial bronchodilator.

Ipratropium bromide is an anticholinergic agent, which can be mixed with albuterol in the

same nebulizer treatment and has been shown to reduce hospital admissions from the ED. It is not very effective for acute asthma exacerbation when used alone.

If given orally and tolerated, then oral prednisone is just as good as IV solumedrol. Dexamethasone has a higher potency and longer half-life. The biologic half-life of dexamethasone at 36 to 54 hours compared to biologic half-life of prednisolone is approximately 12 to 36 hours. Its anti-inflammatory potency is 25 times compared to cortisol. A single dose of oral dexamethasone 0.6 mg/kg has shown a comparable result to a 5 days course of prednisone in children with mild to moderate asthma exacerbation.

Take-Home Message

B_2 agonists and steroids are the initial treatment of choice, and magnesium sulfate is indicated for life-threatening asthma and as an adjunct in severe asthma.

ABP Content Specification

- Recognize the signs and symptoms of an acute asthma exacerbation and can differentiate severe exacerbations from those that are life threatening.
- Know the treatment regimen for each type of asthma exacerbation and the optimal delivery method for each medication.

Question 3

A 17-year-old poorly controlled asthmatic is back in your ED for the second time this month. On questioning, you determine he uses albuterol MDI for his asthma attacks "if there is still medicine in the pump." He has never used a spacer. He takes inhaled steroids only when he begins having an asthma exacerbation and continues to use inhaled steroids for 1 week after his asthma attack resolves. He was also prescribed montelukast as a toddler but was never compliant with this medication. The boy has a history of three to five hospital admissions per year for asthma exacerbations, including five PICU admissions. He has never been intubated for an asthma exacerbation. Currently he has no asthma medications at home. There is cigarette smoking at home, and the boy admits to occasional tobacco use on the weekends.

Which of the following is the most worrisome aspect of this patient's history?

A. Failure to be compliant on montelukast as a child
B. History of smoking cigarettes on weekends
C. Sharing an MDI with another nonrelative asthma patient
D. Failure to keep rescue medications in the home
E. Failure to use a spacer with his MDI

Correct Answer: D. Failure to keep rescue medications in his home

This boy has moderate persistent or severe persistent asthma. Based on his age, and history of PICU admissions, he is at risk for death by an acute asthma exacerbation. Compliance with prescribed inhaled steroids might help prevent asthma exacerbations in this patient, but when he does have an asthma exacerbation, he should promptly begin using rescue albuterol. Montelukast may also help prevent asthma exacerbations, but the effect is not as significant as that of inhaled steroids. His noncompliance on this medication which occurred as a toddler does not affect his current asthma status. Smoking cigarettes is a risk factor for asthma exacerbations. More concerning than the patient's smoking is the history of family smoking in his home.

Sharing an MDI with another patient is not recommended as there is a risk of contracting infectious agent from sharing inhalers, but not a risk factor for a severe asthma attack. Asthmatic patients are at risk if rescue medications are not available and an asthma attack occurs. Of the albuterol, MDI-spacer combination, the MDI is the more important part, because it can be used without a spacer. Lack of spacer use is consistent with other noncompliance frequently seen in adolescents.

Take-Home Message
Lack of compliance to both maintenance and chronic controller medications is a major risk factor in asthma exacerbation.

ABP Content Specification
- Know the risk factors that contribute to acute asthma exacerbations in those with underlying disease, as well as which of those is most likely to be life threatening.

Question 4

While treating a patient in status asthmaticus, which of the following is the most concerning finding that predicts a potential rapid deterioration?

A. A chest X-ray that shows a 10% pneumothorax
B. A chest X-ray that shows a right-sided pleural effusion involving 3 intercostal spaces
C. A white blood cell count of 18,000
D. A venous blood gas PCO_2 of 90 mmHg
E. A serum potassium of 2.8 mEq/L

Correct Answer: D. A venous blood gas PCO_2 of 90 mmHg

All the described investigation findings are abnormal, but the elevated PCO_2 is most concerning for acute deterioration. Since the patient has been tachypneic for several hours, he is now getting exhausted and retaining CO_2. Moreover, because he is tachypneic, one would anticipate his PCO_2 would be lower than 40 mm Hg. This elevated PCO_2 indicates retention and potential respiratory failure. Respiratory failure occurs when ventilation/perfusion mismatch or loss of diffusion capacity is evident. As mismatch worsens, it can cause respiratory failure with hypoxemia, hypercarbia, or both.

Aggressive treatment with continuous albuterol nebulization, parenteral terbutaline or epinephrine, steroids, and IV magnesium sulfate can help. Endotraocheal intubation should be considered, especially if progressive hypercarbia or acidosis manifested with change in mental status is present. Other possible modalities to consider are noninvasive-assisted ventilation such as bilevel positive airway pressure (BiPAP), use of Heliox, or IV ketamine.

BiPAP use is limited to children who weigh greater than 20 kg as smaller children may have difficulty initiating a supported breath and may not adequately synchronize their breathing while on BiPAP. Heliox (helium/oxygen gas mixture) can reduce airway turbulence but is not a good option in patients with significant airway obstruction.

Although 10% pneumothorax is concerning, it is not life threatening and does not require any specific intervention except for monitoring and avoiding invasive ventilation. A pleural effusion on chest X-ray is also concerning and likely the result of a lower respiratory infection. Because it is not a very large effusion, an urgent surgical drainage is not needed.

A white blood cell count of 18,000/mm^3 may be a result of an infection, beta agonist therapy, steroids, or stress response. The low potassium is not indicative of the severity of the asthma exacerbation, but likely a result of albuterol administration and should be corrected.

Take-Home Message
Normal and elevated PCO_2 in blood gas suggest acute respiratory decompensation during an acute asthma exacerbation and require emergent aggressive therapy.

ABP Content Specification
- Be able to clinically identify significant respiratory distress in the patient undergoing treatment for an acute exacerbation of asthma.
- Know which laboratory and/or imaging findings in such a patient should be the immediate cause for concern and which require a conservative approach.

Question 5

In current medical practice, which of the following scenarios are most commonly associated with development of serum sickness?

A. Use of horse-derived rattlesnake antivenom
B. Use of sheep-derived Fab rattlesnake antivenom
C. Use of cephalosporin antibiotics
D. Use of iodine-containing antiseptics such as povidone
E. Use of pig-derived insulin products

Correct Answer: C. Use of cephalosporin antibiotics

Cephalosporin antibiotics particularly Cefaclor are a common cause of serum sickness, primarily due to the widespread use of these medications. Other medications include penicillin, amoxicillin, sulfonamides such as sulfamethoxazole and trimethoprim (Bactrim), thiazides, and aspirin.

Serum sickness is a type III hypersensitivity reaction in which fever, rash, and polyarthritis or polyarthralgia occur after antigen exposure. It usually begins in the first or second week after initiation of the drug and can take many weeks to subside, even after drug withdrawal. Urticaria and morbilliform rashes are the common types of skin eruptions. Originally described in 1905 after patients receiving horse serum to treat diphtheria and scarlet fever, it is now commonly recognized that despite the name "serum sickness," this reaction occurs after exposure to antigens other than animal serum. Because the use of animal serum is quite uncommon, answer A is incorrect.

Fab antivenom would not be expected to cause serum sickness. Though iodine-containing solutions may be associated with anaphylaxis, and a serum sickness-like reaction, it does not cause true serum sickness. Pig- and cow-derived insulin is no longer manufactured in the United States, though they are still available in some other countries. These medications can be a source of local allergic reaction, type 1 hypersensitivity or anaphylaxis, and even a serum sickness-like reaction, but these cases are very rare. Withdrawal of the offending agent is the mainstay of treatment, and anti-inflammatory agents and antihistamines can provide symptomatic relief.

Hypersensitivity reactions are of four types. Type I hypersensitivity reaction, such as anaphylaxis, urticaria, or angioedema, is mediated by mast cell degranulation and the release of histamine. This reaction occurs when initial antigen exposure causes sensitization, and subsequent exposure results in a reaction. Type II hypersensitivity is antibody mediated. IgG or IgM antibodies react with cell antigen, causing complement activation and immune reaction. Examples are autoimmune hemolytic anemia, erythroblastosis fetalis and Goodpasture syndrome. Type III is immune complex-mediated reaction followed by complement activation. Examples are serum sickness and systemic lupus erythematosus. Type IV hypersensitivity reaction is a delayed, cell-mediated reaction in which sensitized T cells encounter an antigen and release lymphokines, which results in macrophage activation. An example of this case is contact dermatitis.

Take-Home Message
Serum sickness is a type III hypersensitivity reaction characterized by fever, rash, and polyarthritis or polyarthralgia after antigen (usually antibiotics) exposure.

ABP Content Specification
- Recognize likely causes for serum sickness.

Question 6

Which of the following symptoms occurring after exposure to an allergen is diagnostic for anaphylaxis and indication for use of an EpiPen?

A. Severe urticaria resulting in scratching with skin bleeding
B. Severe vomiting and diarrhea
C. Sensation of tongue numbness and itching
D. Hypotension without any other findings of anaphylaxis
E. Wheezing without any other findings of anaphylaxis

Correct Answer: D. Hypotension without any other findings of anaphylaxis

Anaphylaxis should be considered in the presence of sudden urticarial rash with respiratory difficulty, abdominal pain, or hypotension. Multiple organ systems need to be involved in the reaction to meet criteria for the diagnosis of anaphylaxis. An exception to this scenario is hypotension. Hypotension alone after allergen exposure is adequate to meet the diagnostic criteria for anaphylaxis.

The widely accepted definition of anaphylaxis, published by the US National Institute of Allergy and Infectious Disease (NIAID), is the following criteria:

1. Acute onset of illness (minutes to hours) within involvement of the skin, mucous membranes, or both (e.g., hives, pruritus, or flushing) and at least one of the following: respiratory compromise, reduced BP, or associated symptoms of end-organ dysfunction.
2. Two or more of the following that occur rapidly after exposure to a likely allergen for that patient: involvement of the skin or mucosal tissue, respiratory compromise, reduced BP or associated symptoms, persistent GI symptoms.
3. Reduced BP following exposure to a known allergen for that patient: infants and children low systolic BP or >30% decrease from baseline, adult systolic BP <90 mmHg or >30% decrease from baseline.

Severe urticaria alone is not an indication to give an EpiPen, though epinephrine can certainly improve symptoms of severe urticaria and some clinicians may use it for this purpose. Severe vomiting and diarrhea are not indications to administer epinephrine. Tongue numbness is not a symptom of anaphylaxis. Wheezing without any other findings does not meet the diagnostic criteria for anaphylaxis; therefore, this answer is not correct. Many clinicians choose to use epinephrine in the setting of allergen-induced wheezing, albuterol could also be used, and a corticosteroid would be indicated. If the patient remains hypotensive after the administration of IM epinephrine and adequate volume replacement, then IV epinephrine should be considered.

Angioedema is a similar reaction as urticaria but involves the deeper subcutaneous tissues of the eyelids, lips, tongue, genitals, and dorsum of the hands and feet. It is characterized by edema of the dermis. In this case, special attention should be provided to the airway as there is a potential for airway compromise. If not certain, then treat presumptively as anaphylaxis.

Take-Home Message

Anaphylaxis is an acute illness triggered by an antigen exposure (type 1 IgE mediated) affecting more than one organ system and typically causing respiratory distress and hypotension.

ABP Content Specification

- Know the appropriate treatment of anaphylaxis.

Question 7

Which of the following is the most critical medication to be available for treatment of anaphylactic reactions?

A. Parenteral epinephrine
B. Nebulized albuterol
C. Oral antihistamines
D. Parenteral dexamethasone
E. Oral dexamethasone

Correct Answer: A. Parenteral epinephrine

Epinephrine is the mainstay of treatment for severe anaphylactic reactions and anaphylactic shock. Epinephrine can treat airway compromise,

bronchospasm, and hypotension/shock. Thus, it treats the most severe symptoms of airway, breathing, and circulation. It has both alpha-adrenergic and beta-adrenergic actions. $Alpha_1$-adrenergic stimulation causes vasoconstriction, increases peripheral vascular resistance, and decreases mucosal edema. $Beta_1$-adrenergic stimulation results in increase inotropic and chronotropic cardiac activity. $Beta_2$-adrenergic stimulation also provides stabilization of mast cells and basophils, and it induces bronchodilation.

Other medications may be used more frequently, but epinephrine is the most critical medication to be available and can be lifesaving.

Because histamine is the predominant chemomediator, antihistamines are the most frequently used medication to treat allergic reactions such as urticaria. They are also used in cases of severe anaphylaxis in conjunction with epinephrine.

Albuterol may be given as a nebulized medication to treat wheezing, but it is only used for this indication. Parenteral epinephrine may also be administered to patients experiencing wheezing with other findings of anaphylaxis. Corticosteroids are typically used to treat reactions of moderate or greater severity. The corticosteroids do not have immediate role, and their onset of action typically does not occur for several hours.

Take-Home Message

Epinephrine is a lifesaving agent and should be administered immediately with the onset of anaphylactic symptoms.

ABP Content Specification

- Understand the treatment regimen for anaphylaxis, especially that epinephrine constitutes the mainstay of treatment.

Question 8

Which of the following best describes the mechanism by which magnesium may be helpful to treat an acute exacerbation of asthma?

A. Destabilization of mast cells with increase in mast cell degranulation
B. Relaxation of bronchial smooth muscle
C. Decrease in bronchial secretions and mucus plugging
D. Increase in endogenous catecholamine release
E. Acting as a stimulant for respiratory drive

Correct Answer: B. Relaxation of bronchial smooth muscle

Magnesium sulfate is indicated for the management of acute, very severe, and life-threatening asthma. Magnesium has multifactorial actions. Magnesium is a physiologic calcium antagonist that inhibits calcium uptake and relaxes bronchial smooth muscle. It has been reported that asthmatic patients may have magnesium deficiency and that low magnesium erythrocyte concentrations reflected decreased magnesium stores in patients with bronchial asthma

Magnesium stabilizes mast cells and prevents degranulation, but the answer A describes the opposite effect and is incorrect. Magnesium causes relaxation of bronchial smooth muscle, but not by $beta_2$-adrenergic activity. Instead, magnesium prevents calcium entry into cells and also prevents calcium binding to myosin, resulting in decrease in smooth muscle contraction.

Magnesium sulfate may improve pulmonary function and in appropriate doses has no significant side effect profile. However, it should be avoided in the patients with renal insufficiency. A careful monitoring should be performed for adverse effects such as hypotension, nausea, and flushing. Serious toxicity is rare and includes cardiac arrhythmias, muscle weakness, areflexia, and respiratory depression. Beware that magnesium is not a substitute for standard asthma treatment regimens.

Decrease in bronchial secretions is an effect of anticholinergic agents such as ipratropium and to a lesser extent epinephrine. Albuterol has a more focused effect than epinephrine and also causes relaxation of bronchial smooth muscle by $beta_2$-adrenergic activity. Though not a mainstay in

asthma therapy, ketamine has been studied in the setting of acute asthma, and there is some evidence that it may be useful in severe status asthmaticus by producing endogenous catecholamine release.

Take-Home Message
Magnesium is a smooth muscle relaxant that prevents calcium entry into cells and prevents calcium binding to myosin, opposing smooth muscle contraction.

ABP Content Specification
- Understand the mechanism of action of various medications used to treat acute exacerbations of asthma, especially as it relates to the underlying pathophysiology of the exacerbation itself.

Question 9

Which of the following is the strongest indication to attempt noninvasive ventilation or endotracheal intubation in a patient experiencing an acute exacerbation of asthma?

A. The patient complains of increasing chest pain.
B. The patient goes from moderate wheeze and subcostal retractions to having nasal flaring, suprasternal, and intercostal retractions.
C. The patient starts to wheeze loudly after several treatments.
D. The patient progresses from having an end-tidal CO_2 of 28 cm H_2O to an $EtCO_2$ of 38 cm H_2O.
E. The patient goes from being awake to sleeping over a 1-hour period.

Correct Answer: B. The patient deteriorates from having only moderate wheeze and subcostal retractions to having nasal flaring, suprasternal, and intercostal retractions.

Noninvasive ventilation, primarily BiPAP, or bilevel positive airway pressure, may be used in patients needing ventilator support, but not yet requiring endotracheal intubation. Its place in the treatment of asthma exacerbations is not fully defined, but may be used to try and avert intubation.

Of the answers listed, answer B is the most concerning. This patient has severe distress and increase in work of breathing. Noninvasive ventilation could be appropriate in this patient. Chest pain is a nonspecific finding in asthma and is not indicative of deterioration or respiratory failure.

A silent or quiet chest may be a finding associated with severe bronchospasm, and progression to severe wheeze from having minimal wheeze is usually the result of improvement in bronchospasm. Likewise, increase in $EtCO_2$ might be associated with worsening of bronchospasm and respiratory failure, but it also might be associated with normalization of respiratory rate and relief of bronchospasm. Therefore, more evidence would be needed before concluding that the patient was deteriorating.

Finally, going to sleep might be associated with hypercarbia, but more commonly is a normal physiologic activity. Inability to wake would be concerning. In such a circumstance, rapid assessment of pulse oximetry, capillary glucose concentration, and, if normal, measurement of the $EtCO_2$ or PCO_2 would be indicated.

Take-Home Message
BiPAP ventilation may help prevent intubation among children with severe worsening asthma exacerbation.

ABP Content Specification
- Recognize the clinical signs and symptoms associated with worsening of an asthma exacerbation, especially those warranted assisted ventilation and measures beyond pure medical management.

Question 10

A 12-year-old African boy is brought to the emergency department by ambulance for a severe asthma attack. His mother reports that he has

developed severe cough and dyspnea over the previous 8 hours and he has not been using any of his controller or reliever asthma medications in the last day.

On presentation he appears to have very labored breathing and speaks only in words or by nodding his head; he cannot speak a full sentence. His vital signs are as follows: temperature is 100.2 °F, heart rate 120 beats/minute, respiratory rate 46 breaths/minute, blood pressure 120/68 mmHg, and oxygen saturation 86% on a nonrebreather mask with oxygen. He blows into an $EtCO_2$ capnograph and has a recorded $EtCO_2$ of 30 mmHg. He has suprasternal, suprasternal, subcostal, and intercostal retractions and abdominal breathing. He has been admitted 14 times for asthma, with six PICU admissions and one endotracheal intubation. He also has severe allergies to many foods including egg and milk and environmental agents, such as pollen and cats. He already received subcutaneous epinephrine, IV methylprednisolone sodium, 3 albuterol, and ipratropium inhalations by paramedics on his way to the hospital. Based on his current findings, you decide the patient requires immediate endotracheal intubation. His medical record indicates that his previous intubations have been difficult, with one failed intubation that required five attempts to pass an endotracheal tube that was ultimately done successfully by a pediatric anesthesiologist.

Which of the following is not an appropriate plan?

A. Rapid sequence intubation with succinylcholine for paralysis and ketamine for sedation
B. Rapid sequence intubation with rocuronium for paralysis and propofol for initial sedation
C. Rapid sequence intubation with vecuronium for paralysis and etomidate for initial sedation
D. Calling for assistance with the intubation by contacting the attending pediatric anesthesiologist who is on call for emergency airway coverage
E. B&C

Correct Answer: E. Rapid sequence intubation with rocuronium for paralysis and propofol for initial sedation and Rapid sequence intubation with vecuronium for paralysis and etomidate for initial sedation.

In this setting, there is no reason to use a long-acting paralytic agent (rocuronium/vecuronium) at the time of intubation if a shorter acting agent (succinylcholine) is available, particularly since this case may be a difficult intubation. Ketamine is preferred for patients with asthma due to its ability to stimulate endogenous catecholamine release and preserve respiratory drive and cardiovascular tone, with normal or elevated heart rate and blood pressure. Propofol should be avoided in this patient since there are other better alternatives, and it is contraindicated in patients with anaphylaxis to egg.

The past history of difficult intubation is a red flag that the current intubation might not be easy and contacting a clinician on call for airway support, such as pediatric anesthesiology, would always be appropriate.

Take-Home Message

It is preferable to use a short-acting paralytic agent or a reversible paralytic agent when faced with difficult airway. Succinylcholine is very short acting and widely available, and rocuronium has fast onset, but is a long-acting paralytic agent. Sugammadex is a reversal agent that can be used to acutely reverse rocuronium-induced paralysis.

ABP Content Specification

- Understand the options for providing a definitive airway in asthma patients with acute distress.
- Know what is likely to be most effective under the given circumstance, especially taking into account the patient's history.

Question 11

Which of the following methods of confirming the endotracheal tube placement has different reliability in patients with asthma exacerbations compared to patients with epiglottitis?

A. Auscultation of breath sounds in the lung fields and none in the epigastric area
B. Chest X-ray confirming endotracheal tube in the trachea
C. CO_2 colorimetric device demonstrating color change
D. Fogging of the endotracheal tube
E. Ultrasound confirmation of the endotracheal tube in the trachea

Correct Answer: C. CO_2 colorimetric device demonstrating correct color change

Capnometry relies on the presence of CO_2 to cause a colorimetric change in its paper. These are generally a highly reliable method to confirm that CO_2-poor and CO_2-rich gas is passing through the capnometer. Patients with CO2-rich gas in the stomach, which could be patients who have recently drank carbonated beverages or patients experiencing hypercapnia and have CO_2-rich gas in the stomach, may have a falsely positive capnometer result.

In this setting, multiple methods to initially confirm the placement clinically, such as auscultation, use of a capnometer, and observation of fogging of the endotracheal tube, should be used.

Fogging of the endotracheal tube is an indicator that moist air is passing through the endotracheal tube. This scenario can be observed with endotracheal and esophageal intubations.

Radiographic confirmation, ideally by chest X-ray, is an excellent method. This should always be done with the understanding that an AP chest X-ray does not definitively confirm tracheal or esophageal intubation. A lateral X-ray would be needed for this case but is not routinely obtained.

Take-Home Message

CO_2 colorimetric device demonstrating correct color change is the most effective way to ensure tracheal intubation.

ABP Content Specification

- Know the various methods for confirming endotracheal tube placement, their limitations, and the best circumstances under which each method is used.

Question 12

Intubation with a 5.5 cuffed endotracheal tube is performed by the pediatric anesthesia fellow. While waiting for a chest X-ray to confirm location and depth of the endotracheal tube, the patient develops hypoxia with the oxygen saturation dropping to 40% and the heart rate dropping to 30 beats/minute. Chest compressions are initiated, and vomitus comes up the endotracheal tube.

What is the most appropriate action?

A. Suction the endotracheal tube, and increase the FiO_2.
B. Suction the endotracheal tube and place a nasogastric tube.
C. Extubate the patient, suction, and provide positive pressure ventilation.
D. Confirm the placement of the endotracheal tube by chest X-ray.
E. Using a laryngoscope, confirm placement of the endotracheal tube.

Correct Answer: C. Extubate the patient, suction, and provide positive pressure ventilation.

Vomitus in the endotracheal tube indicates that that tube is in the esophagus. This patient is demonstrating critical findings of hypoxia, including the low oxygen saturation, and bradycardia, and needs immediate delivery of oxygen to the lungs. Remove the incorrectly placed ET tube, suction the mouth and airway to remove any vomitus, and administer positive pressure ventilation by bag valve mask.

Suctioning the endotracheal tube will be of no benefit, because the primary problem is failure to deliver oxygen-rich gas to the trachea. Confirmation of placement of the endotracheal tube by waiting for an X-ray is useless, and presumption that the tube depth needs adjustment is incorrect. Using a laryngoscope to confirm tube placement could be a correct answer if the patient were not hypoxic and in need of immediate resuscitation.

Take-Home Message

When tracheal intubation is not confirmed and patient is manifesting worsening hypoxia, it is prudent to extubate the endotracheal tube and provide positive pressure ventilation.

ABP Content Specification

- Recognize esophageal intubation and know the steps to take to correct the problem.

Suggested Reading

Question 9

Howell JD. Acute severe asthma exacerbations in children: endotracheal intubation and mechanical ventilation. In: UpToDate, Post TW, editor. UpToDate, Waltham. Accessed on November 20, 2014.

Cardiology

6

Rajesh U. Shenoy

Question 1

A 7-month-old female infant is brought to the Emergency Department. Her parents are concerned about her head appearing swollen. She was discharged from the inpatient unit a week prior to this encounter, after having a successful cavopulmonary anastomosis (Glenn shunt) for single ventricle disease. On examination, the child appears slightly irritable. She is afebrile, her heart rate is 136 beats/minute, respiratory rate is 28 breaths/minute, and transcutaneous oxygen saturation is 88%. Her neck and face appear slightly swollen. There is no pedal edema. On cardiac examination, first and second heart sounds are heard. No murmur is observed. The most likely cause for this patient's clinical findings is:

A. Postoperative atelectasis
B. Superior vena cava syndrome
C. Postoperative renal dysfunction
D. Congestive cardiac failure
E. Drug reaction to antibiotics used in postoperative phase

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Correct Answer: B. Superior vena cava syndrome due to elevated central venous pressure

Superior vena cava syndrome can be iatrogenic and may occur as a complication of a central venous line or cardiac surgery. Patients with single ventricle disease are now successfully palliated in a staged fashion. In many cases, neonatal intervention is followed by a cavopulmonary shunt performed between 4 and 8 months of life. It involves connecting the superior vena cava directly to the right (frequently) or left pulmonary artery (in cases of bilateral superior vena cavae, each is anastomosed to its ipsilateral branch pulmonary artery). Following the repair, the superior vena cava now faces the slightly higher pressure in the branch pulmonary artery. This results in increased cerebral venous pressure, which might cause irritability in the patient. When the pressure in the pulmonary artery is high, there can be swelling of the face and the neck. This might also be the result of any obstruction in the venous system, as seen with thrombosis. Whenever superior vena cava syndrome is suspected, a thrombus in the venous system should always be excluded.

The patient in this vignette is afebrile and does not manifest any respiratory distress. A saturation of 88% is expected following a Glenn shunt. Thus, there is no supportive evidence for postoperative atelectasis. Postoperative renal dysfunction is unlikely to manifest for the first

M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_6

time this late after surgical intervention. The edema is localized to the face and neck. This onset would rule out renal dysfunction and congestive cardiac failure. An anaphylactic reaction to the use of drugs is also unlikely to manifest for the first time this late after the intervention.

Take-Home Message
Unilateral swelling of the face, neck, and chest following a Glenn shunt should always raise the suspicion of superior vena cava syndrome that results from obstruction to the venous circulation or increased venous pressure. In addition to obstruction due to thrombosis, extrinsic compression due to tumors and fungal infections should be considered.

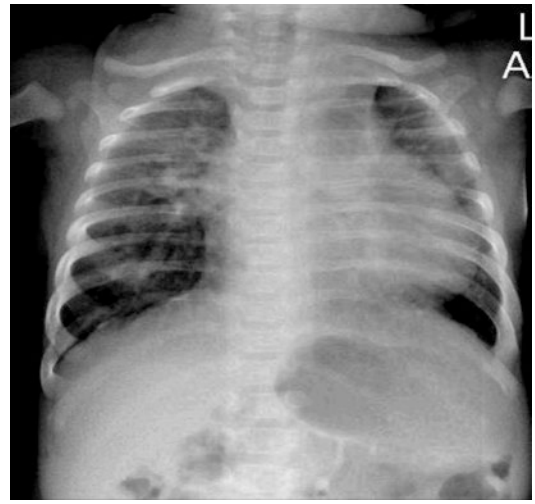
ABP Content Specification
- Evaluation of edema.

Question 2

The parents of a two-week old girl are concerned about her breathing. She was born at full term by a normal vaginal delivery and discharged on the second day of life. At her one-week visit, her pediatrician detected a heart murmur and referred to the ED for further evaluation. She had regained her birth weight but over the past 3 days appears to take longer to complete her feed taking breaks and sweating easily.

On examination, the neonate is observed to be breathing at 50 breaths per minute with nasal flaring. Transcutaneous oxygen saturation is 97%. Peripheral pulses are strong, but the baby has tachycardia at 170 beats per minute. Air entry is equal bilaterally, but crackles are heard at the bases. A pansystolic murmur is heard over the precordium. The liver edge is palpable 3 cm below the right costal margin.

A chest radiograph is obtained and is shown as follows:



At this time, the next best step in the management of this patient would be:

A. Advise the parents to keep the appointment with the pediatric cardiologist.
B. Administer a dose of intravenous furosemide.
C. Obtain a complete sepsis workup, and start intravenous antibiotics.
D. Start the child on nasal oxygen at 2 L per minute.
E. Order a dose of oral digoxin.

Correct Answer: B. Administer a dose of intravenous furosemide.

The neonate in question appears to be in congestive cardiac failure due to a large left-to-right shunt. Her oxygen saturation suggests an acyanotic heart lesion similar to a ventricular septal defect or a patent ductus arteriosus. Neonates with such lesions often become symptomatic

after the pulmonary vascular resistance drops, which usually occurs after 48 hours of life. The large shunt of blood to the pulmonary vasculature results in tachypnea, poor feeding, and failure to thrive. Increase in sympathetic tone results in tachycardia and sweating, especially with feeds. While the accurate diagnosis of the congenital heart lesion and its medical and/or surgical management is appropriately done by the pediatric cardiologist, the child in this vignette is in symptomatic high-output failure and should be treated for the same. Intravenous furosemide would result in diuresis by reducing the preload, decrease pulmonary vascular congestion, and to some degree improve feeding. A single oral dose of digoxin would not be effective in the acute management of this child. The newborn in this vignette has tachycardia, but no other signs to suggest sepsis, and thus a sepsis workup and use of antibiotics is not indicated. The presence of a heart murmur, with supportive radiological evidence of cardiomegaly and pulmonary over-circulation, suggests a left-to-right shunt. The tachypnea in this child is secondary to pulmonary over-circulation. In this scenario, the use of nasal oxygen will not relieve the tachypnea. However, the potent pulmonary vasodilatory properties of oxygen might worsen the shunt and pulmonary over-circulation.

Take-Home Message

Neonates with congestive cardiac failure present with decreased feeding, sweating, irritability, and failure to gain weight. Chest radiograph typically shows cardiomegaly with increased pulmonary markings and vascularity.

ABP Content Specification

- Recognize signs and symptoms of congestive heart failure.
- Plan management of acute congestive heart failure.

Question 3

The triage nurse calls you to assess a six-year-old boy who presents with a two-day history of fever and chest pain. Parents report that he was discharged from the hospital 13 days ago after an uncomplicated surgical repair of an atrial septal defect. You note an anxious child who refuses to lie down on the examination table. His neck veins appear distended. His extremities feel cool to the touch. On palpation, his peripheral pulses are thready. He does not cooperate with an abdominal examination, but his liver feels enlarged. Crackles are audible at the lung bases. You cannot hear his heart sounds very clearly, but there is no murmur or rub. Which of the following abnormal findings on investigation is most likely to be encountered in the patient described in this vignette?

A. A large pericardial effusion on an emergent bedside ultrasound
B. Normal cardiac silhouette with evidence of bilateral pleural effusions on a chest X-ray
C. Marked anemia on a complete blood count
D. Leukocytosis on a complete blood count
E. Supraventricular tachycardia on ECG

Correct Answer: A. A large pericardial effusion on an emergent bedside ultrasound

The boy in this vignette has signs of tamponade from a large pericardial effusion. About 15% of patients who undergo surgical closure of an atrial septal defect may develop a pericardial effusion. The median duration after surgery when the effusion is diagnosed is 13 days. When there is a rapid accumulation of pericardial fluid, there is impaired filling of the ventricles. This results in engorged neck veins and hepatomegaly because of impaired right ventricular filling and pulmonary venous congestion because of impaired left

ventricular filling. Poor cardiac output usually follows, resulting in pallor and thready pulses.

Cardiac tamponade is an emergency. An emergent bedside ultrasound performed by a trained emergency physician can quickly confirm the presence of a pericardial effusion. Resources can then be mobilized to emergently drain the effusion, which can be life-saving.

While bilateral pleural effusions can coexist with a pericardial effusion, the cardiac silhouette will not be normal with a large pericardial effusion. Patients with cardiac tamponade appear pale, but this manifestation is secondary to poor cardiac output. There is no evidence to support an infection in this patient, and the distended neck veins are not seen in supraventricular tachycardia.

Take-Home Message

Cardiac tamponade should be recognized rapidly to prevent death from hemodynamic compromise. Patients with acute tamponade present with dyspnea, tachycardia, tachypnea, signs of hypoperfusion, and shock. Other findings include elevated jugular venous pressure, pulsus paradoxus, and muffled heart sounds. Diagnosis can be made by echocardiography, and treatment is emergent pericardiocentesis.

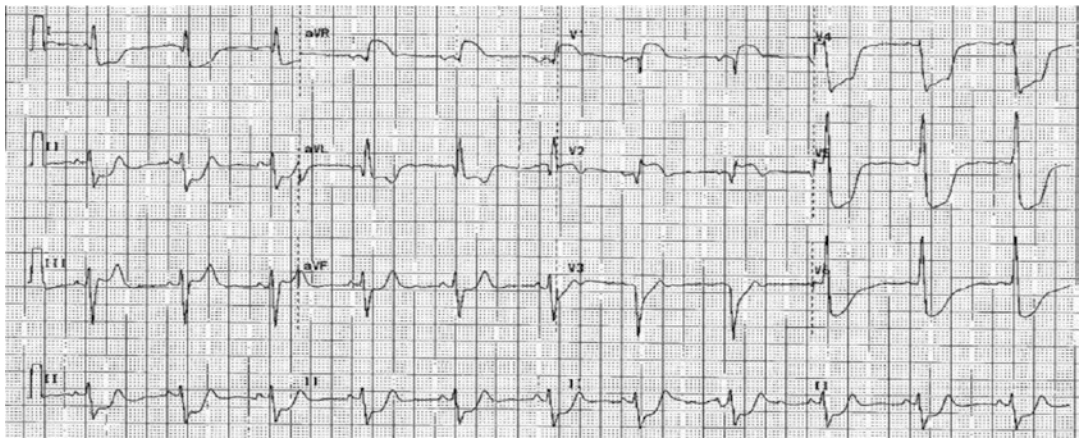
ABP Content Specification

- Recognize the signs and symptoms of pericardial effusion and tamponade.

Question 4

A 16-year-old boy suddenly collapsed while playing basketball in school. His coach rushed to his side, but the student revived spontaneously without requiring any resuscitative measures. Emergency medical services had been summoned, and they brought the student to the emergency department. His transport was uneventful.

You observe a cheerful young adolescent who appears to be in no acute distress. He is afebrile, with a heart rate of 60 beats/minute, breathing at a rate of 14 breaths/minute, and with an automated blood pressure measurement of 108/68 mm Hg in the right arm. He experienced crushing chest pain before his episode of syncope, but is not particularly bothered, because he frequently experiences chest pain while playing basketball. He denied any intercurrent illness, taking prescribed medications or illicit drugs, and any family history of sudden cardiac death. On examination, his peripheral pulses are strong. First, heart sound is normal, while the second is physiologically split. No heart murmur is audible. The nurse obtained a 12-lead electrocardiogram while the patient was in triage, which is now available for review and shown as follows.



The next best step in the management of this patient is:

A. Order a urine toxicology screen.
B. Counsel the patient to maintain adequate hydration before playing basketball.
C. Request an urgent evaluation by a pediatric cardiologist.
D. Order a CT angiogram of the chest.
E. Order a blood test to measure potassium levels.

Correct Answer: C. Request an urgent evaluation by a pediatric cardiologist.

The male athlete in this question has a troubling history of exertional chest pain and now presents with exertional syncope. While chest pain and syncope generally have a benign etiology in the pediatric age group, about 6% of patients do have a cardiac etiology. They frequently present with exertional symptoms. The American Heart Association recommends preparticipation cardiovascular screening for all athletes who give a history of exertional chest pain and syncope. Cardiac causes for exertional chest pain and syncope would include hypertrophic cardiomyopathy, anomalies of the coronary arteries, aortic stenosis, systemic and pulmonary hypertension, myocarditis, and dilated cardiomyopathy. While aortic stenosis is associated with a heart murmur and hypertrophic cardiomyopathy with a dynamic murmur, the other causes may have a normal physical examination at rest. The evaluation of exertional chest pain and syncope can be performed by a pediatric cardiologist on a routine basis, with the caveat that the patient not indulge in competitive sports pending the evaluation. However, the ECG on the patient in this vignette is troubling in that there are marked ST-T changes, indicating an ischemic process. An urgent evaluation by a pediatric cardiologist, including performing an echocardiogram, would be the most beneficial next step. An echocardiogram delineates global or regional ventricular dysfunction and presence of effusions and assess for structural abnormalities like hypertrophic cardiomyopathy or anomalies of coronary origin (namely, anomalous origin of left coronary from the right sinus of Valsalva). Coronary vasospasm induced by cocaine can result in chest pain, though it may occur even without exertion. The purely exertional nature of chest pain in this vignette does not suggest chest pain induced by cocaine abuse. If echocardiography suggests anomalous origin or intramural course of the coronary arteries, then it can be confirmed by CT angiography.

Hyperkalemia results in peaked T wave, widening of the QRS complex followed by pulseless electrical activity. The goal of therapy is to stabilize cell membranes by calcium gluconate or calcium chloride, which counteracts the effects of hyperkalemia on myocardium action potential within minutes. Calcium gluconate is preferred in children as it is less irritating to the veins. The other treatment includes bicarbonate or insulin with glucose, albuterol nebulization, and sodium polystyrene sulfonate. Insulin increases the activity of the Na-K-ATPase pump in the skeletal muscle and drives K into cells. Glucose is administered simultaneously with insulin to prevent hypoglycemia. Sodium polystyrene sulfonate is a resin which exchanges sodium for potassium at a 1:1 ratio and therefore increases potassium excretion.

Take-Home Message

Ischemic heart disease in children is uncommon but should be suspected in children presenting with exertional chest pain. ECG is a good initial screen to identify left ventricular hypertrophy suggestive of hypertrophic cardiomyopathy or manifest ST and or T wave changes indicating ischemia. Patients with electrocardiographic changes should be referred to cardiology for evaluation and prohibited from performing exercise and participating in sports until cleared.

ABP Content Specification

- Recognize ECG abnormalities in children.

Question 5

A 10-year-old girl is brought to the Emergency Department by her parents. She is usually in good health but has been complaining of excruciating pain in different parts of her body over the past few days. Today, she refused to bear weight on her left leg. Her vital signs are as follows: temperature 102.7 °F (39.3 °C), heart rate 132 beats/minute, respiratory rate 20 breaths/minute, and blood pressure 116/68 mm Hg. She is in mild distress. Her left knee appears swollen. It is warm to touch and quite tender. There is no bruising around the knee. Lungs are clear to auscultation. First and second heart sounds are clearly audible. A grade 2/6 pansystolic murmur is heard at the apex of the heart. Abdomen is soft, without any evidence of organomegaly.

The etiology of this patient's symptoms is most likely to be elucidated by which of the following investigations?

A. AP and lateral X-rays of the left knee
B. Elevated antistreptolysin O titer in blood
C. Leukocytosis on synovial aspirate
D. Positive influenza swab
E. Elevated ANA titers in blood

Correct Answer: B. Elevated antistreptolysin O titer in blood

The patient in this vignette fits the profile of rheumatic fever, which occurs most often in children between the ages of 5 and 15 years. It typically occurs several weeks after an episode of streptococcal pharyngitis. The salient features are fever, migratory arthritis affecting major joint groups, an evanescent rash usually over the abdomen, and subcutaneous nodules. Chorea may occur a few months after the pharyngitis. The migratory arthritis refers to the sequential involvement of joints, with inflammation resolving in one joint and then beginning in another joint.

In some patients, pancarditis may occur that affects all three layers of the heart. Valvulitis usually affecting the mitral and aortic valves, causes valvar insufficiency and can manifest with a new murmur.

Since rheumatic fever usually occurs several weeks after the episode of pharyngitis, the rapid strep test or a throat culture may not be positive at the time of evaluation. However, evidence of past streptococcal infection may be deduced from an elevated blood titer of antistreptolysin O. The arthritis in rheumatic fever is flitting and fleeting. The radiograph of the affected joint often reveals nonspecific findings of increase in the joint space. Synovial aspirate will reveal a sterile inflammation, is not diagnostic, and certainly not indicated for making a diagnosis. Rheumatoid arthritis is more likely to affect smaller joints. In a patient who has been in good health, and without a long-standing history of joint pains, one would not consider a diagnosis of rheumatoid arthritis first.

Take-Home Message

Rheumatic fever, although rare, occurs from time to time in the United States, often in clusters. The diagnosis is based on the modified Jones criteria which includes carditis, arthritis, chorea, erythema marginatum, and subcutaneous nodules as major criteria. Arthralgia, fever, a prolonged PR interval, increased acute phase reactants such as ESR, and previous rheumatic fever are minor criteria. Rheumatic fever is diagnosed if there are two major and one minor criterion or one major and two minor criteria. In all situations, there must be evidence of recent streptococcal infections.

ABP Content Specification

- Recognize the signs and symptoms of rheumatic fever.

Question 6

A 17-year-old male is transferred from a juvenile detention facility to the Emergency Department as he was found to be febrile. His past history is significant for multiple arrests for felony to support an intravenous drug addiction. He gives a history of "feeling warm" for many days and has

been given oral aspirin to control his fever. On physical examination, he is in no significant distress. His axillary temperature is 101.4 °F (38.6 °C), heart rate is 112 beats/minute, and blood pressure is 102/68 mm Hg in the right arm. The nasal passages and throat appear normal. There is nonspecific enlargement of lymph nodes in his neck. A 2/6 pansystolic murmur is heard at the left lower sternal border. The abdomen is soft, without any evidence of organomegaly.

At this time, the next best course of action in the management of this patient would be:

A. Arrange for an outpatient appointment with a pediatric cardiologist.
B. Arrange for admission to the inpatient service.
C. Obtain a urine toxicology screen.
D. Obtain a serum salicylate level.
E. Arrange for a psychiatric evaluation.

Correct Answer: B. Arrange for admission to the inpatient service.

This patient likely has infective endocarditis (IE) that needs immediate hospital admission. IE is defined as an infection, usually bacterial, of the endocardial surface of the heart. It occurs with an incidence of 0.3 per 100,000 children per year with a mortality of 11.6%. There has been an increase in the incidence of IE with the greater survival of children following surgical intervention for CHDs. At the same time, improved survival of premature born infants and patients with chronic medical conditions who undergo prolonged hospitalization (frequently with chronic instrumentation) increases the pool of patients with structurally normal hearts who are at risk for IE. Intravenous drug abusers are at risk for developing endocarditis involving right-heart structures.

The classic triad of fever, anemia, and a heart murmur is rarely present. Oftentimes, patients with IE present with nonspecific symptoms. Typically, they have relapsing low-grade fever. There usually is vague myalgia, headache, and arthralgia. If the progression of the infection is rapid, then they may appear toxic. A new or changing heart murmur may signify involvement of one of the valves. In cases of slowly evolving infections, signs relating to peripheral immunologic phenomena, such as the appearance of splinter hemorrhages, Osler nodes, Janeway lesions, and Roth spots, may be noted. Osler nodes are small, painful nodules usually present on the palmar surfaces of the fingers and toes; they may wax and wane. Janeway lesions are hemorrhagic, nonpainful macules which are found primarily on the palms and soles; they are embolic in origin. Roth spots are round, boat-shaped, or flame-shaped hemorrhages in the retina due to septic emboli to the eye.

The patient in this vignette is at risk for developing endocarditis due to his intravenous drug use**.** His heart murmur might be consistent with new onset of tricuspid regurgitation. The best course of action would be to obtain a complete blood count, obtain blood cultures from at least three sites, and start broad-spectrum antibiotic therapy. The classic lesion of endocarditis is the vegetation which may be identified by an echocardiogram, but a negative echocardiogram cannot rule out the diagnosis of endocarditis. An outpatient evaluation by a cardiologist would thus not be appropriate.

Most IE is accompanied by positive blood cultures. A select group of organisms cause most cases of endocarditis. Gram-positive organisms, particularly alpha-hemolytic streptococci (Streptococcus viridans), Staphylococcus aureus, and coagulase negative staphylococci predominate. In native valves, streptococcal involvement is more common, most often affecting the mitral valve. Congenital heart disease accounts for 15% of cases, with bicuspid aortic valve being the most common. S. aureus is generally more common among IVDA patients and involves the tricuspid valve.

While it is possible that the patient might have continued abusing drugs, this would not explain the findings on physical examination. Hyperthermia is a manifestation of severe salicylate toxicity. The patient in this vignette does not have evidence of nausea, vomiting, tinnitus, or

hyperventilation, which would precede hyperthermia. Behavioral intervention by a child psychiatrist would be helpful given the history of drug use but would not manage the acute issues facing this patient.

Take-Home Message

IE presents usually with nonspecific symptoms but should be suspected among IV drug abusers and those that have therapeutic hardware in the heart. While the diagnosis is straightforward in the setting of positive blood cultures and visible vegetations on echocardiography, presumptive treatment may be necessary among those that raise high clinical suspicion, despite absence of these findings.

ABP Content Specification

- Recognize signs and symptoms of infectious endocarditis.

Question 7

A 10-month-old male infant is sent to the Emergency Department from his pediatrician's office. He has been febrile for the past 6 days and has developed a rash over the past day. He lives at home with his parents, who both deny any recent illness. Parents report that child has been irritable since the onset of fever and has had reduced oral intake, but no vomiting or diarrhea. On examination, the child is fussy and febrile at 102.2 °F (39 °C). His eyes appear injected. There is no rhinorrhea. The angles of his mouth appear cracked, while his lips and tongue appear inflamed. A diffuse macular erythematous rash is noted on the trunk. He has palpable axillary lymph nodes. Examination of his ears reveals a mobile tympanic membrane.

At this time, the next best step in the management of this patient is:

A. Complete sepsis workup with blood, urine, and spinal fluid cultures, followed by antibiotic therapy.
B. Reassure the parents that this is a viral illness and prescribe acetaminophen for symptomatic relief.
C. Admit to the inpatient unit for immune globulin therapy.
D. Prescribe amoxicillin for otitis media.
E. Administer intravenous fluids for rehydration.

Correct Answer: C. Admit to the inpatient unit for immune globulin therapy.

The infant in question shows signs strongly suggestive of Kawasaki disease, an acute, self-limited, acquired inflammatory condition characterized by vasculitis of small to medium vessels. The etiology of this acute illness is not well understood. To satisfy the criteria for diagnosis of Kawasaki disease, the patient should have high-grade fever with no obvious cause for at least 5 days and any four of the following 5 criteria: non-purulent bulbar conjunctivitis that spares the limbus, a strawberry tongue, lymphadenopathy, a generalized rash, swelling of the hands and feet, and peeling of the skin around the anus. It primarily afflicts children between 1 and 5 years of age. Laboratory investigations are not diagnostic, but include leukocytosis, and a marked increase in acute-phase reactants, namely, C-reactive protein and erythrocyte sedimentation rate. There is significant thrombocytosis about 3 weeks into the illness. The acute phase is also characterized by hydrops of the gall bladder. Perhaps the most significant effect is on the cardiovascular system. In the acute phase, patients might have myocarditis and a pericardial effusion. About 20% of patients may develop aneurysms of the coronary arteries. Primary treatment is IV immunoglobulin and aspirin. When intravenous immune globulin therapy is instituted prior to 10 days after the onset of fever, the risk of coronary artery involvement drops to about 2%.

The infant in question has had fever without any obvious cause and also manifests supporting criteria for the diagnosis of Kawasaki disease. Elevation in acute phase reactants, and a nonspe-

cific CBC would provide supportive evidence for this diagnosis. The risk of coronary artery involvement would be decreased by prompt institution of immune globulin therapy. An echocardiogram in the acute phase would be helpful in assessing myocardial function and to rule out a pericardial effusion. Absence of coronary artery aneurysms in the acute phase does not rule out Kawasaki disease.

The child in this vignette is ill, without being toxic. Fussiness is common in infants with Kawasaki disease. While a workup for an infectious etiology may not be unreasonable, a spinal tap and administration of antibiotics does not appear to be justified. The infant is febrile, but does not have rhinitis, vomiting, or diarrhea. There are no sick contacts. Under such circumstances, a diagnosis of a viral illness is not appropriate. While fever without an obvious etiology in a 10-month-old should raise suspicion for otitis media, the infant in this vignette has mobile tympanic membranes on examination. Due to stomatitis and glossitis, the infant has poor oral intake and is probably slightly dehydrated. While rehydration would be part of clinical management, investigations for and management of Kawasaki disease would take precedence.

Take-Home Message

The diagnosis of Kawasaki disease should be entertained in children that present with high fever more than 5 days with no evident etiology, with supportive clinical findings. When intravenous immune globulin is administered within 10 days of the onset of fever, the incidence of coronary artery involvement is significantly lower than without treatment.

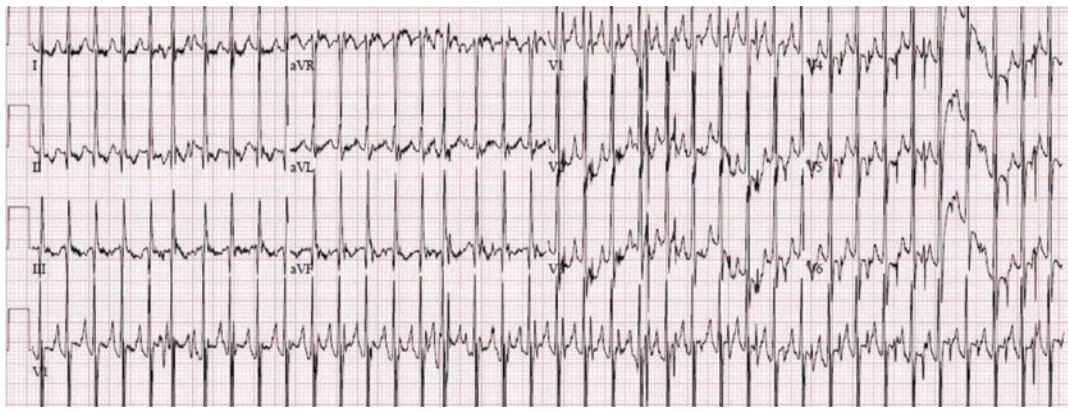
All children who are suspected of having Kawasaki disease require ECG, echocardiogram, and urgent consultation with a pediatric cardiologist.

ABP Content Specification

- Recognize signs and symptoms of Kawasaki disease.

Question 8

A 6-week-old female infant is brought to the Emergency Department by her mother for decreased activity for a few hours and is not feeding as usual. On examination, she is awake, afebrile, and responds appropriately to her mother. Her heart rate is too fast to count. She is breathing at 40 breaths/minute. Her peripheral pulses are weak but palpable, though the automated blood pressure machine is unable to obtain a reading. Other than a fast heart rate, the cardiac examination is unremarkable. A quick examination reveals normal breath sounds, no organomegaly, and normal tone in all extremities. A 12-lead electrocardiogram is obtained and is as shown in the figure.



At this time, the next best step in the management of this infant is:

A. Apply an ice pack to the face, while the nurse attempts to obtain intravenous access.
B. Gently massage the eyeballs of the patient.
C. Obtain intraosseous access to administer fluid resuscitation.
D. Prepare for DC cardioversion with 0.5 J/kg of current.
E. Do a complete sepsis workup and administer broad-spectrum antibiotics.

Correct Answer: A. Apply an ice pack to the face, while the nurse attempts to obtain intravenous access.

The electrocardiogram on the patient in this vignette demonstrates narrow-complex tachycardia (supraventricular tachycardia). When prolonged, it may result in ventricular dysfunction and may manifest with lethargy and poor feeding. The appropriate management of a patient in supraventricular tachycardia depends on the mental status of the patient and the hemodynamic status. If the tachycardia results in hemodynamic collapse, then the appropriate intervention would be synchronized cardioversion. However, the patient in this vignette is awake and responsive. While the automated machine is unable to record a blood pressure, her pulses are palpable. In such a setting, the appropriate intervention would be to pharmacologically cardiovert the rhythm using intravenous adenosine. Adenosine terminates the tachycardia by blocking the atrioventricular node.

While intravenous access is being established, it is acceptable to attempt cardioversion by a vagotonic maneuver such as applying a cold stimulus by an ice pack to the face, bearing down, coughing, gagging, etc. However, noxious modes of increasing vagal tone by massaging the eyeballs should not be applied. While the child may be dehydrated from poor oral intake, abolishing the tachycardia would result in better oral intake and rehydration. Her perfusion and blood pressure would improve. At this time, there is no indication for invasive modes of fluid resuscitation by the intraosseous route. While sepsis does result in tachycardia, the rate in this case is above the limits of sinus tachycardia. P waves are not seen on the ECG, making supraventricular tachycardia the diagnosis as opposed to sepsis.

Wolff-Parkinson-White (WPW) syndrome is suggested by a shortened PR interval, slurred QRS complex (delta wave), and a widened QRS complex. In patients with ECG findings of narrow-complex tachycardia with preexcitation suggestive of WPW syndrome which are refractory to vagal maneuvers and adenosine, procainamide should be used. In unstable patients, synchronized cardioversion should be performed. If WPW is associated with wide-complex tachycardia, atrioventricular nodal blocking agents such as adenosine and digoxin should be avoided.

In patients with wide complex tachycardia who are otherwise stable and do not require immediate cardioversion, adenosine can be used. In such situations, adenosine may convert supraventricular tachycardia to sinus rhythm or differentiate ventricular from supraventricular tachycardia.

Take-Home Message

Narrow-complex tachycardia may manifest with nonspecific symptoms in infants. When confirmed by an electrocardiogram, sinus rhythm can be restored with intravenous adenosine or synchronized cardioversion (in cases of hemodynamic collapse). While setting up to deliver adenosine, non-noxious vagal maneuvers may be used to restore sinus rhythm.

ABP Content Specification

- Recognize and plan the management of ECG abnormalities in children.

Question 9

A 5-month-old male infant is brought by an emergency medical response team to the ED. His parents report that the child has been vomiting once per day and having loose stools for the past 3 days. This afternoon, he woke up “irritable.” He started crying and could not be easily con-

soled. He then progressively turned more and more dusky and finally became unresponsive. By the time emergency responders showed up at the family home, the child had regained consciousness. In the ED, he is noted to be febrile at 101.4 °F (38.6 °C). His heart rate is 156 beats/minute, respiratory rate is 32 breaths/minute, and transcutaneous oxygen saturation is 78% in room air. His fontanelle is slightly sunken, but his lips and eyes are moist. He is comfortable in his mother's arms and is drinking from a bottle. His extremities are warm, but the fingertips appear dusky. Cardiac examination is significant for a harsh 3/6 ejection systolic murmur that radiates to the axillae. His parents report that he was diagnosed with tetralogy of Fallot in fetal life and has regular follow-up with a pediatric cardiologist.

At this time, the most appropriate step in the management of this child is:

A. Arrange for an urgent outpatient follow-up visit with the pediatric cardiologist within 1 week.
B. Initiate workup for IE and start antibiotic therapy.
C. Admit to the inpatient service for observation.
D. IV normal saline bolus of 100 ml/kg over 30 minutes.
E. Discharge the patient home with instructions on oral rehydration therapy.

Correct Answer: C. Admit to the inpatient service for observation.

Tetralogy of Fallot is the most common cyanotic CHD. The degree of cyanosis depends on the severity of right ventricular outflow tract obstruction. In a majority of centers, the surgical approach to this lesion is to perform a complete repair electively at 3–4 months of life. However, some patients with this condition might experience hypercyanotic spells. While the exact etiology of this condition is unclear, it results in an acute increase in right ventricular outflow obstruction, causing increased shunting of desaturated blood into the systemic circulation, which in turn results in a worsening of cyanosis. The increased right ventricular outflow tract obstruction results in acute reduction of pulmonary blood flow. With significant obstruction, the heart murmur disappears, and the patient may lose consciousness. Acidosis and dehydration increase the risk of a hypercyanotic spell.

Management of a hypercyanotic spell involves keeping the patient calm, ensuring euvolemic status, use of supplemental oxygen and the "knee-chest" position, intravenous morphine (0.1 mg/kg) and sodium bicarbonate (1 mEq/kg), and infused esmolol and phenylephrine (neosynephrine) 0.1 mcg/kg/min titrated to effect.

The progression of events in this vignette suggests that the patient had a hypercyanotic spell. While the infant in this vignette appears to have recovered, he is at risk for another spell and should not be sent home. A fluid bolus of 100 ml/kg is out of proportion to the degree of dehydration. While cyanotic patients are at risk for developing IE, the clinical vignette does not support this diagnosis.

Take-Home Message

Tetralogy of Fallot is increasingly diagnosed in fetal life and addressed surgically in an elective fashion at between 4 and 6 months of life in those without severe right ventricular outflow obstruction. However, some of these patients might go on to develop hypercyanotic spells, which would prompt appropriate stabilization and earlier surgical intervention.

ABP Content Specification

- Recognize signs and symptoms and life-threatening complications of congenital cardiac lesions.

Question 10

An obese 17-year-old female presents to the ED with a three-day history of fatigue. She is unable to walk up one flight of stairs to her apartment. She denies any history of fever, rhinitis, vomiting, or diarrhea. Her past history is remarkable for giving birth after a term pregnancy about 3 months ago. Her vital parameters are as follows:

heart rate of 114 beats/minute, respiratory rate of 30 breaths/minute, and blood pressure of 90/62 mm Hg. She appears anxious. Her jugular veins appear slightly distended. Pedal pulses are felt, but there is slight pedal edema. On auscultation, the heart rate is fast, but the heart sounds are slightly difficult to hear. There are bibasilar rales. The patient is unable to cooperate for an abdominal examination. A chest radiograph is obtained, and shows moderate cardiomegaly, with basal congestion. The presentation of the patient in this vignette is consistent with:

A. Peripartum cardiomyopathy
B. Fulminant viral myocarditis
C. Deconditioning secondary to obesity
D. Fatigue associated with caring for a newborn
E. Acute pneumonia

Correct Answer: A. Peripartum cardiomyopathy

Peripartum cardiomyopathy is a rare association with pregnancy and can occur in the last month of pregnancy, up to 5 months after childbirth. While it is more common in women over the age of 30, it can afflict any age group. The causes are poorly understood. The patient in this vignette presents with symptoms of congestive cardiac failure. She is 3 months postpartum and does not have any history of an intercurrent viral infection to suggest fulminant viral myocarditis. While the patient is obese, deconditioning would not explain the distension of jugular veins, pedal edema, bibasilar rales, or the cardiomegaly and pulmonary vascular congestion seen on the chest radiograph. These findings would also not be present in a fatigued mother caring for her newborn. The patient has cardiomegaly and pulmonary vascular congestion on her chest radiograph. She is not febrile. This does not support a diagnosis of acute pneumonia.

Take-Home Message
The clinical findings of congestive heart failure in a postpartum woman of any age should prompt evaluation for peripartum cardiomyopathy.

ABP Content Specification
- Differentiate the etiology of congestive heart failure by age.

Question 11

A 13-year-old boy is brought to the Emergency Department from the school nurse's office. He has been febrile for the past 4 days, with a history of emesis and poor oral intake. This morning, while going from one classroom to another, he fainted. He revived spontaneously and was taken to the nurse's office. On arrival to the ED, he was noted to be febrile at 104 °F (40 °C). His tongue is moist, and skin turgor is maintained. His peripheral pulses are thready. His jugular veins appear distended. On cardiac examination, heart rate is rapid, and sounds are difficult to auscultate. Air entry is equal in both lung fields, though rales are heard at both bases. The liver is palpable 3 cm below the right costal margin. Serum electrolytes are normal. A chest radiograph shows mild cardiomegaly and bilateral lower lobe haziness. At this time, the next best step in the management of this patient is:

A. Intravenous antibiotic therapy
B. One dose of intravenous furosemide
C. Intravenous bolus of 1 L of normal saline over 30 minutes
D. Intravenous infusion of dopamine
E. Inhaled albuterol

Correct Answer: B. One dose of intravenous furosemide

Acute fulminant myocarditis is a rapidly progressive process that follows a viral infection in otherwise healthy children with no personal or family history of cardiac disease. It may present with chest pain, palpitations, syncope, arrhythmia, or sudden cardiac death. While the progression of symptoms is rapid, and the clinical presentation usually dire, when recognized and appropriately treated, the outcomes are generally positive.

The patient in this vignette has become quite symptomatic after a brief illness. He presents with signs of low cardiac output and venous congestion. However, he does not appear to be dehydrated. Anti-congestive therapy with a diuretic such as furosemide would help decrease the pulmonary vascular congestion and improve symptoms. While inotropy with infused dopamine will probably be indicated, empiric treatment with dopamine in a patient who is not in extremis is probably not called for. Though the patient has been vomiting, he does not appear severely dehydrated. Administration of a fluid bolus to a patient clinically suspected of having myocarditis might worsen the pulmonary edema. The patient does not have any evidence to back up the suspicion of pneumonia or a reactive airways attack, so the use of antibiotics and bronchodilators is not supported.

Take-Home Message

Low cardiac output can result from several conditions. It is essential to use clinical findings and investigations to distinguish those that involve intravascular depletion from those that do not. Clinical management is different in each case.

ABP Content Specification

- Know the etiology and recognize the signs and symptoms of myocarditis.

Question 12

A 16-year-old girl presents to the Emergency Department with complaints of severe abdominal pain. She has had two bouts of retching prior to the onset of the pain. She admits to have taken 25 pills of digoxin 4 hours ago, in order to kill herself after fighting with her mother. The mother was upset about her daughter's unplanned pregnancy. The patient's past medical history is significant for supraventricular tachycardia, which is well-controlled with the use of digoxin. On arrival to the ED, the heart rate is 60 beats/minute, respiratory rate is 14 breaths/minute, and blood pressure is 116/68 mm Hg. The patient is awake and alert. She does not appear dehydrated. Serum chemistry, including blood glucose, BUN, and creatinine, is normal, except for a potassium level of 5.2 mEq/L. The serum digoxin level is 0.7 ng/ml. An ECG is obtained and is normal. Urine pregnancy test is positive. At this time, the most appropriate step in the management of this patient is:

A. Administer activated charcoal orally or by a nasogastric tube.
B. Arrange for an outpatient appointment with the adolescent obstetric service.
C. Administer digoxin antibodies intravenously.
D. Admit to the inpatient unit with continuous cardiac monitoring.
E. Admit to the inpatient psychiatry unit.

Correct Answer: D. Admit to the inpatient unit with continuous cardiac monitoring.

Digoxin is a cardiac glycoside with a narrow therapeutic window. Adverse effects can be seen both with acute poisoning and chronic overdose. With acute poisoning, the patient may be asymptomatic for a few hours before developing gastrointestinal symptoms such as nausea, vomiting, and abdominal pain. Chronic overdose usually results in neurological symptoms such as lethargy and mental status changes. In either case, cardiac effects are likely, which include virtually every form of arrhythmia. The approach to the diagnosis of digoxin toxicity would include measurement of serum chemistries, digoxin level, and serial electrocardiograms. An abnormal BUN or serum creatinine would signify renal toxicity. In adults with digoxin toxicity, serum potassium above 5.5 mEq/L is associated with a risk of dying. A digoxin level alone cannot be used to guide management. Patients with acute or chronic digoxin overdose should be monitored in an inpatient setting for cardiac arrhythmias. Beyond the first couple of hours after an acute ingestion, use of activated charcoal may not be helpful. Any clinically significant digoxin overdose can be treated with administration of Fab antibodies to

digoxin. The patient in this vignette does not show any evidence of hypotension or an arrhythmia and thus should be monitored, as opposed to receiving therapy. While the suicide attempt does merit a detailed psychiatry evaluation, the management of the digoxin overdose takes precedence over that of the patient's psychiatric or obstetric conditions.

Hyperkalemia is considered a surrogate indicator for severity in acute digoxin overdose. It increases AV nodal block and can therefore exacerbate conduction delay. Potassium level may predict the outcome in patient with acute digoxin toxicity.

Take-Home Message

In cases of acute digoxin poisoning, a normal digoxin level does not obviate the need for observation. Monitoring the patient for arrhythmias, especially in the setting of hyperkalemia, is important.

ABP Content Specification

- Recognize the signs and symptoms and plan the management of digoxin toxicity.

Question 13

A 6-day-old newborn is brought to the Emergency Department by her parents. She was born after a full-term pregnancy and had an uncomplicated perinatal course. At the time of discharge from the newborn nursery at 3 days of life, a heart murmur was heard. She had a normal ECG, and her transcutaneous oxygen saturation at that time was 98% in room air. An appointment to see a pediatric cardiologist is due in 3 days. However, for the past 2 days, the baby has been tachypneic and feeding poorly. Since this morning, she has also been quite lethargic.

Vital signs in the ED are as follows: temperature 98.6 °F (37 °C), heart rate 175 beats/minute, respiratory rate 38 breaths/minute, and blood pressure 100/64 mm Hg in the right arm. The patient is lethargic, but arousable. Femoral pulses are not palpable. Air entry is heard in both lung fields. Heart sounds are heard, as is a grade 2/6 ejection systolic murmur at the left sternal border. The liver edge is palpable 2 cm below the right costal margin. At this time, the next step in the management of this patient is:

A. Establish intravenous access to start a prostaglandin infusion.
B. Administer broad-spectrum antibiotics.
C. Reassure the parents and ask them to keep the outpatient cardiology appointment.
D. Start an infusion of milrinone at 0.5 mcg/kg/minute
E. Obtain a CT scan of the brain.

Correct Answer: A. Establish intravenous access to start a prostaglandin infusion.

The newborn in this vignette has clinical evidence of coarctation of the aorta. Critical coarctation of the aorta manifests with circulatory failure and shock with closure of the ductus arteriosus. The portion of the aorta distal to insertion of the ductus is hypoperfused after ductal closure. This results in diminished femoral pulse and metabolic acidosis. Since the aorta proximal to the ductal insertion site receives adequate blood flow, blood pressure in the upper extremities might be normal to high, and the oxygen saturation is normal. It may be suspected clinically by a significant upper extremity–lower extremity blood pressure gradient and diminished or absent femoral and pedal pulses.

Coarctation is frequently associated with a bicuspid aortic valve. Initially, the left ventricle is able to pump against the increased afterload it faces, but eventually it fails resulting in symptoms of congestive heart failure. When there is clinical evidence of a ductal-dependent lesion, it is appropriate to institute prostaglandin therapy while awaiting a cardiology evaluation and diagnostic imaging.

While the patient in this vignette is sick enough for a diagnosis of sepsis to be entertained, that is unlikely to result in hepatomegaly. Antibiotic therapy would not be the first medical intervention that is warranted in this case. The poor pedal perfusion is secondary to obstruction at the level of the coarctation. An infusion of mil-

rinone is unlikely to improve lower extremity perfusion. The lethargy demonstrated by the patient is in keeping with the severity of the cardiac condition, and a CT scan of the brain may not be helpful. The management of a newborn with a ductal-dependent cardiac lesion is a medical emergency and cannot wait for a scheduled cardiology outpatient appointment.

Take-Home Message
Prostaglandin therapy is a life-saving intervention in patients with duct-dependent congenital heart lesions. When clinically indicated, a prostaglandin infusion should be started to open the ductus arteriosus and ensure systemic or pulmonary perfusion.

ABP Content Specification
- Understand the pathophysiology of congenital heart disease.

Question 14

A 10-year-old boy recently immigrated from Africa to the United States. His parents bring him to the ED because he has been unable to participate in gym at school. He gets extremely fatigued after running a quarter mile on the track. He becomes very short of breath, and his lips and fingernails turn blue. Vital parameters at triage are a heart rate of 96 beats/minute, respiratory rate of 28 breaths/minute, blood pressure of 100/68 mm Hg, and transcutaneous oxygen saturation of 88% in room air. His extremities are warm and well-perfused, but his fingertips appear unusual. Chest is clear to auscultation, with no added sounds. On cardiac examination, first heart sound is normal, while the second heart sound is single. A grade 2/6 continuous murmur is best heard over the back. The abdomen is soft, and there is no organomegaly.

The next best step in the management of this patient is:

A. Start an intravenous infusion of prostaglandin.
B. Cardiology consultation with echocardiogram
C. Pulmonology consultation with chest CT scan.
D. Orthopedic consultation with radiograph of the fingers.
E. Counseling regarding improving physical conditioning.

Correct Answer: B. Cardiology consultation with diagnostic imaging of the heart.

The boy in this vignette is desaturated and has clubbing of the fingernails. At 10 years of age, this is likely to be untreated cyanotic congenital heart disease or severe pulmonary hypertension secondary to unrepaired acyanotic congenital heart disease. In developed nations, it is rare for hemodynamically significant lesions to remain unaddressed up until 10 years of life. However, the boy recently immigrated from Africa. Since there is only a single second heart sound, and evidence of collateral flow in the lung fields (continuous murmur in lung fields), the lesion here is likely pulmonary atresia and ventricular septal defect with collateral flow to the lung fields. A cardiology consultation with an echocardiogram is the modality most likely to delineate the structural heart lesion.

Prostaglandin infusion is unlikely to be effective at maintaining patency of the ductus at 10 years of age. There is no evidence to support a likely pulmonary cause for the patient's signs. Clubbing is related to desaturation. Radiograph of the fingers is unlikely to delineate the cause for cyanosis.

Take-Home Message
Clubbing is a sign of chronic cyanosis and is frequently secondary to cardiac or respiratory causes. Workup for clubbing should involve investigation for a possible cardiac cause.

ABP Content Specification
- Understand the pathophysiology, signs, and symptoms of congenital heart disease.

Question 15

A 15-year-old girl is brought to the Emergency Department by EMS personnel. She was showering when she felt dizzy. She attempted to steady herself, but was unable to maintain her balance and fell down, hitting her head against the wall. She denied losing consciousness. She had no prior episodes of syncope, palpitations, or other recent illnesses. There is no family history of cardiac disease or sudden death. In triage, her vital parameters are as follows: heart rate 96 beats/minute, respiratory rate 14 breaths/minute, and blood pressure 102/68 mm Hg. She is alert and oriented. A tender bruise is noted on her forehead. Her extremities are warm and well-perfused. Lung fields are clear to auscultation. Heart sounds are heard, with no murmur or rub. There is no organomegaly.

The most appropriate next step in the management of this patient is:

A. CT scan of the brain to evaluate for intracranial hemorrhage.
B. Admit to the inpatient unit for observation.
C. Blood alcohol level.
D. Arranging for outpatient appointment with a pediatric cardiologist.
E. Reassurance about the benign nature of symptoms and discharge.

Correct Answer: E. Reassurance about the benign nature of symptoms and discharge.

Syncope is a very common complaint in the pediatric age group. It is estimated that about 15% of people will have had at least one episode of syncope prior to the end of adolescence. Fortunately, in about 80% of these patients, neurocardiogenic syncope is the cause for symptoms. It is characterized by dizziness and syncope associated with prolonged standing or standing in a hot and humid environment. The outlook for these patients is positive, with no risk of sudden cardiac events. Cardiac causes contribute to a very small percentage of patients with syncope and include structural lesions, arrhythmia, and poor contractility.

The workup of patients presenting with syncope comprises of detailed history-taking and a thorough physical examination. The goal of the evaluation is to identify high-risk patients with underlying heart disease, which may include ECG abnormalities (e.g., long QT syndrome, WPW preexcitation, and Brugada syndrome), cardiomyopathy, or structural heart diseases.

When the history is consistent with neurocardiogenic syncope, and when the family history and physical examination are not contributory, further tests are not required. While an ECG is frequently performed in the scenario, the yield of a positive result is quite low. These patients do not need follow-up with a pediatric cardiologist. The patient should be reassured about the benign nature of symptoms. Lifestyle changes to prevent postural hypotension should be discussed. A brain CT scan is not indicated under the circumstances mentioned in the vignette and should not be obtained. Referral to cardiology or neurology may be indicated for those with recurrent episodes of syncope. There is no indication for inpatient observation.

Take-Home Message

Most cases of syncope in the pediatric age group are benign and are secondary to neurocardiogenic cause (vasovagal). A detailed history of the event is frequently all that is needed to make the diagnosis. A negative family history and physical examination can help support the diagnosis. While the literature likely supports this approach, it would be reasonable to obtain a fingerstick, obtain a pregnancy test in the reproductive group women, and consider CBC (to look for anemia in teenage girls) and an ECG to evaluate for prolonged QT interval or ventricular hypertrophy.

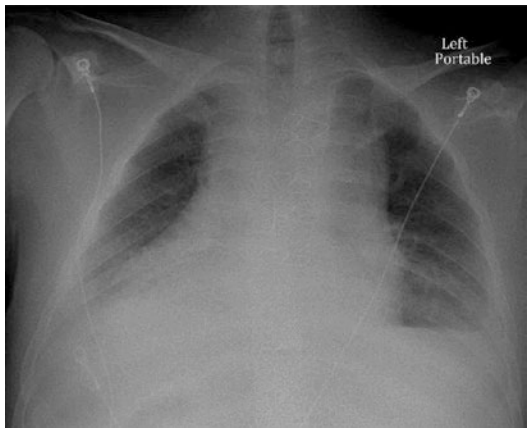
ABP Content Specification

- Understand the causes of syncope.

Question 16

A 5-year-old boy is brought to the Emergency Department by his father. He was discharged 3 days ago following a successful total cavopulmonary connection repair (Fontan operation) for single ventricle disease. His postoperative course was uncomplicated and was discharged home 5 days after surgery. He has a follow-up appointment scheduled with his cardiologist in 3 days. His father is concerned because the boy has been running a low-grade fever for the past 1 day. He is not as active and has difficulty breathing. His vital parameters are temperature of 100.5 °F (38.1 °C, heart rate of 136 beats/minute, respiratory rate of 32 breaths per minute, and blood pressure of 102/64 mm Hg. He has mild nasal flaring and use of suprasternal muscles. Air entry is decreased in the left lung field. Extremities are warm and well-perfused. First and second heart sounds are heard, and no murmur is evident. There is no organomegaly on abdominal palpation. A chest radiograph is obtained and shows haziness in the left hemithorax, with no increase in vascular markings. At this time, the most appropriate intervention is:

A. Discharge the patient home with twice daily oral furosemide.
B. Admit to the inpatient service for further investigation and possible pleurocentesis.
C. Reassure the father and ask him to keep the outpatient appointment.
D. Obtain CBC and blood culture and administer IV antibiotics.
E. Check renal function.



Correct Answer: B. Admit to the inpatient service for further investigation and possible pleurocentesis.

The boy in the vignette clinically has a pleural effusion, which is also borne out by the findings of the chest X-ray. This is a not an unexpected short-term issue following all kinds of cardiac surgical intervention. If the hemodynamic findings preceding a Fontan completion are unfavorable, then recalcitrant pleural effusions are very common. Depending on the rapidity of accumulation of fluid, the findings can include cardiorespiratory collapse to insidious symptoms such as low-grade fever and mild respiratory distress. The boy in this instance appears to be tolerating the effusion well. However, the rapidity with which the fluid has accumulated warrants close follow-up. In cases with hemodynamic embarrassment, the fluid may require emergent drainage followed by oral diuretic therapy. Isolated diuretic therapy without taking into account the speed of accumulation of fluid is not a great option. Likewise, discharging the patient under such circumstances, even with diuretic therapy, does not appear appropriate. The clinical scenario and chest X-ray findings do not suggest an infectious etiology or one related to renal dysfunction.

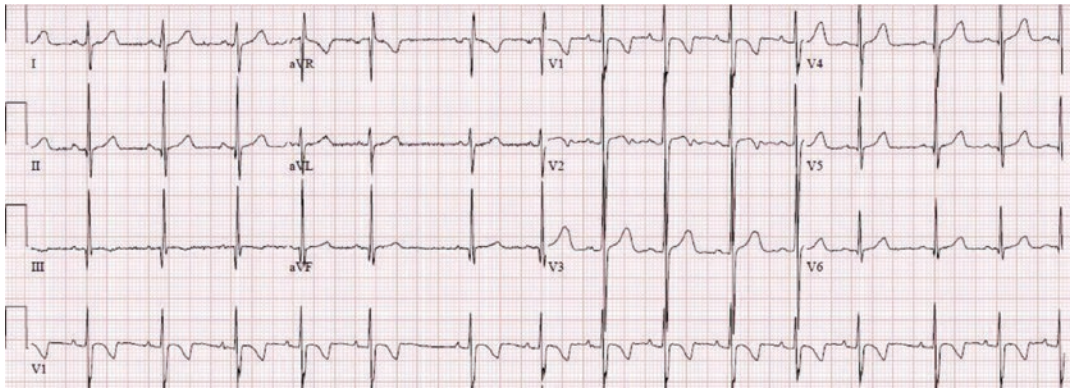
Take-Home Message
Patients recover quickly following open-heart surgical procedures and frequently are discharged home within the first week. Providers need to be cognizant of the potential complications that may manifest after discharge, such as pleural and pericardial effusions.

ABP Content Specification
- Know the etiology of pleural effusion.

Question 17

A 7-year-old girl has been complaining of chest pain for 2 days. She describes the pain as sharp and localized over her sternal region. She experiences the pain mostly while lying in bed. Her past

history is significant for mild-persistent asthma, which has been responding well to inhaled budesonide and albuterol therapy. For the past 2 days, she has had a bad cough and has been wheezing slightly, as per the mother. While getting a routine albuterol nebulizer treatment, she began crying due to acute chest pain. The nurse obtains a12-lead ECG (shown below).



Based on the ECG, the appropriate step in the management of this patient is:

A. Obtain CPK-MB fraction and troponin in view of inverted T waves in the anterior leads.
B. Change therapy to racemic epinephrine.
C. Continue with albuterol therapy, and advance management of acute asthma exacerbation.
D. Call the cardiologist on call for a stat echocardiogram.
E. Obtain a chest radiograph.

Correct Answer: C. Continue with albuterol therapy, and advance management of acute asthma exacerbation.

Chest pain is a common complaint in pediatric practice, but only about 4–6% of pediatric-age patients are likely to have a cardiac cause. Noncardiac causes such as musculoskeletal chest pain, acute asthma exacerbation, and gastroesophageal reflux are far more common. When the personal and family history is reassuring, further laboratory investigations are not necessary. Care must be taken in interpreting pediatric ECGs. While the T waves in the anterior precordial leads are upright for the first 48–72 hours, thereafter, the T waves stay inverted for the next 7–14 years. This should not prompt calls for more testing in these patients. A stat echocardiogram or chest radiograph is not indicated in this scenario. Likewise, racemic epinephrine is not indicated in this patient.

Take-Home Message

Pediatric chest pain is frequently noncardiac in origin. While ECGs are frequently performed as part of the evaluation of chest pain, the normal variations in ECG patterns in children need to be taken into account while interpreting them.

ABP Content Specification

- Know the etiology of chest pain in children and adolescents.

Question 18

A 15-year-old girl presents to the Emergency Department with an episode of syncope. She reports feeling progressively tired for the past month. She denies any viral infection prior to the onset of fatigue. This morning, she had her breakfast and was getting ready for school when she "passed out." Emergency medical personnel were summoned, but she had regained consciousness before they arrived. Her past medical history is

significant for a "heart condition" – her blood vessels are "backward." She reports being evaluated by a cardiologist a few months ago and was told that no intervention was necessary at that time, but that she should follow up at regular six-month intervals. In triage, her vital parameters are heart rate of 48 beats/minute, respiratory rate of 14 breaths/minute, blood pressure of 88/52 mm Hg, and oxygen saturation of 98% in room air. At this time, the most appropriate intervention for this patient is:

A. Make an appointment for an earlier than scheduled follow-up appointment with the cardiologist.
B. Obtain a urine pregnancy test.
C. Check Lyme titers on this patient.
D. Insert a transvenous temporary pacing wire.
E. Obtain an urgent ECG and make preparations for an isoproterenol infusion.

Correct Answer: E. Obtain an urgent ECG and make preparations for an isoproterenol infusion.

The girl in this vignette has significant bradycardia. She also gives the history of her blood vessels being "backward." This would fit with the clinical presentation of corrected transposition of the great vessels. This is a rare anamoly that accounts for 0.5% of all cases of congenital heart disease. It can present either in isolation or in association with other lesions such as VSD or pulmonic stenosis. When occurring in isolation, the defect may not be picked up as patients are not cyanotic, nor do they have a murmur. These patients usually present in adolescence or adulthood with symptoms related to dysfunction of the right ventricle which serves as the systemic ventricle or to bradycardia from high-grade atrioventricular block or complete heart block.

With a heart rate of 48 beats per minute, there is a high likelihood of the patient in this vignette having either high-grade or complete atrioventricular block. However, she is awake and alert and does not need emergent pacing.

If bradycardia is due to complete heart block, then emergency transcutaneous pacing should be performed. If there is refractory bradycardia, then cardiac pacing can be lifesaving, but it should be reserved for unconscious or sedated patients.

The use of a positive chronotropic agent such as isoproterenol could potentially increase the heart rate, blood pressure, and systemic effects while awaiting a permanent pacemaker. A 12-lead ECG will help in identifying the cause of the patient's bradycardia.

Pregnancy can be the cause of dizziness and postural hypotension but is less likely in this patient with a past history of being diagnosed with a heart defect, who also has bradycardia. While Lyme disease can cause atrioventricular block, there is no history of travel, illness, or skin rash to suggest that diagnosis. The patient in this vignette is symptomatic with bradycardia and hypotension and should be managed emergently rather than in an elective outpatient setting in the future with the pediatric cardiologist.

Take-Home Message

Patients with congenitally corrected transposition of the great vessels who have no other cardiac anomaly may present for the first time in adolescence or young adulthood with complete heart block. While the chronic bradycardia is usually well-tolerated, once heart block is established, the patient needs to be evaluated for placement of a permanent pacemaker.

ABP Content Specification

- Recognize signs and symptoms and life-threatening complications of congenital cardiac lesions by age.

Question 19

A 17-year-old girl is brought to the Emergency Department with uterine contractions. She is near-term and had spontaneous rupture of the membranes. She has had regular prenatal care. She has been followed by the maternal-fetal service for hypoplastic left heart syndrome (HLHS) in the fetus. Her labor is fairly rapid, and she is delivered of a 3.2 kg newborn male. After being

dried and warmed, the vital parameters of the newborn are as follows: heart rate 146 beats/minute, respiratory rate 28 breaths/minute, and oxygen saturation 91% in room air. You obtain an arterial blood gas analysis, which shows a PaO_2 of 39 mm Hg. Of the following, the most appropriate intervention at this time would be:

A. Allowing the child to bond with the parents and encourage breastfeeding.
B. Administer oxygen by nasal cannula.
C. Establish an intravenous line and start a prostaglandin infusion.
D. Intubate the child and provide ventilator support.
E. Obtain a CBC and blood culture and start antibiotics.

Correct Answer: C. Establish an intravenous line and start a prostaglandin infusion.

HLHS is a relatively uncommon cyanotic congenital heart lesion that affects around 2000 newborns a year in the United States. The defect is usually detected in fetal life on the basis of an abnormal ultrasound and fetal echocardiogram. About 10% of fetuses with HLHS are noted to have an intact or highly restrictive atrial septum. These fetuses are delivered by a planned C-section, as the neonates are likely to be quite sick and have high mortality rates. In other cases, delivery is planned after 39 completed weeks of gestation. Because this is a mixing lesion with unobstructed pulmonary blood flow, the oxygen saturations are usually in the high 80s to low 90s, with PaO_2 in the arterial blood around 35 to 45 mm Hg. The lesion is ductal-dependent, and hence institution of a prostaglandin infusion to keep the duct open is essential. The oxygen saturation and arterial PaO_2 are completely acceptable for this lesion, and maneuvers to increase the saturations are not likely to be helpful. In fact, by stimulating ductal closure, they may actually be harmful. In a stable patient with no risk factors, there is no indication for starting antibiotics.

Take-Home Message

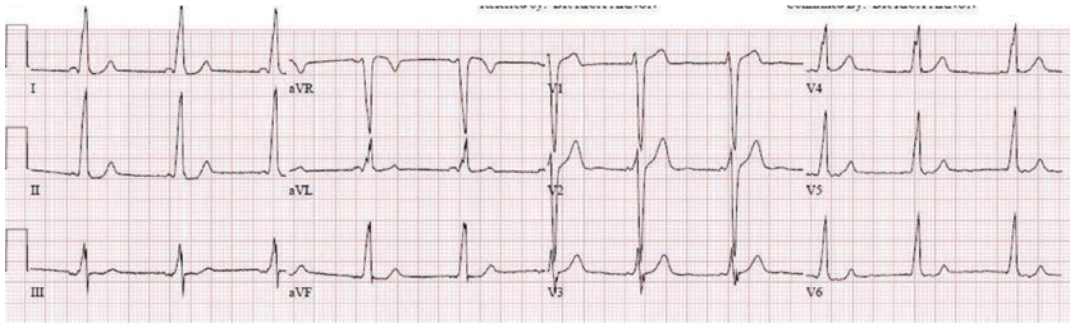
When the diagnosis of a duct-dependent lesion is made prenatally, the immediate postoperative management involves institution of prostaglandin therapy. This measure ensures adequate perfusion of the systemic or pulmonary circulation and prevents the development of acidosis or severe hypoxia.

ABP Content Specification

- Understand the pathophysiology and plan management of acutely symptomatic congenital heart disease.

Question 20

You are evaluating a healthy 16-year-old boy who had a screening electrocardiogram in his pediatrician's office as part of a pre-sport's participation physical. The pediatrician is concerned about abnormalities on the ECG. The patient denies any complaints of chest pain, palpitations, dizziness, or syncope. No family history of sudden cardiac death is noted. His vital parameters are normal for age, and cardiac examination is completely benign. You review the 12-lead electrocardiogram, which is shown as follows.



Your appropriate response with regard to sports participation would be:

A. All forms of physical exertion are permissible because personal or family cardiac history is not a concern.
B. The patient can participate in isotonic but not isometric exercises.
C. A detailed cardiac evaluation, including possibly an electrophysiology study, is necessary before the patient can take part in moderate-to-high intensity competitive sports.
D. The patient can participate in all sports as long as he is taking atenolol.
E. The patient can never participate in competitive sports.

Correct Answer: C. A detailed cardiac evaluation, including possibly an electrophysiology study, is necessary before the patient can take part in moderate-to-high intensity competitive sports.

The athlete in this vignette has evidence of preexcitation (Wolff-Parkinson-White) on the electrocardiogram. This has a prevalence of 0.1–0.3% in the general population and is frequently discovered as an incidental finding. Because these patients have an accessory pathway, atrial impulses can be transmitted to the ventricles with a shorter refractory period between consecutive impulses. Thus, the risk that atrial tachycardia can result in ventricular tachycardia is evident. However, the incidence of sudden cardiac death in an asymptomatic patient is very low (around 0.6%).

The approach to the asymptomatic younger patient with WPW on the ECG is somewhat uncertain. While the incidence of sudden cardiac death is very low, the young age of the patient implies that he might still be at risk for a first episode of supraventricular tachycardia, syncope, or sudden cardiac death. Hence, the recommendation is that such patients be evaluated, including possibly with an electrophysiology study. If the refractory period of the aberrant pathway is low, the pathway should be ablated. Following successful ablation, if there is no recurrence of the preexcitation on the ECG for 2 to 4 weeks, then the patient would be permitted to take part in all competitive sports. However, the use of atenolol alone does not mitigate the risk in these patients, and the patient would still not be permitted to play competitive sports.

Take-Home Message

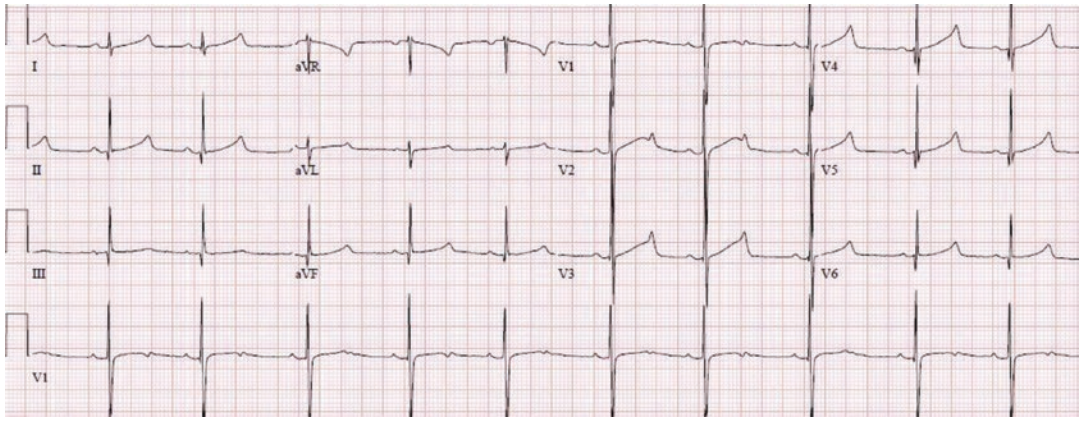
The standards for pre-participation clearance before taking part in competitive sports vary in different countries. While an ECG is not part of the workup in the United States, abnormalities on an ECG warrant evaluation by a cardiologist.

ABP Content Specification

- Recognize ECG abnormalities in children.

Question 21

A 12-year-old girl is brought to the Emergency Department after she fainted at home. She experienced a fast heart beat for a couple of minutes, felt dizzy, and "passed out." She lost consciousness for about 5 minutes, but had no loss of bladder or bowel tone, nor any tonic-clonic movements. By the time the EMT crew came home, she was awake and alert. In the ED, the patient appears well and in no distress. Her vital parameters are as follows: heart rate 70 beats/minute, respiratory rate 14 breaths/minute, and blood pressure 102/70 mm Hg. She is warm and well-perfused. Her pulse is regular. Her heart sounds are normal, and there is no murmur or rub. You review the ECG obtained on her in the ED, which is shown as follows.



At this time, the most appropriate next step in the management of this patient is:

A. Admit the patient for observation and request a cardiology evaluation.
B. Reassure the patient and her parents that her heart rate is within normal limits and discharge her.
C. Obtain intravenous access and give the patient a bolus of 20 ml/kg of normal saline.
D. Refer the patient to a geneticist for heritable arrhythmias.
E. Obtain a neurology consultation for syncope.

Correct Answer: A. Admit the patient for observation and request a cardiology evaluation.

Syncope is a common occurrence in the pediatric population and occurs in 15% of all patients by the end of adolescence. Fortunately, the vast majority of patients have benign vasovagal syncope. Cardiac causes of syncope, though extremely rare, are life-threatening. These would include pump failure as occurs with dilated cardiomyopathy and left ventricular obstructive lesions such as aortic stenosis, pulmonary hypertension, anomalies of coronary arteries, and malignant arrhythmias. While most malignant causes of cardiac syncope tend to manifest with exercise or strenuous activity, malignant arrhythmias may manifest without exertion. The history of preceding palpitations, the absence of postural changes precipitating syncope, and the somewhat prolonged duration of lack of consciousness make an arrhythmia a reasonable etiology for this patient's symptoms. The surface ECG of this patient shows normal sinus rhythm at a rate in the low 70s. However, the corrected QT interval, at 512 milliseconds, is prolonged.

Prolongation of the QTc interval may be secondary to the use of certain medications or to electrolyte abnormalities. Some individuals have congenital long QT syndrome, which is a heritable disorder. Because there is a potential for individuals with prolonged QTc interval to have a malignant polymorphic ventricular tachycardia, an individual with a history of syncope who has a prolonged QTc interval should be observed in a telemetry unit, until an electrophysiology study can be performed.

Torsade may occur in patients with prolonged QT interval during sinus rhythm. It is due to abnormal ventricular repolarization. In stable patients, the treatment of torsade is IV magnesium sulfate. In unstable patients, the treatment is defibrillation.

While the heart rate on the surface ECG is normal, the prolonged QTc warrants further workup, and reassurance of the patient and discharging her is not appropriate. There is no evidence of dehydration on physical examination in this patient, and fluid resuscitation is not called for. Congenital long QT syndrome is a heritable disorder, and genetic evaluation is part of the management of this patient with implications for the family unit. However, this can be done in an elective fashion. The patient's presentation does

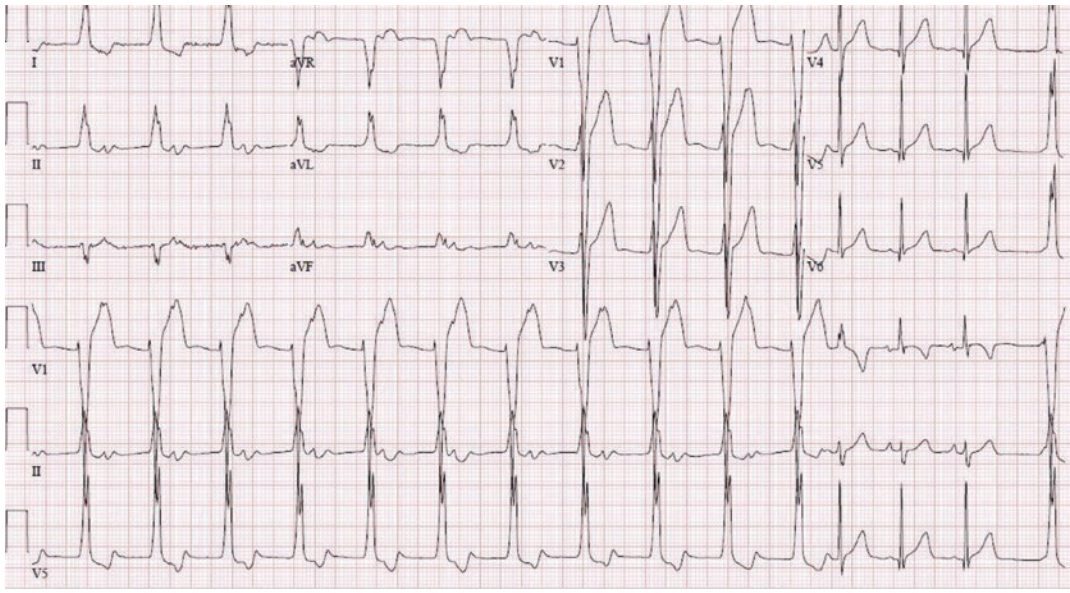
not suggest a neurological cause, and in the scenario where a cardiac cause appears likely, neurological consultation is not required.

Take-Home Message
While most cases of syncope in the pediatric age group are benign, a history of palpitations preceding the episode should prompt a detailed evaluation for a possible arrhythmia. Prolonged QT syndrome may present with ventricular tachycardia and syncope.

ABP Content Specification
- Recognize and plan the management of ECG abnormalities in children.

Question 22

A 6-year-old boy is transferred from a dialysis facility where he presented for his routine dialysis. His nurse noted that his heart rhythm tracing on his cardiac monitor appeared abnormal. On evaluation in the ED, the patient does not appear to be in any distress. His vital parameters are as follows: heart rate 90 beats/minute, respiratory rate 20 breaths/minute, and blood pressure 128/78 mm Hg. He is afebrile. He responds appropriately to your questions. Heart sounds are normal and no heart murmur is noted. Breath sounds are clear. Extremities are warm and well-perfused. The nurse brings over the 12-lead ECG for your review, which is shown as follows.



At this time, the next step in the management of this patient is:

A. Transfer the patient back for his routine dialysis treatment.
B. Electrical cardioversion with 0.5 J/kg of direct current.
C. Admit the patient for telemetry and obtain a complete set of electrolytes in the meantime.
D. Give intravenous potassium at a dose of 0.5 mEq/kg over a half hour.
E. Give oral potassium at dose of 2 mEq/kg/dose.

Correct Answer: C. Admit the patient for telemetry and obtain a complete set of electrolytes in the meantime.

The ECG of the patient in this vignette shows a wide-complex rhythm without a preceding P wave that spontaneously reverts to a sinus rhythm for two beats. This wide-complex rhythm is an

idioventricular rhythm until proven otherwise. Rhythm alterations may be noted in electrolyte abnormalities (commonly of potassium, calcium, and magnesium ions), which are present in patients with end-stage renal disease who have an impaired ability to maintain homeostatic levels of these ions. It is important to note that the patient in this vignette does not have ventricular tachycardia, nor does he have any hemodynamic compromise from his rhythm abnormality. Accordingly, the correct approach would be to assess his electrolyte balance and admit him for telemetry. Sending him back for dialysis without first working him up for his rhythm abnormality is inappropriate. As the patient does not have any hemodynamic compromise from his idioventricular rhythm, pharmacological or electrical intervention is not called for, and empirical therapy with potassium might even be dangerous.

Take-Home Message

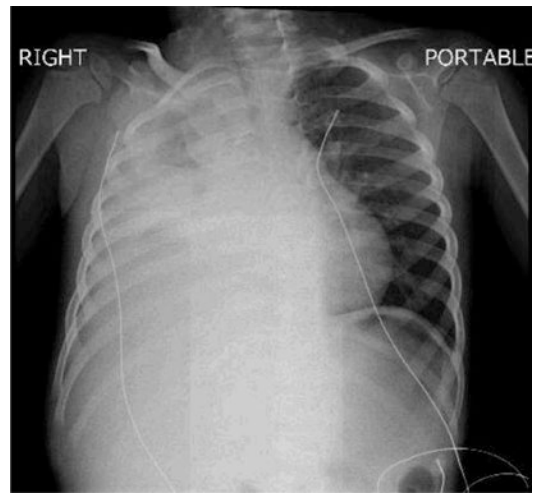
Rhythm abnormalities may be present in patients at risk for dyselectrolytemias. However, in the absence of hemodynamic compromise, they do not warrant emergent treatment, but rather, can be observed.

ABP Content Specification

- Recognize and plan management of acute cardiac dysrhythmias.

Question 23

The parents of a 3-year-old boy bring him to the Emergency Department because they are concerned about his breathing. He underwent surgical closure of an atrial septal defect 10 days ago. His postoperative recovery was uneventful, and he was sent home in 2 days. He appears to have recovered completely, with no history of fever, cough, chest pain, or decreased activity. Over the past 2 days, his parents have noted him to be breathing somewhat faster than before. He has a scheduled appointment with his cardiologist in 2 days. On examination, you notice a well-appearing child in no significant distress. His vital parameters are as follows: temperature 98.6 °F, heart rate 108 beats/minute, respiratory rate 36 breaths/minute, and blood pressure 98/60 mm Hg. Extremities are warm and well-perfused. While he is slightly tachypneic, he is not using accessory muscles of respiration. On auscultation, you do not hear any breath sounds over the right back. Heart sounds are heard, and there is 2/6 ejection systolic murmur over the left sternal border. You obtain a chest radiograph, which is shown as follows.



At this time, the best next step in the management of this patient is:

A. Instruct the parents that it is very important that they keep their follow-up appointment with their cardiologist.
B. Consult the cardiology team and admit the patient for medical management and observation.
C. Arrange for an emergent pleurocentesis.
D. Send the patient home on a regimen of furosemide.
E. Send the patient home on a regimen of steroids.

Correct Answer: B. Consult the cardiology team and admit the patient for medical management and observation.

The patient in this vignette has clinical and radiographic evidence of a large right-sided pleural effusion. This is probably secondary to a post-inflammatory response, which is seen 2 to 5 weeks following cardiac surgery. While the effusion is clearly quite large and occupies most of the right hemithorax, the child in question is not in significant distress. It might be appropriate to admit the child for observation and medical management with diuretics and anti-inflammatory agents (ibuprofen or steroids). If there is no significant change in the fluid volume, or if there is evidence of clinical decompensation, then a pleurocentesis, with placement of an indwelling pigtail catheter, can be performed. Despite the patient's lack of symptoms, the effusion is quite large. Asking the patient to follow-up with the cardiologist or sending him home on medications is not appropriate.

Take-Home Message

Following open-heart surgery, patients are at risk of developing a post-pericardiotomy syndrome which may manifest with a pleural and/or pericardial effusion. It may respond to medical therapy alone and occasionally might require drainage.

ABP Content Specification

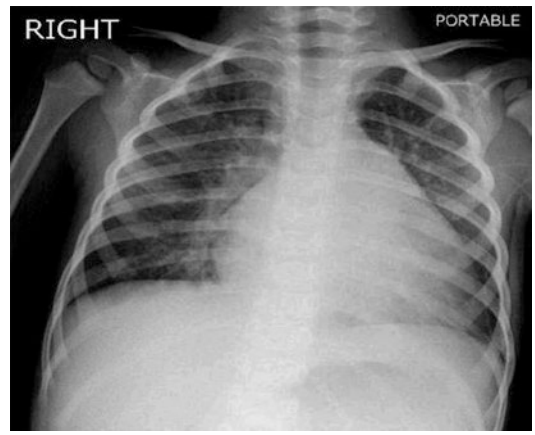
- Recognize the signs, interpret investigations, and plan management of pleural effusion.

Question 24

A 3-year-old girl has been seen in the Emergency Department for the third time in 3 weeks. She started attending preschool 3 weeks ago. She was exposed to a sick contact and developed a fever and runny nose 3 days after starting school. She was evaluated in the ED and diagnosed with a viral upper respiratory tract infection. Ten days later, the parents brought her again for the assessment of a cough. She was diagnosed with reactive airways disease and sent home with a nebulized bronchodilator. Today the parents have brought her with the complaint that the cough remains unresponsive to the medication. The child appears to be breathing heavily and gets tired quite quickly.

Her vital parameters are as follows: afebrile, heart rate 136 beats/minute, respiratory rate 36 breaths/minute, and blood pressure 86/48 mm Hg. Her extremities are warm and well perfused. Faint crackles are heard at the bases of her lung fields. Heart sounds are heard, and there is no murmur. The liver edge is felt 3 cm below the right costal margin.

A chest radiograph is obtained and is shown as follows.



At this time, the next best step in the management of this patient should be:

A. Obtain pediatric cardiology consultation.
B. Give the patient the first dose of prednisone and discharge her on a regimen of albuterol and prednisone.
C. Treat the patient with an antibiotic for pneumonia.
D. Obtain pediatric infectious disease consultation to exclude tuberculosis
E. Consult the pediatric pulmonologist and request a bronchoscopy for a foreign body.

Correct Answer: A. Obtain pediatric cardiology consultation

The patient in this vignette has a chest radiograph with an enlarged cardiac shadow, raising the

possibility of dilated cardiomyopathy or a pericardial effusion in someone with no previous history of heart disease. The prior history of a viral infection and the lack of muffled heart sounds on the physical examination makes myocarditis leading to ventricular dilation a more likely diagnosis. Children, especially neonates, appear to be vulnerable to fulminant viral myocarditis, which can progress to dilated cardiomyopathy.

The diagnosis is easily established by an echocardiogram. Treatment would depend on the clinical manifestations. Those with evidence of low cardiac output would benefit from the use of inotropes and diuretics, whereas those that are well-perfused but present with respiratory symptoms would benefit from the use of diuretics alone.

Patients with reactive airways disease should not have evidence of cardiomegaly or hepatomegaly. There is no evidence of pneumonia or a foreign body on the chest radiograph.

Take-Home Message

Tachypnea in a patient with no past history of asthma, and which is unresponsive to bronchodilators, should warrant additional investigations to rule out another etiology.

ABP Content Specification

- Recognize the signs and interpret investigations of cardiomyopathy.

Suggested Reading

Question 1

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Question 2

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Question 5

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Question 11

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Yang EH, Shah S, Criley JM. Digitalis toxicity: a fading but crucial complication to recognize. Am J Med. 2012;125:337–43.

Question 13

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Question 14

Chan CW. Evaluation of digital clubbing. Aust Fam Physician. 2015;44(3):113–6.

Question 15

Friedman KG, Alexander ME. Chest pain and syncope in children: a practical approach to the diagnosis of cardiac disease. J Pediatr. 2013;163:896.

Question 16

Gupta A, Daggett C, Behera S, et al. Risk factors for persistent pleural effusions after the extra-cardiac Fontan procedure. J Thorac Cardiovasc Surg. 2004;124:1664–9.

Question 17

Massin MM, Bourguignont A, Coremans C, et al. Chest pain in pediatric patients presenting to an emergency department or to a cardiac clinic. Clin Pediatr (Phila). 2004;43:231.

Question 18

Atallah J, Rutledge JM, Dyck JD. Congenitally corrected transposition of the great arteries. In: Allen HD, Shaddy RE, Penny DJ, Cetta F, Feltes TF, editors. Moss and Adams' heart disease in infants, children and adolescents: including the fetus and young adult. Philadelphia: Walters Kluwer; 2016.

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Dermatology

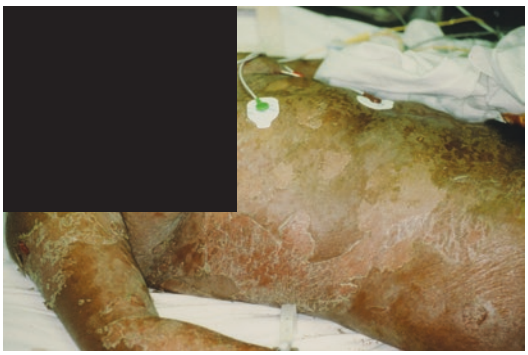
7

Donna M. Simmons, Michael D. Lanigan, and Ashley Keyes Jacobs

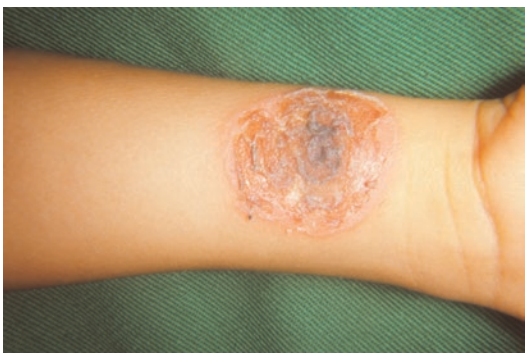
Question 1

A 4-year-old previously healthy boy developed a pruritic, vesicular rash with a fever. After initial improvement, he now has tender, indurated erythema of the right thigh. He is ill appearing and complains of pain; vital signs include a temperature of 103 °F, heart rate of 150 beats/minute, respiratory rate of 32 breaths/minute, and blood pressure of 85/60 mm Hg. What is the most likely cause of his symptoms?

A. Epidermolysis bullosa
B. Bullous impetigo
C. Scarlet fever
D. Toxic shock syndrome
E. Staphylococcal scalded skin syndrome



Toxic shock



Bullous impetigo

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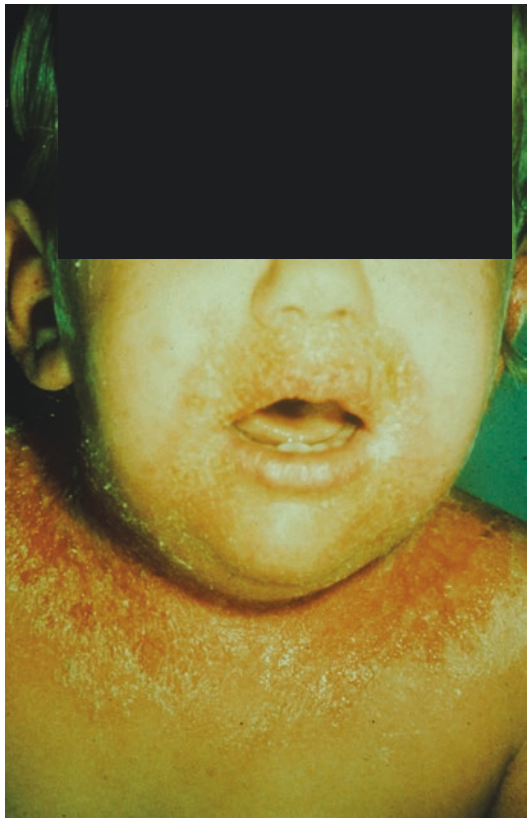
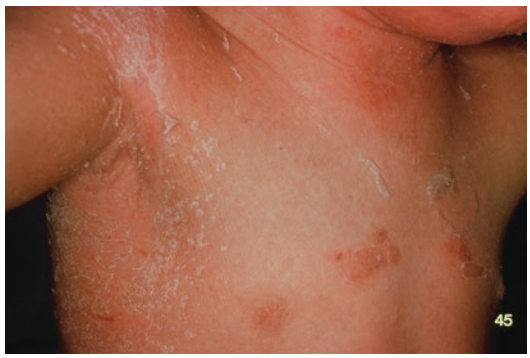
M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_7



Staph scalded skin syndrome



Staph scalded skin syndrome

Correct Answer: D

This child has symptoms consistent with toxic shock syndrome (TSS). It may be caused by either *Streptococcus pyogenes*, group A streptococcus (GAS), or *Staphylococcus aureus*. Streptococcal TSS is more serious and arises from invasive, soft tissue infections such as necrotizing fasciitis and myositis. Clinical manifestations are fever (>102 °F [38.9 °C]), hypotension, diffuse erythroderma, and multisystem involvement. Common laboratory abnormalities include elevated creatine kinase, elevated blood urea nitrogen or creatinine, transaminitis, and thrombocytopenia. These patients require ICU-level supportive care. Antibiotic therapy should include clindamycin to suppress toxin production well as an antistaphylococcal penicillin or vancomycin pending wound cultures. Surgical debridement may be necessary if necrotizing fasciitis or myositis develop. Varicella is a rare predisposing factor for toxic shock in children.

Epidermolysis bullosa (EB) refers to a group of inherited disorders characterized by mechanically fragile skin with a propensity to develop blisters and/or erosions. The blisters develop after minimal trauma. Esophageal strictures may also occur. Infection with *Staphylococcus aureus* or GAS is a common complication.

The rash of scarlet fever has punctate erythematous papules which has a "sandpaper" consistency. It is associated with streptococcal pharyngitis. The rash may accentuate in skin folds with petechiae, a finding called "Pastia's lines." Exudative erythema of the tonsils and a red tongue with prominent papillae, "strawberry tongue," are additional cutaneous findings. A positive culture of group A β-hemolytic strep and elevated serum antistreptolysin-O titer support the diagnosis. With early diagnosis and initiation of penicillin, the prognosis is excellent.

Staphylococcal scalded skin syndrome (SSSS) is caused by infection with exfoliative toxin-producing *Staphylococcus aureus*, usually involving the conjunctivae, nares, or perineum. Patients develop fever, malaise, and irritability due to the systemically circulating toxin, along with characteristic erythema and fragile blisters in skin folds. The skin may be tender and have a sandpaper-like texture similar to that present in scarlet fever. Of note, the rash of scarlet fever is not tender. Superficial desquamation leaves a moist, red, glistening surface, and light stroking may result in separation of the upper portion of the epidermis (Nikolsky's sign). SSSS should be differentiated from TEN. Early distinction between SSSS and

TEN is important because the treatment for SSSS involves anti-staphylococcal antibiotics, whereas in TEN discontinuations of the offending agent and initiation of aggressive burn unit intervention are essential.

Bullous impetigo is caused by cutaneous infection with toxin-producing *Staph. aureus* and is considered a localized form of SSSS. Topical antibiotics may be effective for limited disease; however, systemic antibiotics are often needed.

Take-Home Message
Toxic shock syndrome is a rare and life-threatening complication of bacterial infection with *Streptococcus pyogenes* or *Staphylococcus aureus*.

Question 2

An 8-month-old boy is brought to the emergency department for evaluation of a rash and facial swelling. He has a runny nose and cough without fever, vomiting, or diarrhea. He has been active at home and is voiding normally. On examination, he is noted to have facial edema with rosette-shaped purpuric lesions on the face and both upper and lower extremities. The most appropriate treatment for this patient is:

A. IVIG
B. IV ceftriaxone
C. Supportive treatment
D. Skin biopsy to evaluate for IgA deposition
E. Systemic corticosteroids

Correct Answer: C

Fever, edema, and rosette-shaped or targetoid purpura primarily over the face, ears, and extremities in a nontoxic infant is consistent with acute hemorrhagic edema of infancy (AHEI). AHEI usually occurs following an infectious trigger or vaccination. It uncommonly presents with abdominal or joint pain. Leukocytoclastic vasculitis is seen on histopathology; however, the diagnosis is most often made clinically. No treatment is generally needed and resolution occurs over approximately 3 weeks.

AHEI is distinct from Henoch–Schonlein purpura (HSP), which manifests as symmetric palpable purpura on the lower extremities and abdominal pain with or without joint pain. The treatment is supportive; however, systemic corticosteroids may be required for severe symptoms such as abdominal pain, joint pain, or bullous skin lesions. The diagnosis can be made clinically. A skin biopsy is confirmatory showing leukocytoclastic vasculitis and IgA deposition on direct immunofluorescence. Urinalysis should be obtained to evaluate for renal involvement in the form of hematuria or proteinuria.

The child in this vignette has had symptoms for 3 days and is otherwise well appearing. Purpura fulminans is characterized by rapidly progressive hemorrhagic necrosis of the skin with disseminated intravascular coagulation. Treatment is directed at the underlying cause.

IVIG is a treatment option for patients with immune thrombocytopenic purpura.

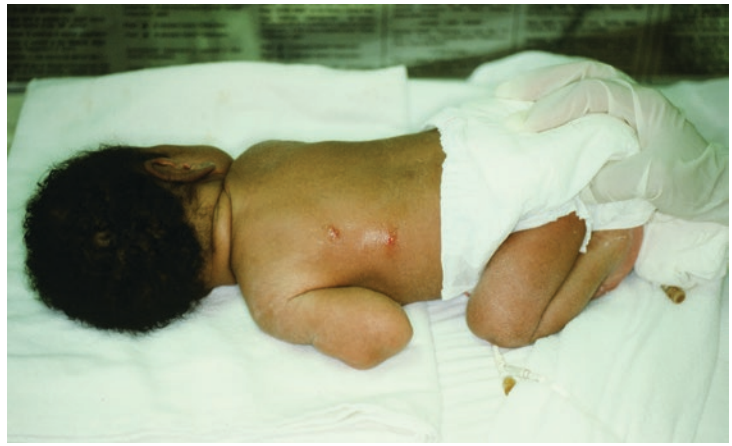
Take-Home Message
Acute hemorrhagic edema of infancy is a benign and self-limiting illness requiring supportive care. Common causes include infection, such as a viral upper respiratory infection, medications, and immunizations.

Question 3

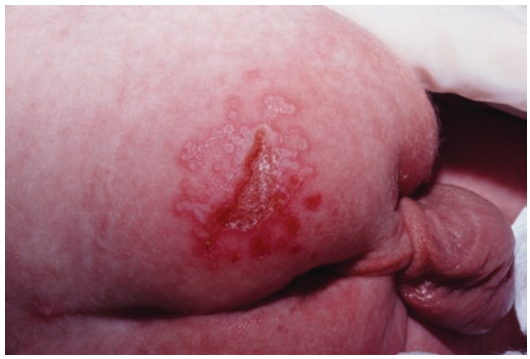
A 10-day-old male infant presents with vesicles on an erythematous base on the face. His mother states he has not been feeding well and has been sleeping more than usual. The most appropriate next step in your management of this child is:

A. Tell mother that a spinal tap is not needed because the child does not have fever
B. Obtain viral cultures of the rash and start oral acyclovir
C. Isolate the baby, evaluate for CNS and disseminated infection, and begin IV acyclovir
D. Reassure the family that all newborns sleep
E. Obtain measles IgG

Correct Answer: C



Herpes simplex



Neonatal herpes simplex

A vesicular rash in a neonate is concerning for herpes simplex virus infection (HSV). Neonatal herpes is classified by pattern: skin, eyes, and mouth, central nervous system, or disseminated. A vesicular rash or suspected HSV in a neonate requires contact isolation; evaluation for systemic involvement, including lumbar puncture; and empiric IV antiviral treatment while awaiting confirmatory diagnostic tests. In this patient, a scraping from the base of the lesion as well as cerebrospinal fluid can be sent for both viral culture and polymerase chain reaction (PCR). The neonate should be treated with high-dose acyclovir while awaiting test results. Expert groups recommend caesarean section if primary genital herpes is present in the third trimester or within 6 weeks of delivery.

Although skin lesions are the most common presentation, neonates may not have cutaneous findings in the initial course of disease; when a mother has a history of genital herpes, fever, irritability, lethargy, seizures, hepatitis, or pneumonitis in a newborn should raise consideration of neonatal herpes.

Measles does not present with vesicles; therefore, measles IgG is not indicated in this child.

Take-Home Message

Herpes or suspected herpes in the neonate is a life-threatening illness requiring empiric high-dose antiviral treatment and evaluation including lumbar puncture. Neonates born to mothers with active primary genital herpes at the time of delivery are at highest risk for infection.

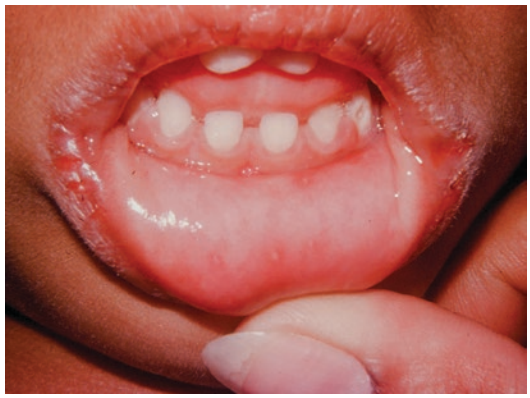
Question 4

A 5-year-old girl with a history of eczema develops a blister in her mouth. Her mother reports decreased oral intake and drooling. On examination, there are erythematous blanching patches with oval vesicles on her hands, feet, mouth, and buttocks. Which of the following statements is true regarding the most likely cause of this child's symptoms?

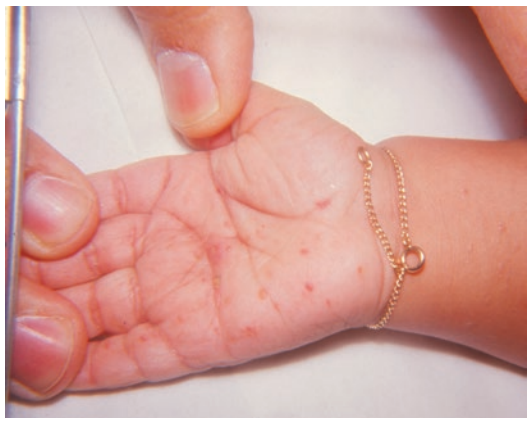
A. Topical acyclovir will decrease viral shedding
B. Topical corticosteroids will prevent recurrence
C. She may develop desquamation of the fingernails after the infection resolves

D. Involvement of the diaper area is atypical
E. The condition is not contagious

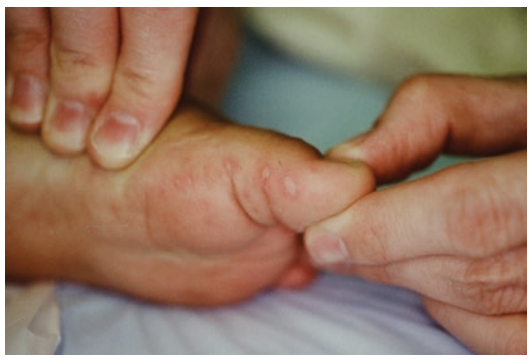
Correct Answer: C



Hand foot mouth disease



Hand foot mouth disease



Hand foot mouth disease

This child has a vesicular eruption in the typical distribution of hand, foot, and mouth disease (HFMD). The most common cause is coxsackie A16. It is highly contagious. There may be a prodrome of low-grade fever, malaise, diarrhea, and irritability which is followed by the appearance of papulovesicles on the palate, tongue, or buccal mucosa.

Vesicles are also found on the hands, feet, and diaper area and may generalize to the upper and lower extremities. Nail changes such as onychomadesis, which is separation of the proximal portion of the nail plate from the nail bed, may occur 2–4 weeks later.

In chicken pox, oral lesions are less common; the lesions are more extensive and centrally distributed; generally palms and soles are not involved. Also, herpangina may resemble HFMD, but it usually involves the posterior oropharynx; typical sites are fauces and soft palate. The vesicles of herpes develop in clusters. Multinucleated giant cells are present in the smear from a vesicle of varicella and herpes but not present in lesions of HFMD. It is usually self-limited and the treatment is supportive.

Take-Home Message
Vesicles on the hands, feet, perioral, and diaper area are characteristics of HFMD.

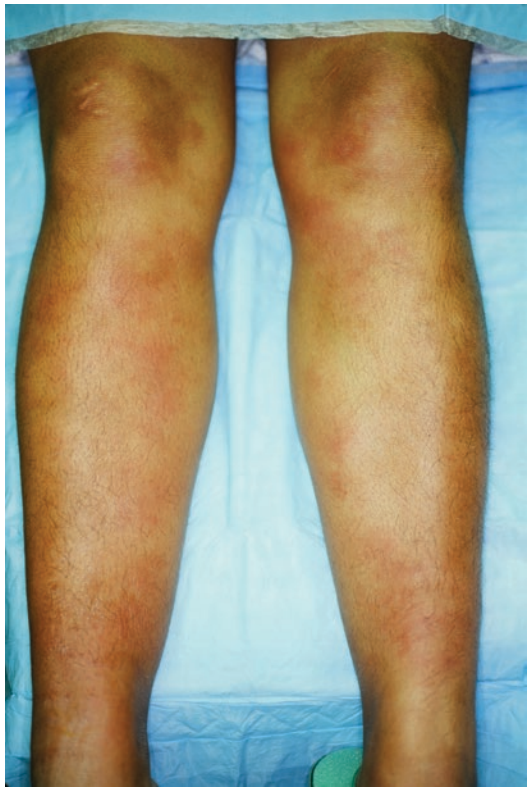
Question 5

A 15-year-old girl presents to the emergency department with painful bumps on her shins. She denies abdominal pain, vomiting, or fever. On physical examination she has tender subcutaneous nodules on her shins bilaterally. She denies recent trauma to her legs and had no improvement after applying ice to the affected areas. Which of the following is true?

A. This rash may be associated with streptococcal pharyngitis
B. She has erythema nodosum associated with irritable bowel syndrome
C. The rash is characteristic of cold panniculitis

D. The rash is due to necrosis of the subcutaneous fat
E. The condition is equally common in women and men

Correct Answer: A



Erythema nodosum

Erythema nodosum (EN) is a panniculitis, or inflammation in the fat, which is characterized by erythematous tender nodules typically localized to the anterior surface of the shins. The thighs and forearms are occasionally involved.

EN is a delayed-type hypersensitivity reaction and is rarely seen in children less than 2 years of age. In most cases the cause is unknown; however, associated conditions include group A streptococcal infection, inflammatory bowel disease, tuberculosis, and sarcoidosis. Medications (such as oral contraceptives), pregnancy, and malignancy have also been implicated. Episodes usually resolve spontaneously within several weeks and may recur. Treatment should be directed towards the underlying disorders.

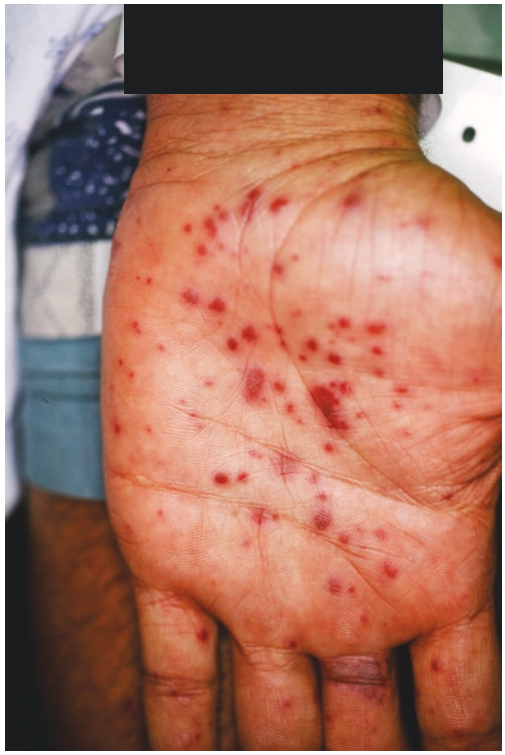
Cold panniculitis occurs within a few hours to days following exposure to cold and is characterized by erythematous plaques or subcutaneous nodules in healthy individuals. Infants and children are particularly susceptible. In this case, the nodules developed prior to the application of ice.

Take-Home Message
Erythema nodosum is a panniculitis requiring evaluation for underlying systemic disease. Common triggers include streptococcal throat infection, inflammatory bowel disease, sarcoidosis, pregnancy, and medications.

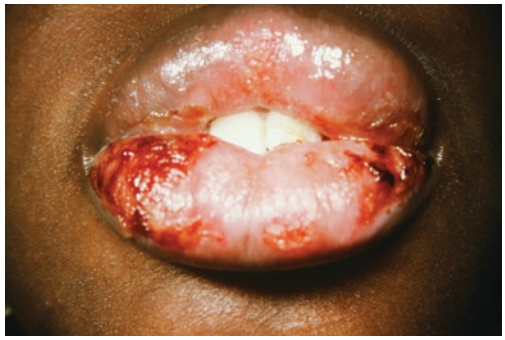
Question 6

An 11-year-old boy presents to the emergency department with an expanding red rash on his left leg. On examination, there is an annular erythematous patch. He complains of a headache and myalgias. He recently returned from a visit to Vermont. All of the following statements are true *except*:

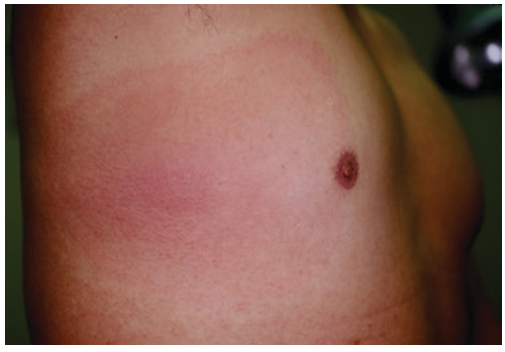
A. This rash is not typical of tinea corporis
B. This rash can be associated with AV nodal conduction blocks
C. He most likely does not have erythema multiforme
D. The rash is caused by *Borrelia burgdorferi*
E. The rash is not consistent with Lyme disease without a history of a tick bite and should not be treated



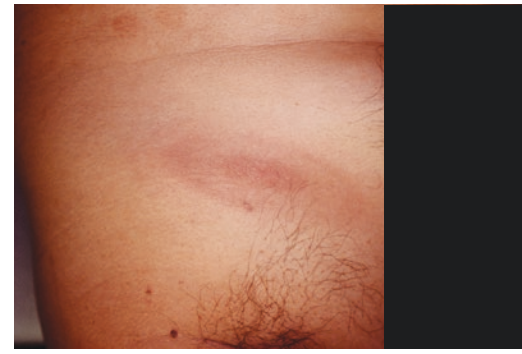
Erythema multiforme



Erythema multiforme



Lyme



Lyme

Correct Answer: E

This child has constitutional symptoms, an annular rash consistent with erythema chronicum migrans (ECM) and possible tick exposure. This suggests a diagnosis of Lyme disease caused by the spirochete *Borrelia burgdorferi* and requires treatment. It is the most common clinical manifestation of Lyme disease. The rash begins at the site of inoculation with spreading erythema expanding several centimeters per week. An annular appearance develops as the edge continues to advance and the center clears. Most cases do not itch.

Untreated Lyme disease can be complicated by heart disease manifested by conduction delays, myocarditis, and pericarditis. Neurologic symptoms can include cranial nerve palsies and meningitis. Arthritis is the most common symptom of disseminated infection.

Amoxicillin is the treatment of choice for children less than 8 years of age and doxycycline is preferred in older children.

Tinea corporis classically presents with annular erythematous patches or plaques with scale. The lesions are pruritic. Partial resolution can occur spontaneously leaving areas of post-inflammatory hyperpigmentation. Topical antifungals can be effective, though widespread involvement may require systemic treatment.

Erythema multiforme is a cytotoxic hypersensitivity reaction characterized by a target lesion. The classic target has an erythematous to dusky center surrounded by a ring of paler erythema and edema and a brightly erythematous border. Due to necrosis, the center may develop a vesicle

or erosion. Extensive mucosal involvement can occur. In children, herpes simplex is the most common triggering infection.

Take-Home Message
An annular rash after potential tick exposure requires empiric treatment for Lyme disease. It is important to note a history of tick bite is only elicited in approximately half of patients with ECM.

Question 7

A 3-year-old child presents to the emergency department with red patches on his cheeks. On examination, he is well appearing and has erythematous reticular patches on the trunk and extremities. Which of the following is true?

A. The child is infectious
B. The condition is associated with rheumatoid arthritis in children
C. In utero infection poses no risk to a fetus
D. This virus is associated with aplastic crisis
E. The child should be given topical corticosteroids for eczematous dermatitis

Correct Answer: D

Erythema infectiosum, also known as fifth disease, is caused by parvovirus B19. The exanthem is characterized by facial erythema with a "slapped-cheek" appearance. The rash then spreads to the trunk and proximal extremities with diffuse macular erythema evolving into a lacy, reticular pattern. Patients are only contagious during the prodromal viremic phase prior to the onset of cutaneous findings. For this reason, isolation and exclusion from school or childcare are unnecessary and ineffective after diagnosis. Exposure in nonimmune pregnant women has potentially severe consequences to the fetus, including anemia, congestive heart failure, hydrops fetalis, and intrauterine demise. This infection is associated with aplastic crisis in predisposed individuals. Joint involvement is more common in adults than children. The rash is self-limited and not responsive to topical corticosteroids.

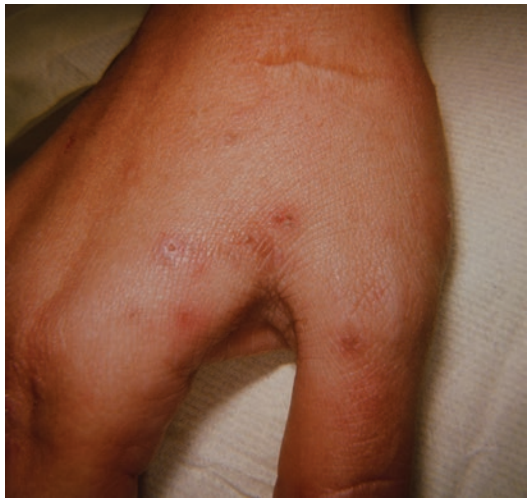
Take-Home Message
Parvovirus is a self-limited viral illness. The presence of rash indicates a patient is no longer contagious. Infection during the first half of pregnancy can have devastating consequences such as fetal loss or hydrops fetalis.

Question 8

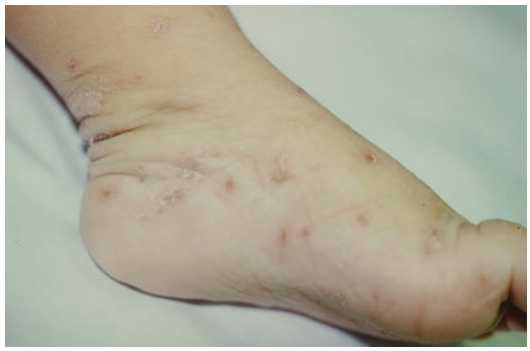
A father brings his 9-month-old son in with a pruritic rash that developed after a month-long visit with his mother. On exam, he has papules and vesiculopustules most densely on the axillae, hands, feet, and penis. The best treatment is:

A. Lindane from head to toe for the entire family
B. Permethrin 5% cream from head to toe overnight
C. Topical corticosteroids for the itching
D. Permethrin for all the adults but not the infant
E. Oral ivermectin 200 mcg/kg

Correct Answer: B



Scabies



Scabies

The presentation is consistent with a scabies infestation, caused by the mite *Sarcoptes scabiei hominis*. The incubation period for scabies is approximately 3–4 weeks. Characteristic findings include burrows, which represent the intraepidermal tunnel created by the moving female mite. Inflammatory papules and nodules are typically found on the ventral wrists, axillae, breasts, umbilicus, and genitalia. Nodules on the male genitalia can be a particularly important clinical finding. Infants commonly have involvement of the palms and soles, and unlike adults, the scalp and face may be affected.

Permethrin 5% cream is FDA approved for infants 2 months and older; it is the treatment of choice. Treatment should be applied to all skin surfaces including the genitalia and beneath the nails. In children, permethrin should be applied to the scalp and face. Lindane is not recommended for infants due to CNS toxicity. Additionally, there is a high rate of resistance. Ivermectin is an oral antihelminthic used for a variety of parasitic infections worldwide. It causes paralysis of parasites by affecting GABA-mediated nerve synapses and is available in topical and oral formulations. The safety of ivermectin has not been established in patients weighing less than 15 kg. All household members and intimate contacts should be treated simultaneously due to the risk of transmission via asymptomatic carriers.

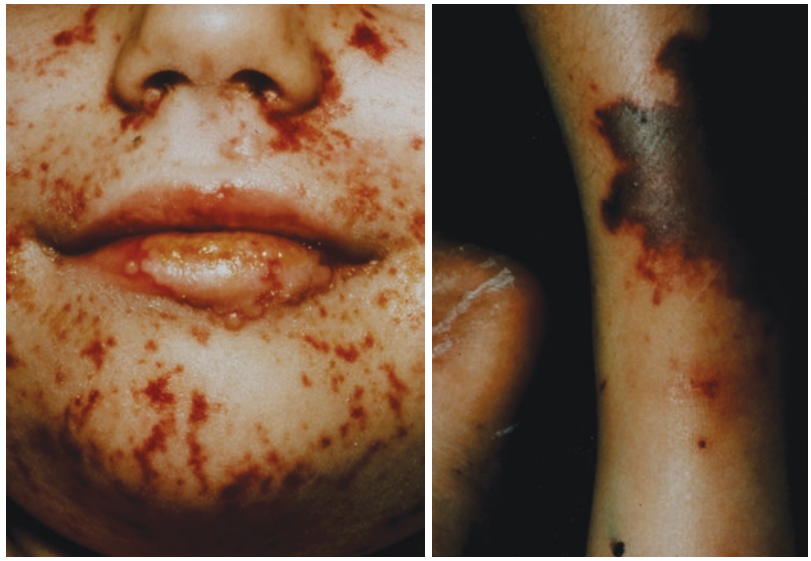
A topical steroid may be given for the associated hypersensitivity reaction and pruritus, after treatment with permethrin.

Take-Home Message
Eradication of scabies requires appropriate application of topical therapy and treatment of close contacts. Unlike adults, involvement of the scalp and face as well as acral pustules are seen in children.

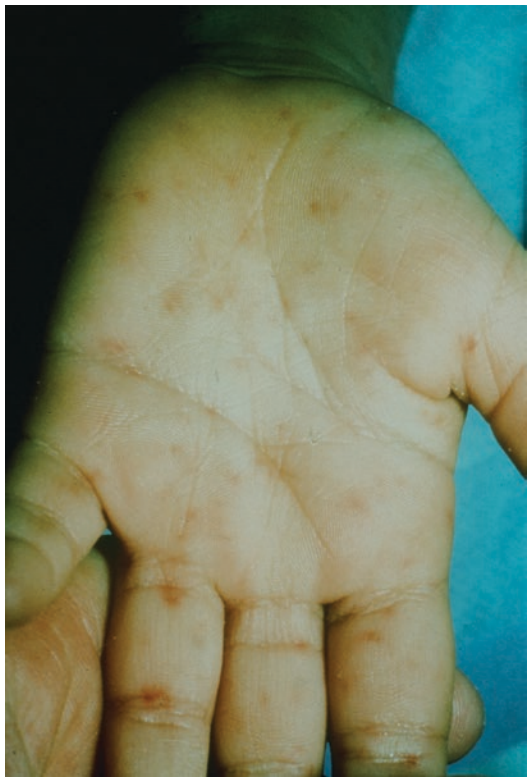
Question 9

An 11-year-old boy recently arrived from Europe after a visit with his family. He has had a few days of cough and rhinorrhea followed by macular erythema of the face which has spread to the body. He also has injected conjunctivae which the family believes is due to the high fever and lack of sleep after his long flight home. His vaccinations are not up to date. He most likely has:

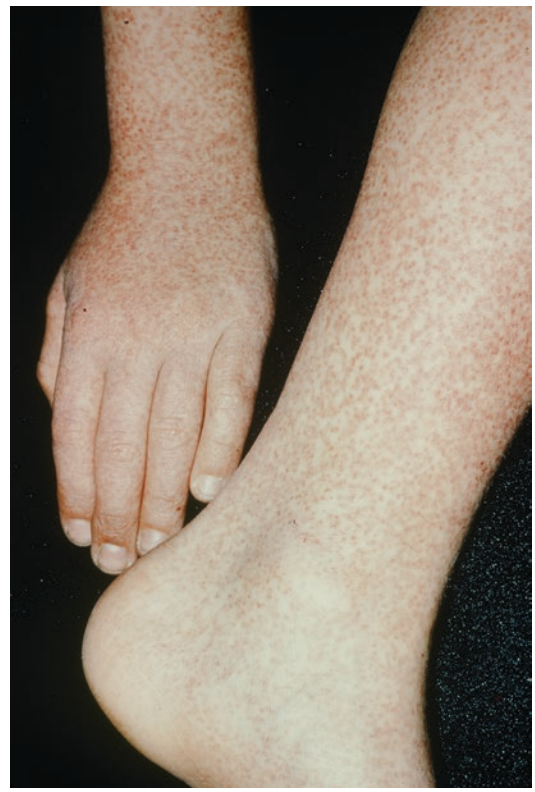
A. Meningococcemia
B. Rocky Mountain spotted fever
C. Measles (rubeola)
D. Erythema infectiosum (fifth disease)
E. Scarlet fever



Meningococcemia



Rocky mountain spotted fever



Atypical measles

Correct Answer: C

The most likely diagnosis in this child is measles, which presents with fever and the 3 Cs: cough, coryza, and conjunctivitis. During this prodrome, some patients will develop Koplik spots, bluish-white macules on the buccal mucosa, which are pathognomonic. Around day four, a rash begins on the face and spreads to the trunk and extremities. Initially macular, the rash evolves to fine papules and may be slightly pruritic. Complications include secondary bacterial infections such as pneumonia and otitis media; encephalitis is a rare but serious complication. Routine vaccination of children has dramatically reduced the incidence of measles worldwide.

Meningococcemia is caused by a gram-negative organism, *Neisseria meningitidis*. Classic skin findings include petechiae or purpuric plaques due to angioinvasion by the organism and subsequent development of disseminated intravascular coagulation. Patients are critically ill.

In Rocky Mountain spotted fever (RMSF), symptoms include headache, gastrointestinal symptoms, malaise, and myalgias followed by fever and rash. The petechial rash begins on the wrists, ankles, palms, and soles and then spreads centrally. The classic triad of RMSF consists of fever, headache, and rash; however, patients may not present with all findings. A history of a tick bite may or may not be present. Doxycycline is the treatment of choice.

The rash of erythema infectiosum presents with "slapped-cheek" facial erythema followed by a lacy, reticulated eruption on the trunk and extremities. It is caused by human parvovirus B19. Conjunctivitis is not a characteristic finding.

Take-Home Message

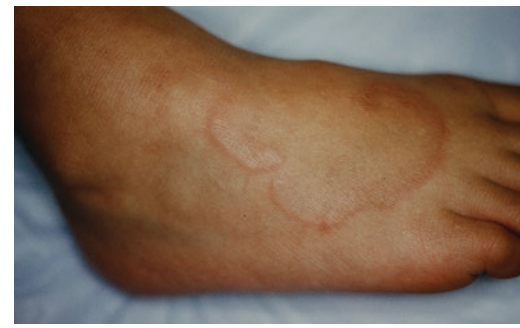
The classic triad of measles includes cough, coryza, and conjunctivitis. Koplik spots are considered pathognomonic and occur before the exanthematous stage.

Question 10

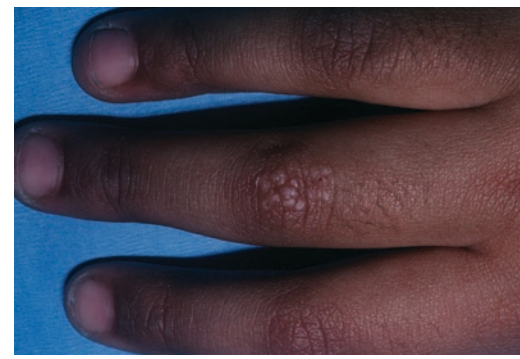
A 4-year-old boy presents with a solitary, asymptomatic lesion on his lower leg. On exam, he has an annular, erythematous plaque with small papules peripherally. There is no scale. His doctor prescribed antifungal cream without improvement. The next best step is:

A. No treatment as the condition is self-limited
B. Systemic antifungals
C. Topical corticosteroids
D. Combination antifungal/corticosteroid cream
E. Systemic antibiotics

Correct Answer: A



Granuloma annulare



Granuloma annulare

This patient most likely has granuloma annulare (GA). The clue is the absence of scale and lack of response to topical antifungals. The cause of GA is unknown, though some studies suggest an association with diabetes mellitus. Potent topical corticosteroids may be helpful; however, given the self-limited and asymptomatic nature and potential side effects of topical corticosteroids, observation is an acceptable approach.

Systemic griseofulvin is the treatment of choice for tinea capitis or extensive tinea corporis. The diagnosis of dermatophyte should be confirmed with microscopic examination of skin scrapings and fungal culture.

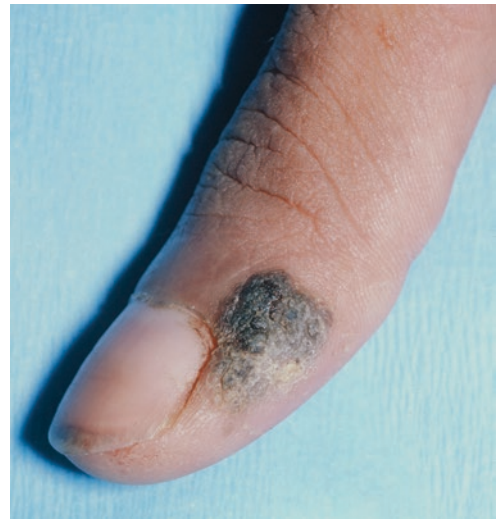
Combination treatments with antifungal and corticosteroids should generally be avoided for their potential for misuse and adverse effects such as atrophy, dyschromia, and telangiectasias.

Take-Home Message
Granuloma annulare is a benign skin condition which presents as annular, dermal papules or plaques.

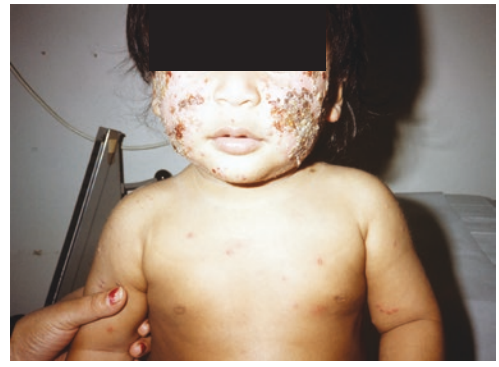
Question 11

A 3-year-old boy is brought to the emergency department with a several-month history of a rash on the left thigh, now with a nodule in the groin. On examination, there is a 1-cm nontender nodule in the left inguinal fold without overlying erythema. On the same thigh there are many skin-colored pink papules with central umbilication, some with heme-colored and honey crust. Your primary diagnosis is:

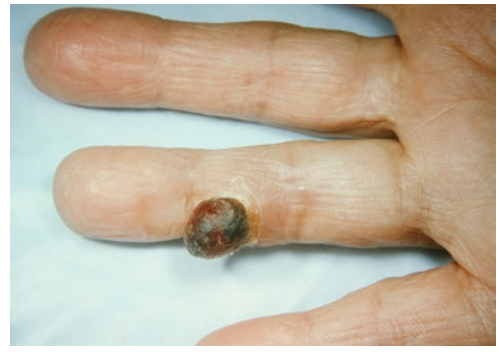
A. Verruca vulgaris
B. Pyogenic granuloma
C. Cold panniculitis
D. Molluscum contagiosum
E. Impetigo



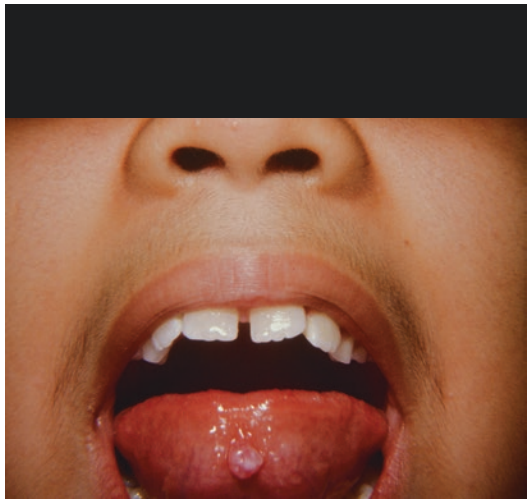
Wart



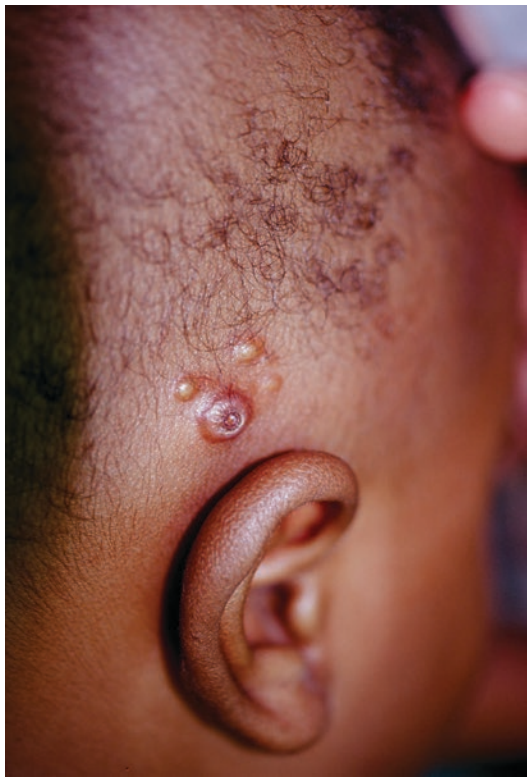
Impetigo



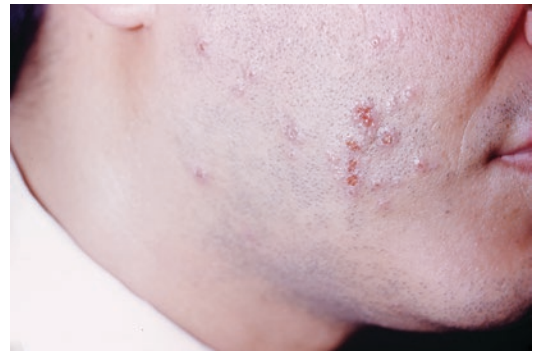
Pyogenic granuloma



Pyogenic granuloma



Molluscum contagiosum



Impetigo

Correct Answer: D

Skin-colored to pink, umbilicated papules are typical of molluscum contagiosum (MC). Caused by the poxvirus, the condition is benign and self-limited. Occasionally, individual lesions may become inflamed, which may indicate impending resolution. Destructive methods may be considered for treatment, if tolerated by the patient; however, watchful waiting is a reasonable choice. MC may become secondarily impetiginized resulting in regional lymphadenopathy. When MC involves an area of atopic dermatitis, topical corticosteroids should be continued for the treatment of eczema to prevent further spread via scratching.

Verruca vulgaris, the common wart, is a benign tumor caused by human papillomavirus (HPV) infection of the skin. These hyperkeratotic papules do not have central umbilication. Like molluscum, warts are benign and resolve spontaneously. A variety of topical and destructive therapies are available if treatment is desired.

Pyogenic granuloma (PG) is a benign, acquired vascular tumor presenting as an exophytic friable papule. A collarette of scale at the base is characteristic. Ulceration and bleeding prompt patients to seek medical attention. PG is treated by shave removal followed by destruction of the base with electrodesiccation to prevent recurrence.

Cold panniculitis is characterized by painful erythematous plaques or subcutaneous nodules that occur in areas exposed to cold.

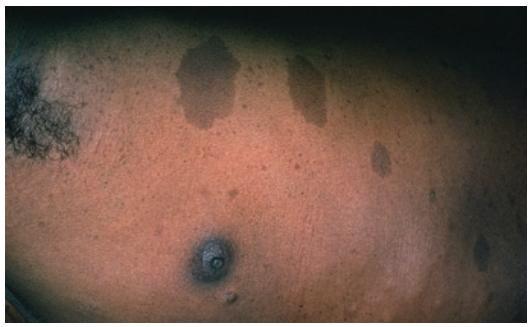
Impetigo can be bullous or non-bullous. The non-bullous type is the most common form of impetigo, easily recognized by its characteristic honey-colored crust. In the bullous form, vesicles enlarge to form flaccid bullae with clear yellow fluid. Often, patients will present with erosions and a collarette of scale. Bullous impetigo is the result of exfoliative toxin, which is also implicated in staph scalded skin syndrome.

Take-Home Message
The primary lesion of molluscum contagiosum is a skin-colored to pink umbilicated papule. Secondary impetiginization with *Staphylococcus aureus* is not uncommon.

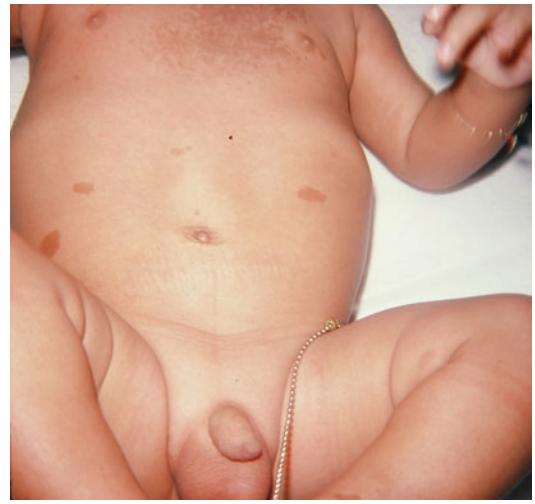
Question 12

A 4-year-old boy is brought to the emergency department due to multiple seizures. On examination there are hypopigmented macules over the stomach and back. He also has firm pink-brown papules on the nasolabial folds and cheeks. After admission to the hospital, the EEG shows a hypsarrhythmic pattern and MRI of the head shows subependymal nodules. This constellation of features is consistent with:

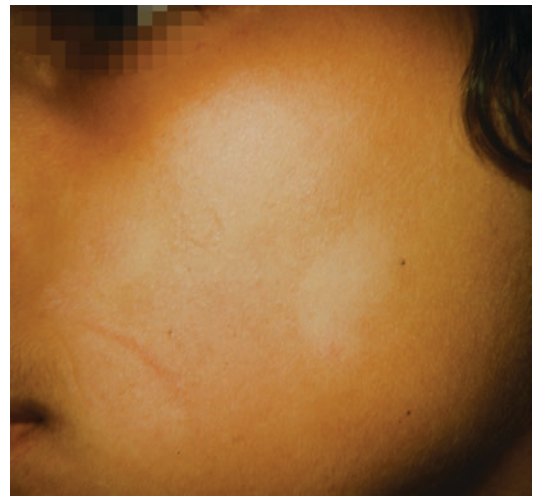
A. West syndrome
B. Tuberous sclerosis complex (TSC)
C. Neurofibromatosis
D. Pityriasis alba
E. Sturge–Weber syndrome



Neurofibromatosis



Neurofibromatosis



Pityriasis alba

Correct Answer: B

This child has the typical lesions of tuberous sclerosis complex (TSC). TSC occurs by autosomal dominant inheritance; however, the majority of cases are thought to be due to new mutations. Patients with TSC may have any of the following cutaneous findings:

- Hypopigmented macules
- Confetti skin lesions
- Angiofibromas (adenoma sebaceum)
- Fibrous forehead plaque
- Shagreen patch (connective tissue nevus)

- Ungual or periungual fibromas
- Gingival fibromas

The majority of patients will have cutaneous findings: angiofibromas, periungual fibromas, the shagreen patch, and hypopigmented ash-leaf-shaped macules, which are considered pathognomonic. The classic features of TSC include skin changes, intellectual impairment, and epilepsy; however, early diagnosis is important to screen for hamartomas of the eye, kidney, or heart. Prognosis is largely dependent on the extent of neurologic involvement.

West syndrome is a severe epilepsy syndrome with infantile spasms, characteristic EEG pattern termed hypsarrhythmia, and mental retardation. There are no cutaneous lesions associated with West syndrome.

Neurofibromatosis is a neuroectodermal genodermatosis. Inheritance is autosomal dominant, though up to 50% of cases occur due to spontaneous mutation. The cutaneous findings in neurofibromatosis type I include café au lait spots, axillary freckling, and neurofibromas. Epilepsy can occur; however, neurologic problems occur in less than half of patients.

Pityriasis alba is a common skin disorder in children characterized by the presence of ill-defined, hypopigmented patches, usually on the face, neck, or upper trunk. There may be fine scale present. The condition is considered a marker for atopy.

Sturge–Weber syndrome (SWS) is a sporadic neurocutaneous disorder characterized by a facial capillary malformation. The port-wine stain follows the distribution of the trigeminal nerve, usually the first branch (V1). Early recognition is important to evaluate for leptomeningeal angiomatosis, which may cause seizures and glaucoma.

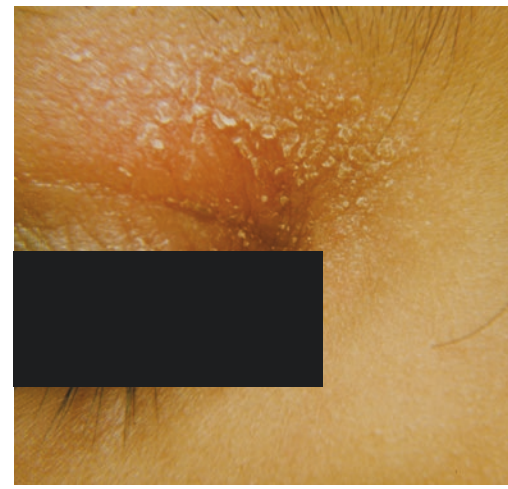
Take-Home Message

Three or more hypopigmented macules present at birth should prompt consideration of tuberous sclerosis.

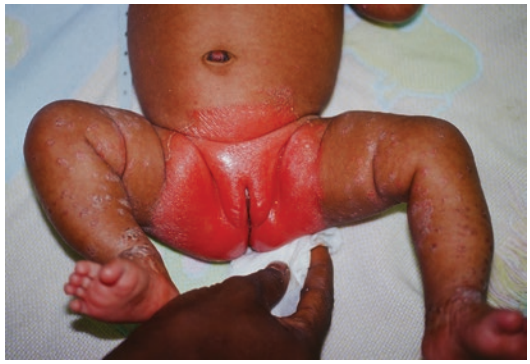
Question 13

An 18-year-old girl was sunbathing and noticed a non-itchy rash on her upper trunk and neck. She denies any recent illnesses or systemic symptoms at the present time. In the emergency department, she appears well, and her skin exam reveals multiple coalescing tan macules with scale. The rest of her physical exam is normal. What is the most likely diagnosis?

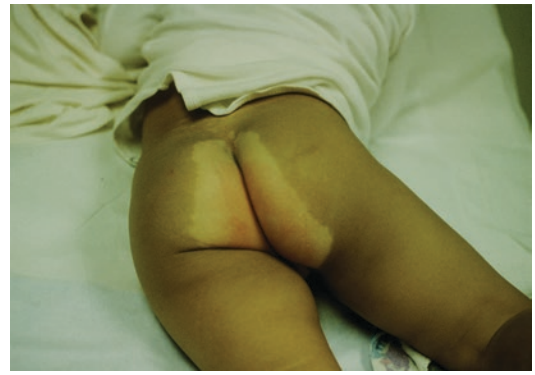
A. Psoriasis
B. Pityriasis versicolor
C. Sarcoidosis
D. Vitiligo
E. Insect bites



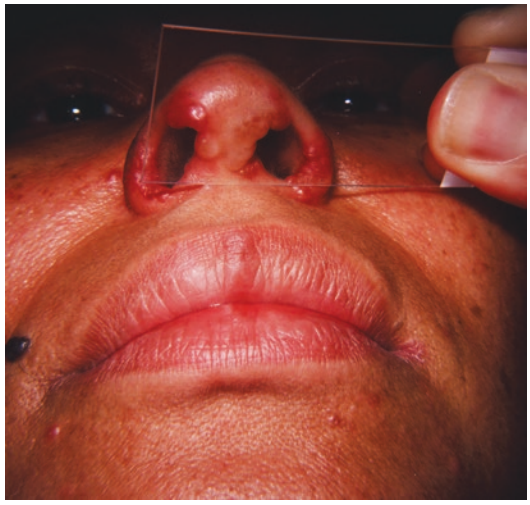
Psoriasis



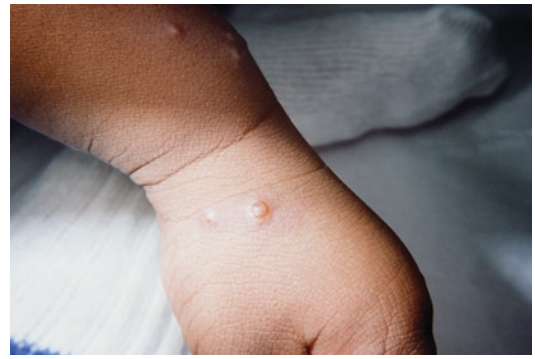
Psoriasis



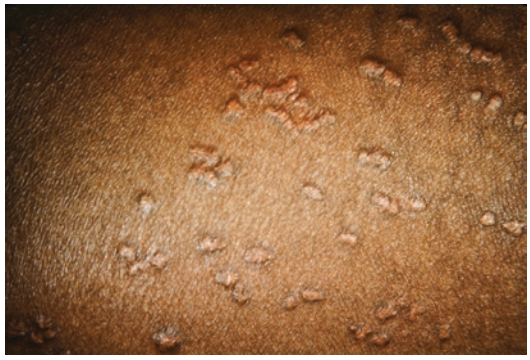
Vitiligo



Sarcoid



Insect bite



Sarcoid

Correct Answer: B

This patient has tinea versicolor, caused by *Malassezia furfur*. It is a superficial fungal infection, usually involving the upper trunk and upper arms. Typical lesions are skin-colored tan-pink macules with scale, often coalescing into large patches. Patients are usually asymptomatic, although mild pruritus may occur. The diagnosis can be made on the basis of the clinical appearance of lesions and their distribution. Potassium hydroxide (KOH) scraping shows numerous round yeasts with short hyphae. A Wood lamp examination may show a characteristic yellow-orange fluorescence. Hypopigmentation may occur, due to inhibition of melanin production by dicarbox-

ylic acid production from metabolism of skin surface lipids by the yeast.

Vitiligo presents with well-demarcated depigmented macules and patches. The distribution is characteristic around the eyes, mouth, genitals, elbows, hands, and feet. It is caused by a loss of melanocytes within the skin. The hair of affected areas can also depigment. Vitiligo is associated with other autoimmune endocrinopathies, most commonly thyroid disease. A family history and review of systems therefore are important parts of the evaluation.

Sarcoidosis is a systemic, granulomatous disease which is rare in children. It is characterized by non-necrotizing granulomas in affected organs, most commonly the lungs. Cutaneous lesions include yellow-brown to red papules and nodules. Erythema nodosum may precede or accompany the disease. Ophthalmology referral is essential to evaluate for uveitis.

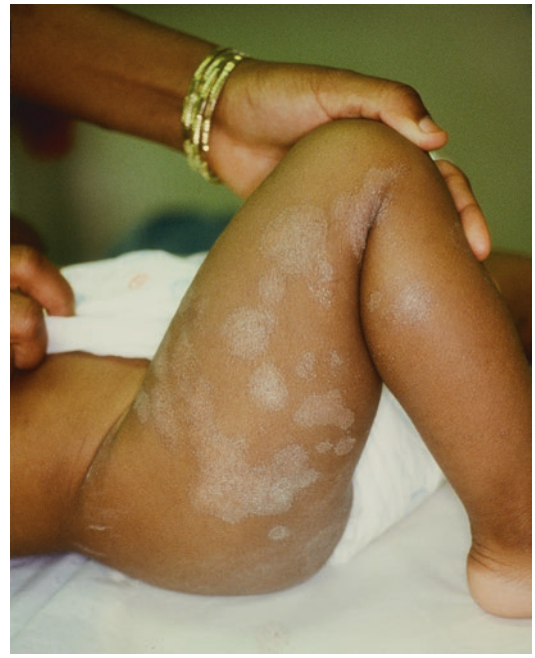
Psoriasis is characterized by sharply demarcated erythematous plaques with silvery scale, most commonly on the scalp, extensor surfaces, and gluteal cleft. Examination of the nails may reveal pitting or onycholysis.

Take-Home Message
Tinea versicolor is a superficial fungal infection causing temporary hypopigmentation. It should be differentiated from tinea corporis and pityriasis rosea as the treatment is different.

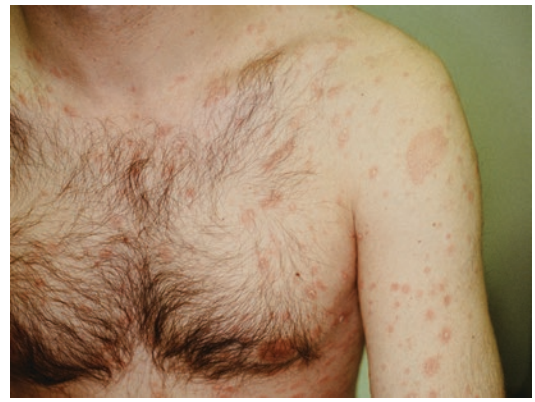
Question 14

A mother brings her 3-month-old girl for evaluation of a rash of a week's duration. There are erythematous patches with scale on the scalp, neck, underarms, and diaper area. The family history is notable for asthma in her older brother. What is the most likely diagnosis?

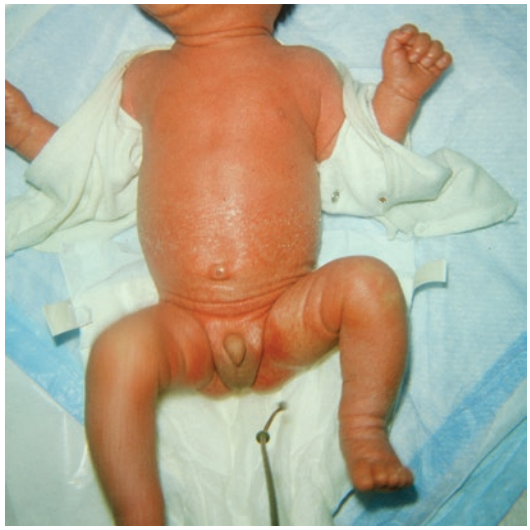
A. Atopic dermatitis
B. Psoriasis
C. Seborrheic dermatitis
D. Langerhans cell histiocytosis
E. Tinea corporis



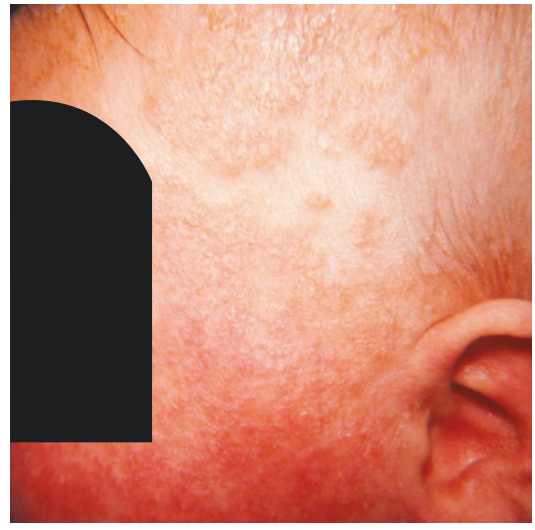
Atopic Dermatitis



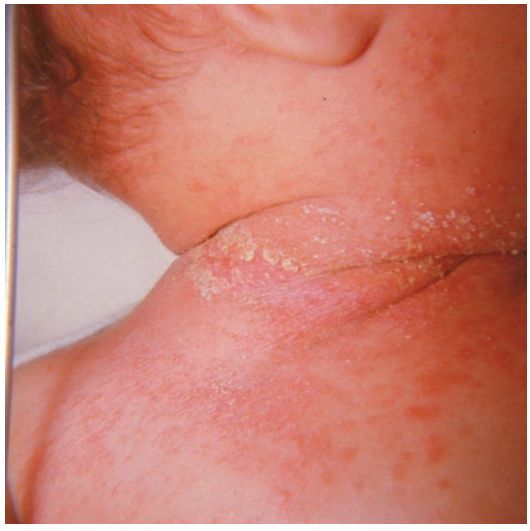
Pityriasis Rosea



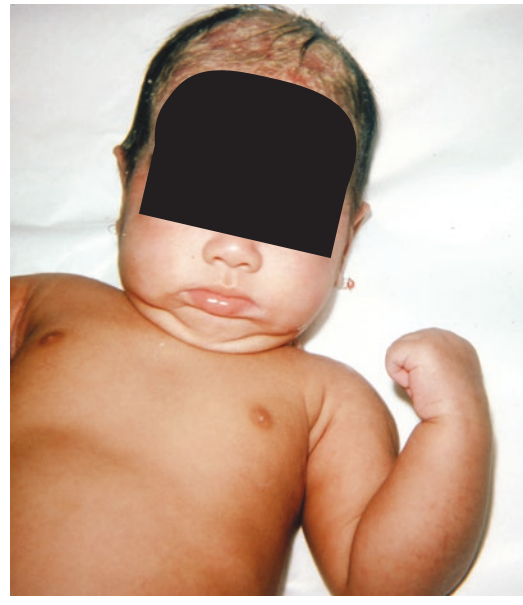
Seborrheic Dermatitis



Seborrheic Dermatitis



Seborrheic Dermatitis



Seborrheic Dermatitis

Correct Answer: C

The rash described is seborrheic dermatitis. It is an erythematous, scaly, symmetric eruption involving hair-bearing (scalp) and intertriginous regions. In infants, it usually presents in the first month of life and incidence peaks at 3 months of age. Many infants with atopic dermatitis have a history of infantile seborrheic dermatitis. Involvement of the diaper area can be a useful clinical clue to the diagnosis of seborrheic dermatitis. In atopic dermatitis, by contrast, the diaper area is usually spared as it is a moist area and the diaper inhibits infants from being able to scratch and worsen the rash.

Atopic dermatitis (AD) is a chronic, pruritic inflammatory skin disease; it is one of the most common dermatoses of infants and children. AD and seborrheic dermatitis may overlap, with features of AD becoming more prominent after 3 months of age. In infants, lesions are symmetrically distributed over the cheeks, forehead, scalp, trunk, and extensor surfaces of the extremities. In children, flexural surfaces are most commonly involved. The course involves remissions and exacerbations. These children may present to the ED with intense pruritus. The majority of children may improve by puberty. Associated conditions include asthma and allergic rhinitis.

Psoriasis presents with discrete, sharply demarcated erythematous plaques with thick scales. The scale is adherent and silvery white leaving pinpoint bleeding when removed (Auspitz sign). The inverse form affects intertriginous areas and can have a similar appearance to seborrheic dermatitis. The lesions are usually symmetric and common sites involved are the scalp, elbows, and knees. Compared to seborrheic dermatitis, psoriasis has a slower response to treatment and requires potent to ultrapotent topical corticosteroid treatment. Systemic steroids should not be used because of risk of rebound or induction of pustular psoriasis.

Langerhans cell histiocytosis (LCH) should be considered in the differential diagnosis of seborrheic dermatitis refractory to conventional treatment. The presence of yellow-red crusted papules, erosions, or purpura should raise concern for LCH. Many organs may be involved including bone, lung, liver, hypothalamus, posterior pituitary, and the lymphatic system. A skin biopsy can distinguish LCH from seborrheic dermatitis.

The classic lesion of tinea corporis is a pruritic, annular lesion with central clearing. The border is raised with an advancing scale and may have papules or vesicles. The lesions may be single or multiple. The diagnosis can be confirmed by KOH examination of skin scrapings. Lesions may be mistaken for nummular eczema, psoriasis, or erythema annulare centrifugum, as well as the herald patch of pityriasis rosea.

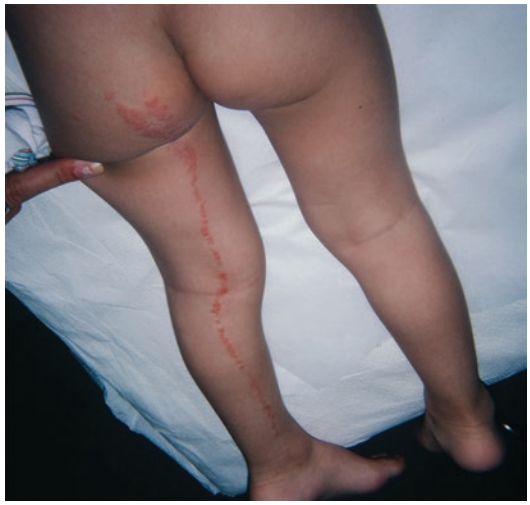
Take-Home Message
Seborrheic dermatitis is an inflammatory skin condition characterized by erythematous, scaly, symmetric eruption that occurs most often in hair-bearing and intertriginous regions.

Question 15

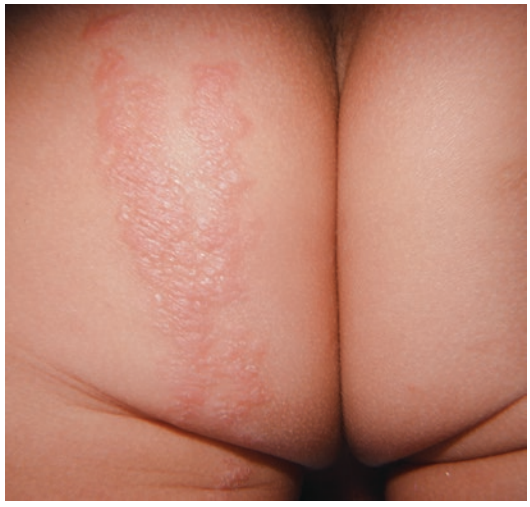
A 5-year-old boy has had a non-pruritic rash on his arm for several days. His mother decided to bring him to the emergency department as it appears to be expanding. On examination, you note flat-topped papules in a linear distribution. What is the best treatment?

A. No treatment
B. Topical vitamin D
C. Topical corticosteroids
D. Tar therapy
E. Oral antihistamines

Correct Answer: A



Lichen striatus



Lichen striatus

This rash is characteristic of lichen striatus. Lichen striatus is a linear, papular eruption of unknown etiology, which is a self-limited condition, most commonly affecting children. This rash begins as 2–4-mm lichenoid papules that coalesce to form a curvilinear band along Blaschko's lines.

The lesions usually occur on the trunk and face and may be erythematous and scaly. Pruritus may occur, especially in children who are also atopic. Nail changes such as longitudinal ridging and nail plate thinning may occur. Since it usually resolves spontaneously, therapy is not required.

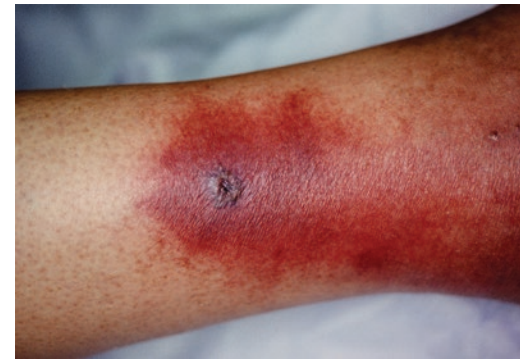
Take-Home Message
Linear, asymptomatic papules are characteristic of lichen striatus.

Question 16

A teenage boy was cleaning the attic with his mother and going through some old clothes. The next morning upon awakening he noticed his arm was painful with blue discoloration. The most likely cause of his symptoms is:

A. A bee sting
B. Erythema migrans
C. Brown recluse spider bite
D. Stevens–Johnson syndrome
E. Pediculosis corporis

Correct Answer: C



Spide bite (brown recluse)

These symptoms are consistent with a brown recluse spider bite. In the United States, *Loxosceles reclusa* is the predominant species. Bites usually occur when spiders become trapped in attics, basements, or storage closets. The initial bite is often painless and therefore may remain unnoticed. Pain usually begins hours later, and an erythematous area with a central pustule or hemorrhagic vesicle may develop. Ultimately, there may be gangrenous ulceration or necrosis. The venom contains sphingomyelinase D, which is mainly cytotoxic, causing local tissue destruction by destroying endothelial cells; it also has a

hemolytic component, which may result in hemolysis. Systemic symptoms such as fever, myalgias, and hemolysis are rare but develop more commonly in children due to toxin burden.

ECM, the cutaneous form of Lyme disease, presents with annular erythema. There is no associated eschar or ulceration. The skin changes are not painful; however, there may be associated fever, fatigue, headache, and arthralgias. A tick bite may not be reported.

Pediculosis corporis, body lice, presents with generalized pruritus. Clinical manifestations include pruritus, excoriations, and small, red macules. The organism lives and reproduces in the lining of clothes and leaves the clothing only for feeding from the skin; therefore, examination of clothing is important. It should be suspected in children with generalized itching, excoriations and poor hygiene. All clothing and bedding should be washed in hot water or dry cleaned. All household contacts should be treated.

Stevens–Johnson syndrome (SJS) is a rare, life-threatening systemic hypersensitivity reaction. It is a T-cell-mediated toxic reaction targeting the basement membrane resulting in separation at the dermal-epidermal junction. Mucous membrane involvement is a characteristic finding. Usually a prodrome of fever, malaise, and sore throat precedes the rash. The palms and soles may be an early site of involvement. Targetoid lesions, dusky macules and patches, bullae, and erythroderma may be seen. The Nikolsky sign may be a helpful clinical clue in patients who have yet to develop epidermal detachment. The distinction between SJS and toxic epidermal necrolysis (TEN) is based on body surface area involvement and is important prognostically. SJS affects ≤10% of the total body surface area and TEN ≥30% of the body surface area. Medications are the most common cause including antibiotics such as sulfonamide, cephalosporins, and anticonvulsants such as carbamazepine, phenytoin, phenobarbital, valproic acid, and lamotrigine. Other agents include nonsteroidal anti-inflammatory drugs. *Mycoplasma pneumoniae* has also been identified in pediatric patients without drug exposure.

Take-Home Message
Most spiders in the United States cause only local pain, redness, and swelling. Body lice are more likely to be found in the clothing seams than on the skin of patients.

Question 17

A 10-year-old girl is brought to the emergency department for evaluation of a painful swelling over her scalp. On examination, the posterior scalp has a boggy plaque with pustules and alopecia. All of the following are true *except*:

A. The condition is contagious
B. Topical steroids should be used to prevent permanent scarring
C. Griseofulvin is effective for most cases
D. Cervical adenopathy is common
E. Permanent alopecia is possible

Correct Answer: B

A tender plaque with pustules and purulent drainage on the scalp of a child describes a kerion, a fungal infection affecting hair follicles. It is characterized by intense inflammation and a boggy, erythematous mass. It is due to a hypersensitivity reaction to the dermatophyte infection. Cervical lymphadenopathy is common, supporting the diagnosis of tinea capitis. Local alopecia and scarring may occur if not promptly treated. Secondary bacterial infection, usually *Staph. aureus*, is common; it should be confirmed with bacterial culture and treated with systemic antibiotics. The initial lesion may be overlooked until alopecia develops. Beware that a kerion may have pustules and crusting and therefore be mistaken for an abscess.

This inflammatory form of tinea capitis requires prompt recognition and treatment with griseofulvin to prevent permanent scarring. Systemic antifungal agents such as griseofulvin for at least 6–8 weeks are required. There is no role for topical corticosteroid therapy; however, prednisone may be used to decrease inflammation and prevent scarring. Tinea capi-

tis is highly contagious; therefore, close contacts, especially prepubescent children, should be evaluated.

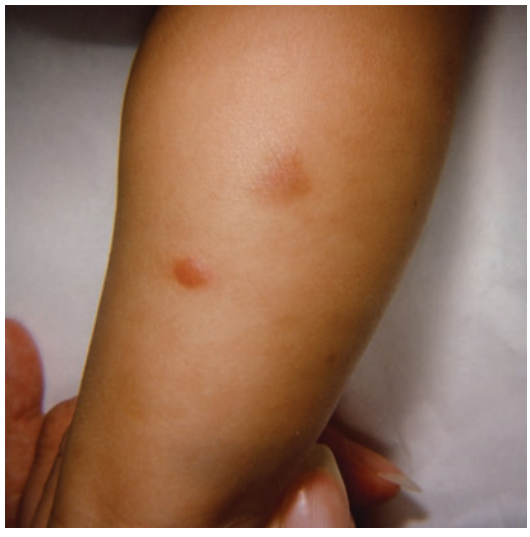
Take-Home Message
The diagnosis of kerion should be strongly considered in children with scalp infections. Prompt initiation of griseofulvin is curative and may prevent permanent hair loss.

Question 18

A 3-year-old who recently came from South America is referred by a local pediatrician for the evaluation of recurrent episodes of abdominal pain and diarrhea. On examination, she has multiple red-brown papules. With the help of an interpreter, you learn that the child was born with these lesions, which sometimes become red and swollen. When you stroke the lesions, a wheal-and-flare reaction occurs. One form of this disorder can:

A. Be treated with acyclovir
B. Result in anaphylaxis
C. Result in scarring
D. Be treated with antibiotics
E. Be treated with topical diphenhydramine

Correct Answer: B



Mastocytosis

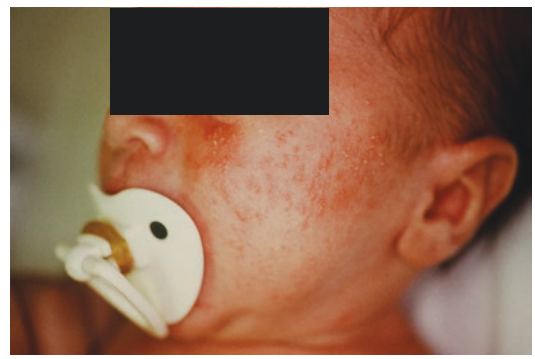
The child has urticaria pigmentosa (UP), the most common form of mastocytosis. Patients with UP have many well-demarcated tan to red-brown papules which react to stroking with a wheal-and-flare reaction. This is known as Darier's sign. The lesions predominantly affect the trunk. Mucous membranes may be involved and the palms and soles are usually spared. It may be present at birth and usually onset occurs in the first 4 years of life. It is usually limited to the skin in children and often resolves by puberty. Measures to avoid histamine release triggers are the mainstay of treatment as these patients may have an increased risk of anaphylaxis. Generally, the prognosis for childhood mastocytosis is favorable.

Take-Home Message
Darier's sign, urtication after brisk stroking of the lesions, is pathognomonic of cutaneous mastocytosis. Widespread cutaneous involvement and positive review of systems warrant evaluation for systemic mastocytosis.

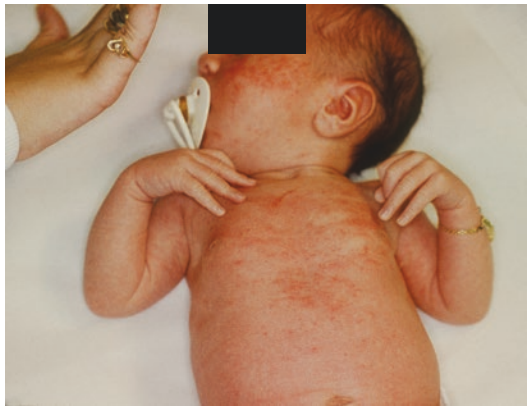
Question 19

A mother brings her 3-week-old infant for evaluation of a rash. She explains the baby had a pustular rash at birth and now has many brown spots. On examination, the baby has diffuse brown macules. The most likely cause of this rash is:

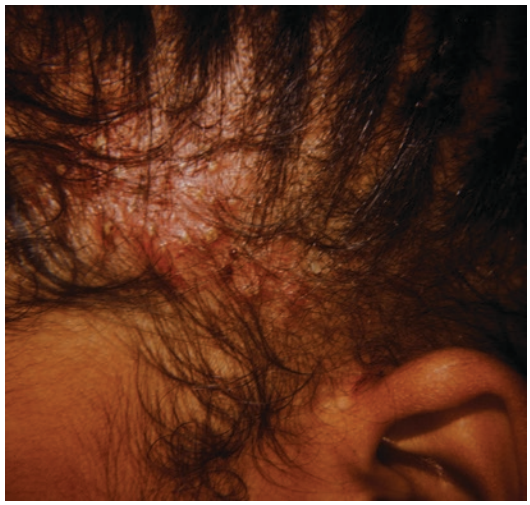
A. Transient neonatal pustular melanosis
B. Erythema toxicum
C. Milia
D. Sebaceous gland hyperplasia
E. Folliculitis



Erythema toxicum



Erythema toxicum



Folliculitis

Correct Answer: A

Transient neonatal pustular melanosis is a benign, self-limited skin disorder which commonly affects black infants. The pustules are present at birth and resolve within the first 24–48 hours of life. After rupture, the pustules leave collarettes of scale and hyperpigmentation, which may persist for weeks to months. Affected areas include the face, neck, and trunk and more rarely the scalp, palms, and soles. Neutrophils can be visualized on wright stain smears of the pustules. No treatment is needed.

Erythema toxicum is a common dermatosis that presents with blotchy erythema and yellow-white pustules in full-term neonates. The palms and soles are usually spared. Lesions typically appear in the first few days of life, waxing and waning over the first couple weeks. Examination of pustule contents with Wright's or Giemsa staining reveals eosinophils.

Milia are small retention cysts that occur on the face of newborns, most commonly on the nose. Filled with keratinocytes and sebaceous debris, they are white-yellow, 1–2-mm papules and require no treatment.

Sebaceous gland hyperplasia is a physiologic phenomenon triggered by maternal androgen exposure. The yellow-colored papules on the face of full-term infants resolve spontaneously.

Bacterial folliculitis is most commonly caused by *Staphylococcus aureus*. Treatment includes antibacterial soap, topical antibiotics, or oral antibiotics in more extensive or recurrent cases. A bacterial culture should be obtained prior to starting oral antibiotics. Twice weekly bleach baths may be helpful to prevent recurrence.

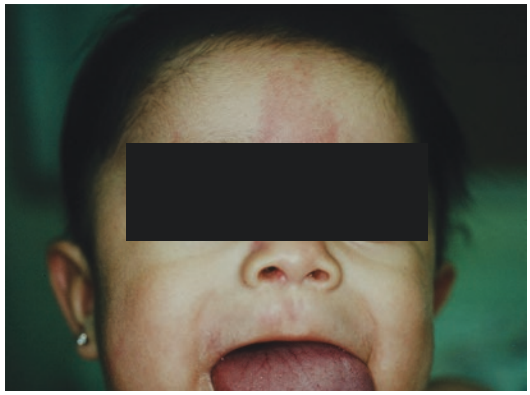
Take-Home Message

Post-inflammatory hyperpigmentation is an important clue to the diagnosis of transient neonatal pustular melanosis and may persist for weeks to months. This condition is seen most commonly in patients with dark skin.

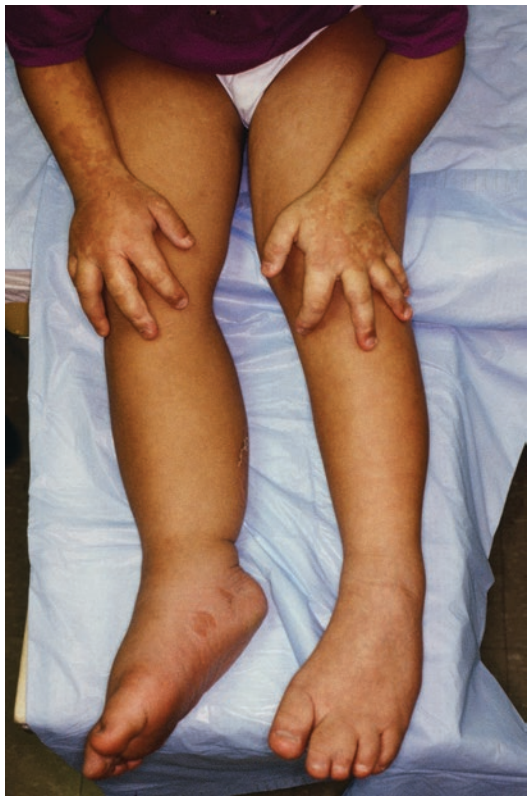
Question 20

A 4-month-old baby presents to the emergency department with a right-sided seizure that initially responds to lorazepam and then recurs. The child has no fever and was fed shortly prior to arrival. On examination, the child has a dark red patch on the right side of the face, involving both the upper and lower eyelids. The remainder of the examination is unremarkable. This child likely has:

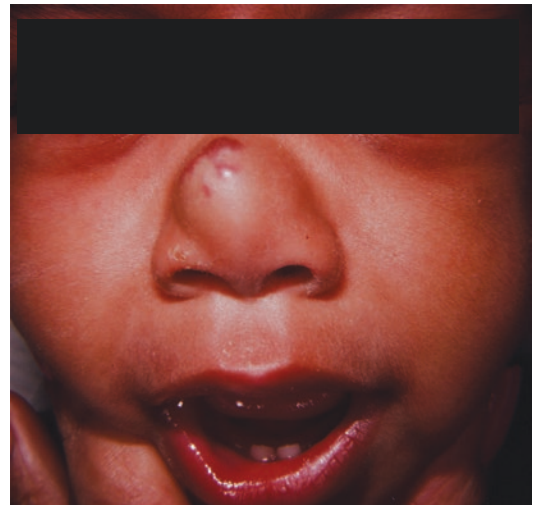
A. Sturge–Weber syndrome
B. Beckwith–Wiedemann syndrome
C. Klippel–Trenaunay syndrome
D. Arteriovenous malformations
E. Infantile hemangioma



Beckwith–Wiedemann



Klippel–Trenaunay



Hemangioma

Correct Answer: A

The presence of seizures and a facial vascular malformation suggests the diagnosis of Sturge–Weber syndrome. The classic triad includes a facial capillary malformation called a port-wine stain (PWS), leptomeningeal angiomatosis, and glaucoma. The PWS is a pink to red, non-blanching patch typically involving the upper face in the cutaneous distribution of the ophthalmic or maxillary division of the trigeminal nerve. It is usually present at birth. With age, the malformation may darken and develop hypertrophy. There is an increased risk for associated neuro-ocular complications if the lesion involves the cutaneous distribution of the ophthalmic division of the trigeminal nerve (i.e., forehead and upper eyelid). Seizures are often the first symptom to appear and are typically focal but may become generalized. The seizures usually develop before the age of five. Early referral to ophthalmology with close follow-up is recommended to screen

for glaucoma, which may be detected at birth. The presence of acute glaucoma with a cloudy cornea is an infantile emergency.

Klippel–Trenaunay syndrome (KTS) consists of PWS, anomalous veins, and progressive overgrowth of the affected extremity. This is present at birth and usually involves a lower extremity. The PWS is generally localized to the hypertrophied area. Thick-walled venous varicosities may become apparent when the child starts ambulating.

Beckwith–Wiedemann syndrome (BWS) is the most common overgrowth syndrome characterized by macroglossia, organomegaly, cardiomyopathy, and neonatal hypoglycemia due to islet cell hyperplasia. It is associated with prenatal and postnatal overgrowth. A capillary malformation of the upper central face including the bilateral upper eyelids is common. There is an increased risk of malignancy, particularly Wilms's tumor and hepatoblastoma. The placentas are large, and pregnancies are often complicated by polyhydramnios.

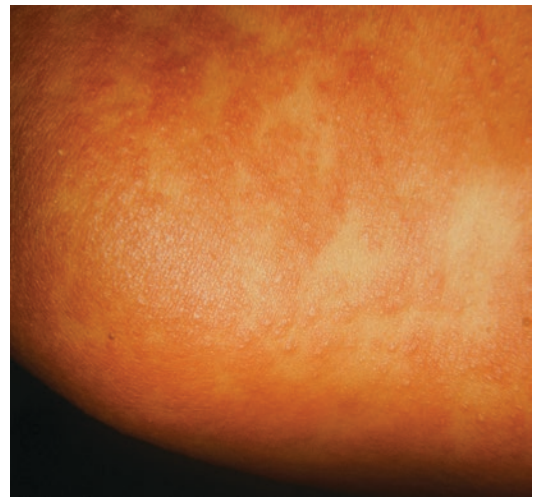
Arteriovenous malformations (AVMs) are vascular malformations with arterial and venous components. On exam they may be warm and pulsatile and have a bruit. Imaging is essential prior to considering therapeutic intervention. The most severe complication includes cardiovascular compromise.

Take-Home Message
A facial port-wine stain requires consideration of Sturge–Weber Syndrome and evaluation by neurology and ophthalmology.

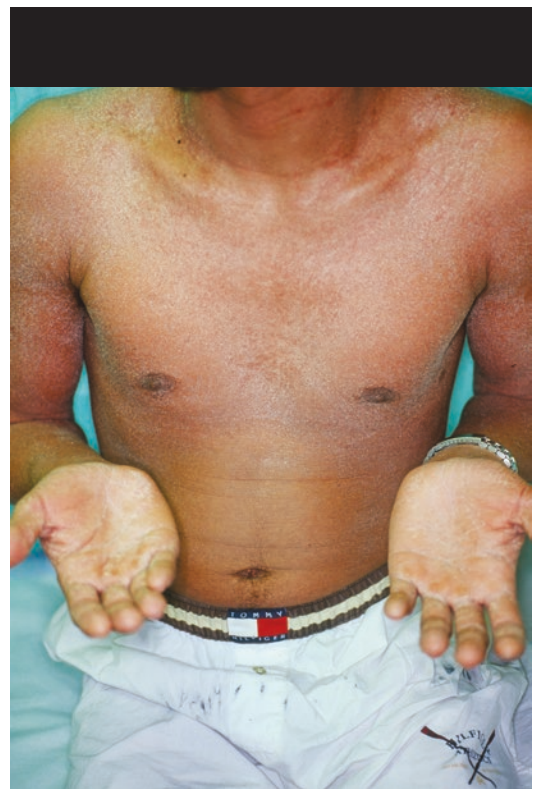
Question 21

A previously healthy 14-month-old infant is brought to the emergency department for evaluation of a fever at 1 am. The child is irritable and has right-sided crackles to auscultation. The chest X-ray shows a pneumonia and IV antibiotics were administered. In the ED, the child continues to be febrile and develops a rash. On examination, there are irregularly shaped ecchymoses and purpuric plaques with surrounding erythema on the bilateral legs. The diagnosis is:

A. Immune thrombocytopenic purpura
B. Purpura fulminans
C. Drug hypersensitivity reaction
D. Child abuse
E. Cutis marmorata



Drug hypersensitivity



Drug hypersensitivity

Correct Answer: B

Purpura fulminans (PF) is a rare clinical manifestation of disseminated intravascular coagulation (DIC). It causes ecchymotic patches and plaques and hemorrhagic necrosis of the skin due to thrombosis of the cutaneous microvasculature. Causes include severe infections such as streptococcus, meningococcus, and pneumococcus. It may also occur as a post-infectious phenomenon with varicella and scarlet fever. The congenital form due to protein C or S deficiency presents in the neonatal period. Treatment should focus on the underlying cause, in addition to supportive measures.

Immune thrombocytopenic purpura (ITP) classically occurs in a previously healthy child following a viral illness. Symptoms may include petechiae, epistaxis, and gingival bleeding. The diagnosis requires the exclusion of other causes of thrombocytopenia. The condition resolves in weeks to months and does not recur. The treatment is determined by the severity of the thrombocytopenia. In general, patients with platelet counts higher than 20,000/mm^3 who remain symptom-free may not require hospitalization. Hospitalization is required for children with platelet counts below 20,000/mm^3 with significant mucous membrane bleeding or with life-threatening hemorrhage.

A morbilliform eruption is the most common drug hypersensitivity reaction. Small pink to red macules and papules usually begin on the face and spread from head to toe on the trunk and extremities. Mucous membranes are typically spared. It occurs 7–14 days after the initial exposure to the offending agent. On subsequent exposure, the eruption will occur more quickly. Antibiotics are among the most common agents, particularly penicillin, sulfonamides, and cephalosporins.

Ecchymoses and purpura in young children raise the question of nonaccidental trauma. However, the presentation is not consistent with nonaccidental trauma in this child.

Cutis marmorata is a transient, netlike, mottling of the skin due to variable vascular constriction and dilation. This refers to physiologic livedo reticularis in response to cold. Livedo reticularis is most commonly seen on the legs. It usually resolves with increasing age.

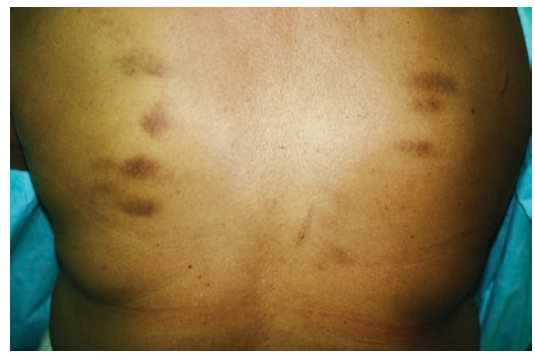
Take-Home Message
Purpura fulminans is the cutaneous presentation of disseminated intravascular coagulation in the setting of sepsis or thrombophilia. This cutaneous finding is a sign of life-threatening illness.

Question 22

An anxious resident calls you to evaluate a child with fever and runny nose as well as a rash on the back. He is worried about physical abuse because the child has multiple linear ecchymotic streaks on the back. The most likely cause of this skin finding is:

A. Gridding
B. Cupping
C. Child abuse
D. Coining
E. Acupressure

Correct Answer: D



Traumatic purpura

In general, bruises on buttocks, trunk, and back are unusual in accidental trauma. However, the pattern described is suggestive of coining or spooning which is a cultural practice, where heated oil is applied to the skin followed by repeated rubbing of the skin with a coin, or other

object, to produce petechiae or ecchymoses. It is a common practice in Southeast Asia to improve circulation or to relieve common symptoms including fever and headache.

Cupping is another remedy that is believed to aid in symptoms such as abdominal pain, fever, and poor appetite. Heated cups create a vacuum on the skin producing characteristically shaped ecchymoses. The technique is used by various cultural groups including Russians, Asians, and Mexicans.

Gridding is a remedy that is most commonly practiced in Russian cultures as well as Ukraine and other eastern European countries. Gridding is the practice of painting the back with iodine in a crisscross pattern. This results in a hyperpigmented grid-like pattern on the back. It is used to treat respiratory illness because the topical application of iodine is thought to relieve cough and congestion. All of these lesions can be mistaken for physical abuse.

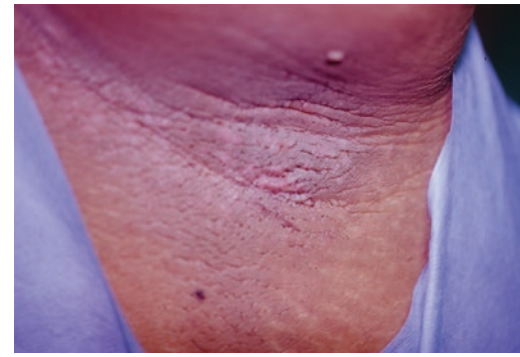
Acupressure and acupuncture generally do not leave cutaneous signs of treatment. The presence of petechiae or ecchymoses should raise the question of nonaccidental trauma, especially in the pediatric population. Increased cultural competency is required to understand the mechanism of these cutaneous findings.

Take-Home Message
Complementary alternative medicine practices can result in cutaneous findings such as circular bruising and linear purpuric streaks that can be mistaken for nonaccidental trauma.

Question 23

A 13-year-old girl is brought to the emergency department for evaluation of fatigue, weakness, and recurrent episodes of vomiting and diarrhea. On examination, you note hyperpigmentation, most prominently on the palms, soles, and skin folds. Her skin is notably darker than her mother's. Her findings are consistent with:

A. Acanthosis nigricans
B. Addison's disease
C. McCune–Albright syndrome
D. Classic congenital adrenal hyperplasia
E. Polycystic ovary syndrome



Acanthosis nigricans

Correct Answer: B

This child has findings consistent with Addison's disease, primary adrenocortical insufficiency. Acute Addisonian crisis is one of the most severe endocrine emergencies manifesting during episodes of acute stress, infection, or trauma. It is characterized by hypovolemia, hypotension, and acute cardiovascular collapse due to renal sodium wasting, hyperkalemia, and loss of vascular tone. An increased pigmentation of the skin and mucous membranes is also present. In addition, increased pigmentation may be noted in existing nevi. Hyperpigmentation occurs due to increased levels of proopiomelanocortin, a precursor to melanocyte-stimulating hormone. As the pigmentation may be subtle, comparison of the patient to other family members may be useful in highlighting the skin findings. Decreased aldosterone production leads to hyponatremia and hyperkalemia. There is also an increased renin level. The diagnostic criteria include low cortisol level and failure to rise with ACTH stimulation. Treatment includes immediate restoration of the intravascular volume with administration of intravenous saline as well as dexamethasone or hydrocortisone.

Acanthosis nigricans (AN) is characterized by hyperpigmentation and hyperkeratosis in intertriginous areas, most commonly the neck and

axillae. It usually manifests at puberty but can occur in childhood with early development of obesity. AN is a cutaneous marker for metabolic disturbance, most commonly insulin resistance.

The triad of McCune–Albright syndrome (MAS) consists of fibrous dysplasia of the bones (polyostotic fibrous dysplasia), patchy cutaneous pigmentation, and endocrinopathies. Precocious puberty is the most common endocrinopathy; other associated disorders include pituitary adenomas (secreting growth hormone), hyperthyroid goiters, and adrenal hyperplasia. In MAS, the café au lait macules have irregular borders, described as the "coast of Maine," and present early in life.

Females with classic congenital adrenal hyperplasia (CAH) due to 21-hydroxylase deficiency present with ambiguous genitalia at birth. Boys generally have no obvious physical signs; hyperpigmentation and/or penile enlargement may be present. Precocious puberty may occur in patients not on appropriate treatment.

Polycystic ovary syndrome presents with hyperandrogenism, irregular menses, and polycystic ovaries. Cutaneous signs of hyperandrogenism include acne vulgaris, hirsutism, and androgenetic alopecia.

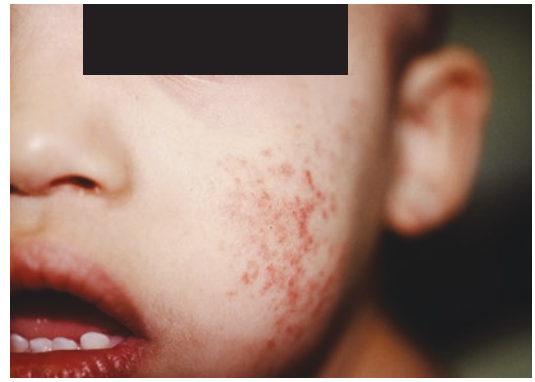
Take-Home Message
Addison disease is a potentially life-threatening condition. Hyperpigmentation is present in nearly all patients with Addison disease.

Question 24

A 5-year-old boy presents with a history of coughing for 4 days. He is well appearing and has a fine petechial rash around the eyes and on the cheeks. Which of the following is true?

A. The rash is most likely due to abnormal platelets.
B. He most likely has a normal platelet count.
C. The petechiae are unrelated to coughing.
D. He should be referred to the ophthalmologist.
E. He should be hospitalized for observation.

Correct Answer: B



Purpura – Valsalva

Petechiae are non-blanching less than 3 mm. The presence of petechiae does not always indicate serious illness. Prolonged crying, forceful coughing, and vomiting increase intravascular pressure and can result in endothelial damage. This can also result from strenuous activities or exercise. The petechiae usually localize to the face, upper chest, or arms (usually above the nipple line).

Idiopathic thrombocytopenic purpura following a viral illness can occur in an otherwise healthy and well-appearing child; however, the petechiae do not localize only to the upper body.

Petechiae caused by infection usually involve gram negative organisms, especially *Neisseria meningitidis*, and rickettsiae. A child presenting with a petechial rash and fever should be evaluated promptly for such life-threatening illnesses. With the appropriate history, certain viral illnesses such as dengue fever, Ebola, and yellow fever should be considered. Other causes of generalized petechiae include malignancies such as leukemia and other that cause thrombocytopenia, medications, radiation, autoimmune disorders, and vasculitis.

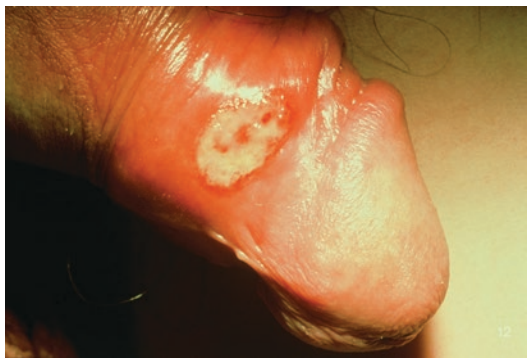
Take-Home Message
Increased intravascular pressure can cause petechiae. The presence of a petechial rash in a febrile child should raise the suspicion of meningococcal infection.

Question 25

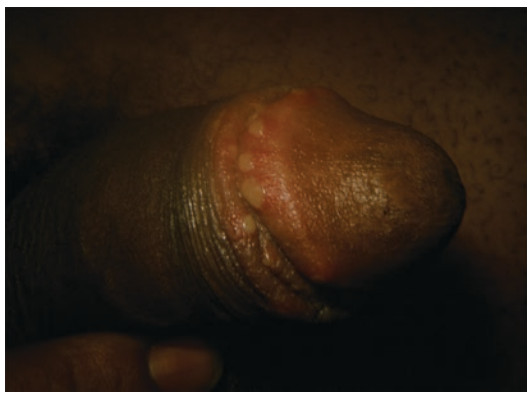
Which of the following associations is INCORRECT?

A. Painless genital chancre: herpes simplex
B. Erythema migrans: *Borrelia burgdorferi*
C. Pastia's lines: scarlet fever
D. Slapped cheeks: erythema infectiosum
E. Blueberry muffin: congenital rubella

Correct Answer A



Chancre (primary syphilis)



Primary herpes simplex

Genital ulcers have a broad differential diagnosis including infectious and inflammatory etiologies. Syphilis is a systemic, sexually transmitted disease caused by the spirochete *Treponema pallidum*. Primary syphilis is manifested as a single, painless ulcer called "chancre," which develops 0–90 days, on average 3 weeks, following exposure. It begins as a small red papule or a crusted superficial erosion.

The chancre can be found most commonly on the penis, vulva, anus, or cervix and is associated with regional lymphadenopathy. The treatment of choice at this stage is a single, intramuscular dose of benzathine penicillin, 2.4 million units.

Herpes simplex infection is characterized by grouped vesicles on an erythematous base. Genital herpes is most commonly caused by herpes simplex virus type-2 (HSV-2). Primary infection is usually painful and symptomatic, with associated systemic symptoms such as tender regional lymphadenopathy, fever, headache, and malaise. Recurrent episodes can have a prodrome of itching or pain, or be asymptomatic. When vesicles rupture, characteristic punched-out and scalloped ulcerations remain. HSV PCR can be performed on the base of the ulcer to confirm the diagnosis if needed.

Lyme disease is caused by the spirochete *Borrelia burgdorferi* and is the most common vector-borne disease in North America. The initial cutaneous manifestation of Lyme disease is a solitary erythematous patch called erythema chronicum migrans. The erythema spreads centrifugally after originating at the site of the bite of the Ixodes tick. The average interval between the tick bite and the appearance of the skin lesion is approximately 1–2 weeks. Erythema migrans does not involve the mucous membranes, palms, or soles. Diagnosis is based on history of exposure to ticks in an endemic area, clinical presentation, and serology. However, many patients with documented Lyme disease may not report a tick bite.

Scarlet fever is caused by infection with group A β-hemolytic streptococcus, which produces streptococcal pyrogenic exotoxins (SPEs). The exanthem of scarlet fever presents with small, erythematous

papules and has been described as “sandpapery”; the erythema blanches with pressure. It involves the trunk and extremities and may be accentuated in skin folds. The petechiae may appear in a linear distribution along the creases, forming Pastia lines. The skin may be pruritic, but it is not tender. Examination of the oropharynx may reveal exudative tonsils and palatal petechiae.

Erythema infectiosum is caused by human parvovirus B19. The rash begins on the face with a bright red, nontender rash most prominent on the cheeks, with circumoral pallor producing the classic “slapped-face” appearance. The rash then spreads to the trunk and proximal extremities. Central clearing of lesions gives the rash a lacy, reticulated appearance. This tends to be more prominent on extensor surfaces, sparing the palms and soles. Mild prodromal symptoms may occur a week prior to rash onset. The patients are afebrile and do not appear ill.

Congenital rubella can present with a characteristic, bluish, papular eruption, termed a “blueberry muffin” rash, which represents dermal hematopoiesis. Other associated anomalies include cataracts, deafness, cardiac defects, and CNS abnormalities. The fetus is most susceptible to infection in the first 16 weeks of gestation.

Take-Home Message

A painless genital ulcer, known as a chancre, is the characteristic lesion of primary syphilis. Herpetic ulcers are characterized by a scalloped border. Typical herpetic lesions present as a cluster of small erythematous painful vesicles, which quickly ulcerate.

Neonatal

8

Muhammad Aslam and Omid Fathi

Question 1

A former 26 week gestation male infant, now with a corrected age of 42 weeks, presents to the emergency department with what the mother describes as a worsening cough and "breathing difficulties" over the past several days. You review the chart and note that the baby had a complicated NICU stay – there were multiple intubations for respiratory distress and he was discharged with a diagnosis of chronic lung disease.

His mother describes the coughing as hoarse and that the infant also has "noisy breathing" when asleep or trying to feed. There has been no fever, runny nose/congestion, or sick contacts. He is making normal wet diapers and stooling once a day. In the emergency department, the infant is afebrile with normal vital signs, saturating 99% on room air. While he is sleeping in the mother's arms, you clearly hear both inspiratory and expiratory stridor.

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This infant most likely has

A. Viral croup
B. Aspiration of a foreign body
C. Subglottic stenosis
D. "H-type" tracheoesophageal fistula
E. Congenital heart disease

Correct Answer: C. Subglottic stenosis

Description

Infants with subglottic stenosis have an upper airway obstruction that can present in several ways. This is typically seen as biphasic stridor, hoarseness, and/or cough. There may be a history of recurrent croup. The history of multiple intubations while in the NICU is strongly suggestive in this presentation. Viral croup generally presents with a runny nose and cold symptoms. It is unlikely that the obstruction is secondary to a foreign body since the baby is too young to grasp an object and release it in his mouth. An "H"-type fistula would have presented earlier with aspiration. Although a vascular sling may cause stridor, this is not a cardiac malformation.

Take-Home Message

Biphasic stridor suggests a fixed obstruction at the subglottic level.

M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_8

ABP Content Specification

- Resuscitation – Recognition: Recognize signs and symptoms of upper airway obstruction.

Question 2

A 19-year-old pregnant woman presents to the emergency department with lower abdominal cramping and leakage of fluid. While interviewing her, she nervously tells you that she has had no prenatal care during this pregnancy. She precipitously delivers a heavily meconium-stained female infant. You take the infant immediately to a nearby warmer. The baby is vigorous and crying and has a heart rate of 140 beats/minute. The next best step in the resuscitation of this infant is:

A. Warm, dry, and stimulate
B. Administer positive pressure via bag and mask
C. Suction the oropharynx
D. Give the baby to the mother immediately
E. Endotracheal intubation and suctioning below the vocal cords

Correct Answer: A. Warm, dry, and stimulate

Description

Any infant born through meconium requires careful consideration about the best way to proceed with resuscitation. Most meconium aspiration likely occurs either in utero or during delivery. Meconium is highly inflammatory and, in cases of significant aspiration, can cause a high degree of morbidity and mortality. If an infant is born through meconium yet deemed to be vigorous (defined as having good tone, adequate respiratory effort, and heart rate >100), then the infant can be routinely resuscitated. This involves simple measures like warming, drying, stimulating, and bulb suctioning the oropharynx. Recent NRP (Neonatal Resuscitation Program) guideline no longer recommend intubation and suctioning of non-vigorous infants. The new recommendation is to proceed as you would with any "routine" resuscitation. The new rationale is that having previously intubated and suctioned these non-vigorous infants caused a delay in clearing the airway and initiating positive pressure ventilation.

Take-Home Message

Current NRP guidelines as of January 2016 no longer recommend routine intubation and suctioning of meconium-stained infants that are non-vigorous at birth. Proceed with routine NRP resuscitation and escalate as necessary based on the infant's clinical response.

ABP Content Specification

- Neonatal resuscitation – Management: Plan management of meconium aspiration.

Question 3

A 10-day old, full-term female infant presents to the emergency department with her father who reports that the baby is not feeding well and has fewer wet diapers for the past 2 days. The pregnancy was otherwise uncomplicated, and the baby was born via an elective, repeat cesarean section with APGAR scores of 8 and 9 at 1 and 5 minutes, respectively. The baby had an uneventful nursery stay and went home with her parents after 48 hours before returning to the emergency department with the above complaints. You note in the chart that the baby passed her congenital heart disease screening just prior to discharge home. In the ED, you find the baby to be cold and mottled with weak peripheral pulses. She is quite lethargic and hypotensive. There is no murmur noted. The baby is saturating 82% on room air, and the arterial blood gas results were as follows: pH 7.08, PCO_2 48, PaO_2 67, and base deficit −19. A stat echocardiogram by the on-call cardiologist confirms the diagnosis of hypoplastic left heart. Prostaglandin infusion is ordered while you await transfer to a pediatric cardiac center. Your medical student on call with you asks you how it is possible that this infant could pass her congenital heart disease screen with such a life-threatening lesion. The best explanation for this is:

A. A relatively large patent ductus arteriosus (PDA) and decreasing pulmonary vascular

resistance (PVR) shortly after birth can conserve enough pulmonary flow to maintain relatively normal arterial saturations
B. High pulmonary vascular resistance at birth limits left to right shunting of blood
C. The congenital heart disease screen was performed incorrectly
D. Interatrial mixing due to a patent foramen ovale (PFO) allows for normal saturations
E. Newborn infants have lower metabolic requirements and thus will have higher arterial oxygen saturations

Correct Answer: A. A relatively large patent ductus arteriosus (PDA) and decreasing pulmonary vascular resistance (PVR) shortly after birth can conserve enough pulmonary flow to maintain relatively normal arterial saturations

Description
Hypoplastic left heart syndrome describes a small left ventricle with underdevelopment of the mitral and aortic valves. Because of its small size, the left ventricle is unable to support the systemic circulation, thus becoming the right ventricle's role. At birth, the pulmonary vascular resistance is still relatively high as it was in utero, and the patent ductus arteriosus (PDA) is still quite large. Oxygen-rich blood that returns from the pulmonary veins into the left atrium crosses the patent foramen ovale (PFO) into the right atrium and mixes with deoxygenated blood returning from the right side of the body. The mitral valve and left ventricle are essentially atretic and thus little to no blood will pass to this chamber. The mixed blood in the right atrium is then pumped by the right ventricle; the relative flow to the pulmonary or systemic circulation at this point is largely dependent on the relative resistance of each vascular bed, as well as the presence of a PDA. Blood will preferentially flow through the path of least resistance. Therefore, at birth when the PDA is still mostly open and the pulmonary resistance relatively high, a brief "honeymoon" period begins in which systemic perfusion is maintained. If oxygen saturations are checked at this point, they may be found to be low. There is a brief transitional period where the PDA begins to close (but is still relatively large) and the pulmonary vascular resistance decreases; this will cause a relative increase in the pulmonary circulation. If oxygen saturations are checked at this point, they may be normal or very close to normal. Systemic circulation is now beginning to be compromised, however. It is not long before signs of systemic underperfusion and cardiogenic shock begin to manifest (metabolic acidosis, poor distal pulses, oliguria).

Take-Home Message
The sensitivity and specificity of congenital heart disease screening varies depending on which study is analyzed. While they are both generally very high, much of screening depends on slight differences in unit practices as well as the timing of the screen. Be aware that even though an infant may have passed his/her congenital heart disease screen, they may still present later with signs of cyanotic heart disease.

ABP Content Specification
- Cardiovascular – Congenital heart disease: Understand the pathophysiology and anatomy of congenital heart disease.

Question 4

A 7-day-old full-term newborn boy is brought into the hospital with vomiting and poor feeding. On examination, the vitals are as follows: temp 98.4 °F, heart rate 199 beats/minute, respiratory rate 60 breaths/minute, blood pressure 62/30 mm Hg, and oxygen saturation 100% in room air. The chart reveals that the infant has lost 1 kg since birth. He has a sunken anterior fontanelle, and has capillary refill of at least 4–5 seconds. On genital examination, a relatively normal phallic structure is seen, the scrotum is markedly hyperpigmented, and no testes are palpated. You astutely order an electrolyte panel which demonstrates hyponatremia and hyperkalemia. Which of the following enzymes is mostly often implicated?

A. 17 alpha-hydroxylase
B. 11 beta-hydroxylase
C. 21 hydroxylase
D. 3-beta-hydroxysteroid dehydrogenase
E. Aromatase

Correct Answer: C. 21 hydroxylase

Description
This newborn likely has congenital adrenal hyperplasia resulting from (95% or more) defective conversion of 17-hydroxyprogesterone (17-OHP) to 11-deoxycortisol by the enzyme 21-hydroxylase. A very high serum concentration of 17-OHP can often be diagnostic of the disease, as the substrate of the 21-hydroxylase enzyme will build up when enzyme activity is deficient. The state newborn screen will often, but not always, detect this elevated substrate.

Take-Home Message
Metabolic causes should always be considered in any newborn that presents to the ED with a septic- or shock-like presentation. This is especially true when there are GU anomalies on exam.

ABP Content Specification
- Endocrine – Adrenal hyperplasia, congenital: Know the etiology and understand the pathophysiology of adrenal hyperplasia.

Question 5

A former 31-week premature male infant, now corrected to 35 weeks and 6 days' gestation, presents to the ED with bloody stools and abdominal distention for the past 24 hours. The infant was just discharged from the NICU 2 days ago. The mother had severe preeclampsia during the latter stages of her pregnancy, and the baby had to be delivered via emergent cesarean section. The infant was severely growth restricted. As the cesarean section was for maternal indications, the NICU team did not start empiric antibiotics. The mother tells you that the infant is exclusively formula fed and the formula has been fortified from 20 kcal/ounce to 27 kcal/ounce. On examination, he is in mild respiratory distress with intermittent retractions and grunting. The abdomen is markedly distended and tense with erythema overlying the right and left lower quadrants. On palpation, the infant appears uncomfortable and instantly cries when you examine him. Serum lactate is 12.6 mmol/L, and complete blood count demonstrates neutropenia and thrombocytopenia. A plain abdominal radiograph is obtained that demonstrates diffuse pneumatosis.

The risk factor(s) that mostly likely contributed to the development of this disease process is/are:

A. Prematurity
B. Low birth weight
C. Lack of breast milk
D. Chronic hypoxia in utero
E. All of the above

Correct Answer: E. All of the above

Description
Necrotizing enterocolitis (NEC) is one of the most common and dangerous gastrointestinal emergencies in the newborn infant. It is a disease process that is characterized by ischemic necrosis of the intestinal mucosa associated with inflammation, translocation of enteric bacteria, and dissection of gas into the muscularis and portal venous system. This gives rise to characteristic abdominal x-ray findings of pneumatosis and portal venous gas, consequently, NEC accounts for substantial long-term morbidity in survivors of neonatal intensive care. It is a multifactorial disease that is almost only exclusively seen in premature infants. The highest-risk infants are those of extreme prematurity and low birth weight, although it can still be seen even in "older" or late-premature infants. Breast milk has been shown to be the only currently known protective agent against NEC. Any prenatal conditions which predispose the fetal GI tract to chronic hypoxia or underperfusion (i.e., placental insufficiency from maternal pre-

eclampsia or pregnancy-induced hypertension) would also be recognized as influential in the development of NEC as there is also a strong vascular component to the multifactorial nature of the disease.

Take-Home Message
Bloody stools and signs of systemic illness in any premature infant should prompt immediate evaluation for NEC. This is even true in late-premature infants that are 35–36 weeks of gestation.

ABP Content Specification
- Gastrointestinal – Necrotizing enterocolitis: Know the risk factors for necrotizing enterocolitis.

Question 6

A term baby that is now 11 days old presents to the emergency department with his mother who is worried that he has become increasingly jittery over the past 48 hours, and she is finding it increasingly difficult to feed him. He was a rather large-for- gestational age (LGA) infant, although the mother tells you that she did not have diabetes during pregnancy. The mother has been breastfeeding the infant since birth and endorses excellent milk production. On examination, the infant is hypotonic and calm at rest, but on examination becomes very jittery. The abdomen is soft without any palpable masses. The infant has normal male genitalia for age. The serum glucose is <20 mg/dL despite having breastfed just prior to arrival to the emergency department. Which of the following statements is most true about this infant's condition?

A. A genetic focus can be identified in almost 50% of neonates
B. Is due to undisclosed, uncontrolled gestational diabetes in the mother
C. Is due to a pituitary problem in the baby
D. Exogenous insulin administration by the mother should be investigated
E. Ketone bodies will be elevated

Correct Answer: A. A genetic focus can be identified in almost 50% of patients

Description
The patient as described above has hyperinsulinemia of infancy or congenital hyperinsulinism. It is the most common cause of persistent hypoglycemia in neonates that persists beyond the first few days of life. The disease is characterized by inappropriate and persistent secretion of insulin that can result in severe hypoglycemia. There are a variety of gene mutations that disturb the normal relationship between glucose concentration and insulin secretion. In more than 50% of cases, a genetic basis can be established. The hyperinsulinism can be present even in fetal life and can many times lead to a macrosomic or LGA infant (insulin is the major driving force of fetal growth) in which this is mistakenly attributed to "missed" maternal diabetes during pregnancy. While hypopituitarism can lead to hypoglycemia, the elevated insulin levels in the face of hypoglycemia and normal genitalia make it much less likely. Exogenous insulin administration should always be considered, but recall that injected insulin does NOT contain C-peptide and can in fact suppress endogenous C-peptide production. In cases of hyperinsulinism, the C-peptide levels will be markedly elevated as a by-product of oversecretion of insulin. Lastly, insulin inhibits lipolysis and promotes further fatty acid storage leading to decreased formation of ketones.

Take-Home Message
Persistent hypoglycemia in a neonate after 5–7 days should warrant a full endocrine evaluation. Hypoglycemia associated with an infant of a diabetic mother should resolve by 2–3 days.

ABP Content Specification
- Endocrine – Hypoglycemia: Differentiate the etiology by age and understand the pathophysiology of hypoglycemia.

Question 7

A young couple and their newborn male infant arrive to the emergency department after having just delivered the infant at home. Their midwife has accompanied them and states that there was a tight nuchal cord at birth and that the infant was born limp and apneic with a "very low heart rate." The midwife states that she has been performing resuscitation measures since the baby was born. She believes the infant is probably about 10 minutes old now. On examination, the baby is limp, unresponsive, and not breathing. The heart rate is still less than 60 beats/minute. Chest compressions are started and you are getting ready to intubate the infant when your resident asks you what type of intravenous access you would prefer to establish. The best course of action here would be:

A. Simply use the endotracheal tube to administer any necessary resuscitative medications
B. Place an intravenous line
C. Place a femoral central venous catheter
D. Place an umbilical venous catheter
E. Place a PICC line

Correct Answer: D. Place an umbilical venous catheter

Description

Current Neonatal Resuscitation Program (NRP) guidelines clearly delineate the sequence of events that should be followed during a neonatal resuscitation. It is estimated that only 1% of all deliveries will require such extensive interventions as endotracheal intubation, vascular access, and the need for vasoactive medications. The initial step to any neonatal resuscitation is securing an airway and establishing adequate ventilation of the infant's lungs. Even in the most depressed infant this will usually be enough to stabilize the baby and improve the heart rate and circulation. There will, however, be those infants that even after effective positive pressure ventilation will still be bradycardic and require chest compressions and vasoactive agents. The preferred method of establishing emergent intravenous access in a newborn is via an umbilical venous catheter. This can be performed quickly and in a nonsterile fashion so as to save time. The endotracheal tube can be used to administer certain medications (namely, epinephrine), but it is not the preferred route. A femoral central line would be difficult to place quickly in a newborn. A regular intravenous line can relatively be more time consuming than the placement of an umbilical venous catheter. An intraosseous line maybe used, but the ubmilical vein is generally preferred as it is readily and easily accessible.

Take-Home Message

Be aware that the umbilical vein can readily and easily be accessed in a neonatal resuscitation to provide medications and fluid boluses.

ABP Content Specification

- Neonatal resuscitation – Management: Know modalities for vascular access in the neonate.

Question 8

A former 33-week male infant, corrected to 35 weeks and 3 days, presents to the emergency department for maternal complaints of poor feeding and "feeling cool." The mother states that the baby was just discharged from the NICU yesterday and had gone home earlier than expected because he had been doing so well. He had been moved from a closed incubator to an open crib just 3 days prior to discharge, but had been able to maintain his core temperature without problem. In the emergency department, his core temperature is 94.6 °F despite being tightly wrapped in two warm blankets and wearing a thick cap. He seems uncomfortable and mildly tachypneic. You consider the possibility that the baby may be septic. By which of the following mechanisms does his hypothermia contribute to his morbidity?

A. Increased microvascular and skin blood flow
B. Peripheral vasodilatation
C. Metabolic alkalosis
D. Hypoxia and upregulation of anaerobic metabolism
E. Decreased immune cell chemotaxis

Correct Answer: D. Hypoxia and anaerobic metabolism

Description
A neonate's core body temperature is tightly controlled by the hypothalamic regulatory center in the preoptic and anterior nuclei of the hypothalamus and represents a fine balance between heat loss and heat generation. When an infant is exposed to a cold stimulus, peripheral thermal receptors found on the skin send signals to this regulatory center, leading to the perception of cold and behavioral changes seen usually as crying or "fussiness." Efferent signals from the hypothalamic regulatory center then result in increased sympathetic activity, including vasoconstriction and stimulation of non-shivering thermogenesis in brown fat to help generate more heat. Premature infants are lacking in brown fat. Unchecked hypothermia, as can be seen in disease states such as sepsis, can result in a metabolic crisis of sorts due to hypoxia and increased, almost unchecked, anaerobic metabolism. Tissue necrosis can sometimes be seen, which only further perpetuates this process. Furthermore, hypothermia is also associated with severe end-organ dysfunction, including acute renal failure, coagulopathy, intraventricular hemorrhage, and persistent pulmonary hypertension.

Take-Home Message
Hypothermia is an independent risk factor for worse outcomes across the board in all neonates, especially those that are premature. It always requires further investigation.

ABP Content Specification
- Understand the role of thermal regulation in neonatal distress and instability.

Question 9

A 21-day-old, full-term female infant with a known diagnosis of tetralogy of Fallot presents to the ED with her mother for complaints of runny nose and a diaper rash. The infant was discharged from the NICU 2 days prior and is awaiting surgical correction. The medical student rotating with you notices that the infant is saturating 94% on room air. He recalls that such a lesion typically shunts blood right to left and thus asks you how is it possible for this infant to maintain such high oxygen saturations. You remind him that this infant has a "pink tetralogy," and the high saturations are best explained by:

A. Decreasing pulmonary vascular resistance with age and more pulmonary blood flow via the patent ductus arteriosus
B. These patients have an unrestricted ventricular septal defect
C. These patients have less right ventricular outflow tract obstruction
D. Equalization of pressure in the ventricles and less right-to-left shunting of blood
E. Absent pulmonary valves and unregulated pulmonary blood flow

Correct Answer: C. These patients have less right ventricular outflow tract obstruction

Description
The typical findings in tetralogy of Fallot are as follows: pulmonary valve stenosis, large ventricular septal defect (VSD), subpulmonary infundibular narrowing, and an aorta typically overriding the large VSD. There is usually subsequent right ventricular overload and resultant hypertrophy. Infants with tetralogy of Fallot that have significant right-to-left shunting also have significant right-sided obstruction causing right ventricular pressure to exceed left ventricular pressure. A large, unrestrictive VSD in this setting only further compounds right-to-left shunting. These infants, because of relative right ventricular outflow tract

obstruction, will classically be cyanotic. Neonates that have less subpulmonary infundibular stenosis have less right ventricular outflow obstruction. They do not shunt as much blood from right to left, if at all. These infants are said to have a "pink tetralogy" and thus can maintain normal or close-to-normal arterial oxygen saturations. They will also usually have a very loud murmur as there is more turbulent blood flow across an abnormal valve/outflow tract; the murmur is softer or even absent in cases of right-to-left shunting and subsequent cyanosis. Some may even have left-to-right shunting with subsequent pulmonary overcirculation and heart failure like that seen in large, isolated VSDs.

Take-Home Message
The degree of right ventricular outflow tract obstruction in tetralogy of Fallot determines the amount of cyanosis. If there is minimal obstruction, there may not be any cyanosis.

ABP Content Specification
- Cardiovascular – Congenital heart disease: Understand the pathophysiology and anatomy of congenital heart disease.

Question 10

A term male infant, now 7 days old, is brought into the emergency department by his parents for increasing lethargy over the past 24 hours. He was born via vaginal delivery to a 21-year-old female who had late prenatal care. The mother recalls that she was GBS negative, but cannot remember the rest of her prenatal screening. The baby had an uneventful nursery stay and then went home with his parents. At home, he had been doing well until the day prior to presentation, when he became increasingly sleepy and would not awake for feeds. On examination, the infant has a rectal temperature of 101.2 °F, heart rate 185 beats/minute, respiratory rate 76 breaths/minute, and a blood pressure of 31/16 mm Hg with a mean arterial pressure of 29 mm Hg. He is saturating normally on room air. The infant appears obtunded and will hardly react to your examination. The rest of the examination is unremarkable. You establish intravenous access, obtain cultures, and send screening blood work. The complete blood count reveals neutropenia and a platelet count of 69. His aspartate aminotransferase (AST) is 925 IU/L and alanine aminotransferase (ALT) is 1060 IU/L. The BUN is 75 mg/dL and creatinine is 2.1 mg/dL. Aside from fluid resuscitation and starting broad-spectrum antibiotics, what is the MOST important treatment to consider?

A. Acyclovir
B. Intravenous immunoglobulin (IVIG)
C. Sodium bicarbonate
D. N-Acetylcysteine
E. Platelet and fresh frozen plasma transfusions

Correct Answer: A. Acyclovir

Description
The incidence of neonatal herpes simplex virus infection (HSV) is estimated to be between 1 in 3000 and 1 in 20,000 births. It remains an extremely important cause of neonatal morbidity/mortality and important to consider in any febrile or lethargic infant up to the first 6 weeks of life, regardless of lack of overt exposure history. Neonates can acquire HSV via three main routes: intrauterine, perinatal, and postnatal. Most cases are transmitted perinatally as the infant passes through the birth canal and comes into contact with maternal lesions or virus in maternal bodily fluids. There are many infants who are born to mothers without a known history of HSV infection, but become infected as the mother can still shed virus without any overt symptoms. This is especially true in reactivations. Infection in the neonate presents in one of three ways: skin/eye/mouth disease (SEM), CNS disease, or disseminated disease. The latter is the most severe form, with most infants presenting typically around the first week of life with nonspecific symptoms of lethargy, irritabil-

ity, temperature instability, poor feeding, and/or apnea. These infants can have varying degrees of multiorgan dysfunction and cardiopulmonary compromise. Elevated transaminases can be a helpful marker to help identify HSV infection in a neonate with fever and other nonspecific findings. As such, acyclovir should be immediately administered in any suspected cases. The infant in this case should receive a lumbar puncture in addition to broad-spectrum antibiotics. N-Acetylcysteine has been used to protect against hepatic injury, but no evidence exists to suggest it would be helpful in this scenario nor would it be first-line treatment. The same could be said for IVIG. While this patient is at very high risk for DIC and may very well need multiple blood products, the platelets are not yet low enough to warrant addressing it first.

Take-Home Message
HSV should be considered in any infant presenting from home with a sepsis-like presentation. This consideration should be taken for any infant up to 6 weeks of age, regardless of maternal HSV status.

ABP Content Specification
- Herpes simplex virus, acquired/congenital: Recognize and interpret relevant laboratory and imaging studies for herpes simplex virus.

Question 11

A 10-day-old Hispanic male presents to the emergency department with a 1-day history of poor feeding, fever, lethargy, and increased work of breathing. The mother reports a normal pregnancy. The baby was delivered via normal spontaneous vaginal delivery with thick green meconium staining, but was vigorous at delivery and required no resuscitation. There have been no sick contacts. As you gather more history from the mother, she tells you that she moved to the United States from Mexico early in her second trimester. She states she used to live with her family on a farm that produces large amounts of unpasteurized goat cheese. Which of the following is most true about this infant's condition?

A. Review of the mother's placental pathology would have revealed multiple infarcts
B. Infants presenting at this age with this condition usually have meningitis
C. The causative organism typically has high rates of antibiotic resistance
D. The causative organism rarely causes disease in other patient populations
E. Acyclovir is the agent of choice to treat this infant

Correct Answer: B. Infants presenting at this age with this condition usually have meningitis

Description
The infant in this vignette is likely suffering from neonatal listeriosis. *Listeria monocytogenes* is a gram-positive rod that is important to consider in any suspected case of neonatal sepsis. It ranks behind group B streptococcus and *E. coli* as a common cause of neonatal sepsis and meningitis. The history of maternal exposure to unpasteurized dairy products is a strong risk factor for listeria infection. Passage of meconium in utero (especially if a premature infant) is also linked to listeria infection. Many infected mothers may only have mild gastrointestinal symptoms or none and therefore are never tested or treated. The bacteria easily cross the placenta and are known to cause multiple placental micro-abscesses, some of which are easily visible. Listeria in the neonate presents differently based on the age of the infant. Early-onset disease (less than 4 days of age) is typically one of overwhelming sepsis or pneumonia and can often be indistinguishable from GBS. Late-onset disease (up to 2 weeks of age) usually presents as meningitis, which is what the infant in this scenario has. There should be a high index of suspicion for listeriosis when there is a history of meconium-stained fluid at birth in a preterm infant, which is generally an unusual finding. Fortunately, the organism is highly susceptible

to ampicillin, which is first-line therapy in neonates.

Take-Home Message

While not as common as GBS or *E. coli*, listeria is still considered a serious agent of neonatal sepsis. It should be strongly suspected when there is a history of unpasteurized dairy products consumed by the mother. One other strong clue will be the presence of microabscesses in the placenta.

ABP Content Specification

- Infectious disease – Lymphatic/hematologic, Sepsis: Differentiate by age the etiology and understand the pathophysiology of sepsis.

Question 12

A full-term male infant presents to the emergency department after having been born at home. The mother is a teenager, and when you ask her about the pregnancy, she tells you she had very little prenatal care. She does, however, confide in you that she thinks she recently contracted "some sort of sexually transmitted infection." An external genital examination of the mother in the emergency department identifies maternal vaginal vesicular lesions that are highly suspicious for herpes simplex. No such lesions or rashes are present on either the skin or mucous membranes of the infant, who otherwise appears well. What is the most appropriate first step in the care of this infant?

A. Discharge home
B. Observe in the hospital for 72 hours
C. Perform a full sepsis evaluation including lumbar puncture
D. Obtain lumbar puncture for HSV PCR from cerebrospinal fluid only
E. Obtain HSV surface cultures and blood PCR and begin IV acyclovir

Correct Answer: E. Obtain HSV surface cultures and blood PCR and begin IV acyclovir

Description

Maternal genital herpes simplex virus (HSV) infection is associated with a high risk of neonatal morbidity and mortality. The risk of intrapartum transmission of HSV to the neonate is directly related to previous maternal exposure to HSV, with mothers who are experiencing a first-time infection carrying a transmission risk of up to 57%. Although asymptomatic, the infant in the vignette has clearly been exposed to active HSV lesions via vaginal delivery. The approach of the HSV-exposed neonate largely relates to the type of maternal infection (primary versus recurrent) and the overall well-being of the infant. The current American Academy of Pediatrics Committees on Fetus and Newborn and Infectious Diseases recommendations suggest PCR testing of the infant in such a situation. Again, this is related primarily to the high degree of risk to the neonate given the maternal HSV status, primary infection, and mode of delivery. Therefore, the best course of action would be to obtain full surface HSV cultures from skin and blood PCR and start intravenous acyclovir while awaiting the results.

Take-Home Message

- Cases in which HSV transmission to the infant is deemed high risk require prompt investigation of neonatal HSV infection and initiation of prophylactic acyclovir.

ABP Content Specification

- Recognize and interpret relevant laboratory and imaging studies for herpes simplex virus.
- Know the risk factors associated with congenital herpes simplex virus.
- Recognize signs and symptoms associated with congenital herpes simplex virus infection.

Question 13

A full-term male infant is born at term via spontaneous vaginal delivery and discharged home at 72 hours of life. The mother has been attempting

to breastfeed him at home, but brings him to the emergency department on day of life 6 with poor feeding, lethargy, vomiting, and tachypnea. The infant is grossly obtunded, demonstrates poor suck, and is profoundly hypotonic. You immediately begin a sepsis workup and evaluation for inborn errors of metabolism. Of significance, the complete blood count and complete metabolic panel are normal, but the plasma ammonia is greatly elevated. You now strongly suspect a metabolic disorder; as you prepare to contact the metabolic consultant on call and order additional lab work, which of the following enzymes can you assume is MOST likely to be deficient based on the above information?

A. Citrate synthase
B. Arginase
C. Fumarase
D. Argininosuccinate synthetase
E. Ornithine transcarbamylase

Correct Answer: E. Ornithine transcarbamylase

Description
The infant in the vignette has a classic presentation for an inborn error of metabolism involving the urea cycle with marked hyperammonemia, a normal blood sugar level, and the absence of any metabolic acidosis. It is vitally important to remember that his symptoms occurred after the introduction of protein into his diet. The most common and severe of these inborn errors is ornithine transcarbamylase (OTC) deficiency. OTC deficiency is the most common and serious urea cycle defect to appear in the first few days of life; it accounts for nearly half of cases of severe hyperammonemia occurring in the neonatal period. It is an X-linked disease with an estimated incidence of 1 in 14,000 live births. Female heterozygotes have been reported and can be severely affected depending on the specific mutation and the proportion of liver cells that carry the mutation. While the amino acid and urine organic acid testing is in progress, initial treatment of the infant with a suspected urea cycle defect consists of emergent hemodialysis to treat the hyperammonemia and other forms of continuous renal replacement therapy. Other forms of initial treatment include elimination of protein intake and instead using high-dextrose fluids and lipids. Other agents such as arginine hydrochloride, sodium benzoate, and sodium phenylacetate have been reported to have some temporizing effects.

Take-Home Message
Hyperammonemia in a male infant without metabolic acidosis is ornithine transcarbamylase until proven otherwise.

ABP Content Specification
- Metabolic emergencies – Inborn errors of metabolism, Urea cycle defects: Understand the pathophysiology of urea cycle deficiencies.

Question 14

A former extremely low-birth-weight infant, now corrected to 46 weeks, presents to the emergency department with significant respiratory distress. The infant had a very complicated NICU stay and was only recently discharged home with his parents. On your initial examination, you note that the infant has what appears to be a rather large hemangioma just below the left edge of the mandible. The mother states that they were prescribed a medication for this on discharge, but that she has not had time to obtain the prescription. An arterial blood gas is obtained which reveals pH 7.2, PCO_2 of 70 mm Hg, and a base excess of +2. The most likely category of acid-base disturbance best described by this gas is a/an:

A. Acute respiratory alkalosis
B. Acute respiratory acidosis
C. Chronic respiratory acidosis
D. Metabolic acidosis
E. Metabolic alkalosis

Correct Answer: B. Acute respiratory acidosis

Description

The infant in this scenario has a significant hemangioma in the "beard" distribution which raises the risk of airway infiltration/involvement. Her respiratory distress and CO_2 retention are likely related to this. When analyzing a blood gas, the first initial step is to evaluate the reported pH. A low pH as above is likely to have been caused by an acidosis (a process that makes excess hydrogen ions). In the clinical vignette above, the pH of 7.2 is likely to have been caused by a respiratory acidosis and/or metabolic acidosis. The next step involves the correction of the pH by evaluating the PCO_2. The general rule of thumb is that for every 10 mm Hg that the PCO_2 rises above 40 mm Hg, the pH responds by decreasing by about 0.08 units. Taking the above scenario, if one were to adjust the PCO_2 down by 30 mm Hg to 40 mm Hg (essentially a normal PCO_2), this should raise the pH by 0.24 points to 7.44. This corrected (and now normal) pH suggests that an acute PCO_2 increase is the reason for this infant's acidosis. Therefore, one can confidently state that acute respiratory acidosis is the most likely cause, likely secondary to airway obstruction and inability to properly ventilate.

Take-Home Message

Know how to evaluate a blood gas result not just on the reported values and calculation of acute vs chronic, but also with the given clinical information.

ABP Content Specification

- Respiratory failure/arrest – Recognition: Recognize and interpret relevant laboratory studies for respiratory failure.

Question 15

You are asked to assess a term, 1-month-old male infant in triage who was brought in by his mother for excessive fussiness. In triage, it is noted that he has tachycardia. The pregnancy was uncomplicated and the infant was born at term via vaginal delivery. He is hemodynamically stable and saturating 100% on room air. The monitor demonstrates a heart rate of 295 beats per minute. The EKG shows narrow complex tachycardia with no discernable p waves. You diagnose him with supraventricular tachycardia. What should you administer first?

A. Lasix
B. Adenosine
C. Calcium bolus
D. Labetalol
E. Amiodarone

Correct Answer: B. Adenosine

Description

It is first important to note that the child in the above scenario is suffering from a narrow complex tachycardia. This typically suggests supraventricular tachycardia (SVT), with the two most common forms being atrioventricular reentrant tachycardia and atrioventricular nodal reentrant tachycardia. Initial management includes stabilization providing supportive measures such as oxygenation and ventilation as needed. A 12-lead EKG should be obtained immediately. In an otherwise hemodynamically stable infant, one can use either vagal maneuvers or adenosine to attempt to terminate the arrhythmia. It is important to note that adenosine has a very short half-life and, as such, should be given rapidly via an IV that is preferably in the upper extremities (as close to central as possible). Parents should be warned about the brief asystole (<1 second) that often follows successful treatment. Lasix, while useful for treating hyperkalemia or fluid overload, has no use here nor is there any reason to suspect hyperkalemia. A calcium bolus, while useful in cases of hyperkalemia or when cardiac membrane instability is suspected, is not indicated for this scenario. Beta blockade is typically used for chronic, long-term control of SVT. Amiodarone is rarely used acutely in the neonate; it can be used for management of SVT, but typically only after failed adenosine and cardioversion trials.

Take-Home Message
Otherwise healthy newborns and infants can tolerate SVT for quite some time before any concern of cardiac compromise. While vagal maneuvers can initially be attempted, the pharmacotherapy of choice in terminating the SVT is adenosine.

ABP Content Specification
- Cardiac dysrhythmias: Plan management of acute cardiac dysrhythmias.

Question 16

A full-term female infant is brought into the emergency department by her mother at 3 weeks of age with concern that her urine is dark and stools are clay-colored. Physical examination is unremarkable. Her vital signs are normal for age. There is mild jaundice of the face and chest, including marked scleral icterus. Her abdominal examination is without organomegaly or palpable masses. You order a bilirubin panel, which reveals a total bilirubin concentration of 12 mg/dL, with a direct bilirubin concentration of 9.7 mg/dL. Based on the above information, what is this infant's most likely diagnosis?

A. Alagille syndrome
B. Choledochal cyst
C. Congenital cytomegalovirus (CMV) infection
D. Biliary atresia
E. Hepatitis A infection

Correct Answer: D. Biliary atresia

Description
Persistent jaundice beyond 2 weeks of age is always abnormal and should always raise concern for investigating for cholestasis. Indicators of cholestasis sometimes include acholic stools (white-, gray-, or clay-colored), dark urine, and hepatomegaly. Occurrence of acholic stools in an infant is always abnormal and should prompt immediate evaluation to determine etiology. Early recognition is vital because it can decrease significant morbidity and mortality. The initial step in evaluation in such an infant should begin with measuring both total and conjugated levels of serum bilirubin, as was done in the vignette. Conjugated hyperbilirubinemia is the keystone of neonatal cholestasis and should never be dismissed as normal. Conjugated hyperbilirubinemia is defined as a direct bilirubin concentration greater than 1 mg/dL when the total bilirubin is less than 5 mg/dL, or more than 20% of the total bilirubin if the total bilirubin is greater than 5 mg/dL. One can remember cholestasis as generally resulting from either impaired bile formation or from obstruction of bile flow through the biliary tree. Most conditions that cause cholestasis can therefore be classified as either obstructive or metabolic in origin. Biliary atresia is the most common cause of neonatal cholestasis in an otherwise healthy, full-term infant. There is a slight female predominance. If left undiagnosed or untreated, liver failure by 2 years of age is almost guaranteed. Acholic stools and jaundice are usually the first signs, but infants are usually asymptomatic and otherwise doing well. Alagille syndrome is a genetic disease that can cause cholestasis, but these infants are usually dysmorphic and have significant cardiac disease. Hepatitis infection is another rare cause of cholestasis, but unusual in a neonate with no risk factors or exposure history. Choledochal cysts (or other biliary obstruction) are an important cause of cholestasis to consider. These infants also present with jaundice and acholic stools, but usually have a palpable abdominal mass in the upper quadrants. Congenital CMV can also cause cholestasis, but usually presents much sooner and has other associated findings such as low birth weight, thrombocytopenia, and characteristic skin and retinal findings.

Take-Home Message
Direct hyperbilirubinemia is always abnormal and warrants a full investigation. An etiology like biliary atresia requires surgical intervention and the prognosis is much better the sooner it is discovered and treated.

ABP Content Specification

- Biliary tract disease, acute: Know the etiology and understand the pathophysiology of biliary tract disease.

Question 17

A term female infant, now 50 days old, is referred from the pediatrician's office for evaluation of tachypnea and detection of a heart murmur. The parents initially brought her to the doctor's office because she was tiring with feeds and having rapid breathing for the past several days. The pregnancy and delivery were otherwise uncomplicated. On examination, the infant is tachypneic, saturating 93% on room air. She has a grade 3/6 harsh systolic murmur at the lower sternal border and an active precordium; her vitals are otherwise normal. You also find that her liver is enlarged and palpable 3 cm below the right costal margin. A chest x-ray is obtained and shows cardiomegaly and increased pulmonary vascular markings.

You request a cardiology consult and start to order some blood work. What is the most probable cause for this infant's symptoms?

A. Congestive heart failure due to persistent patent ductus arteriosus
B. Undiagnosed hypoplastic left heart syndrome
C. Tetralogy of Fallot
D. Congenital cystic adenomatoid malformation (CCAM)
E. Congestive heart failure due to large ventriculo-septal defect

Correct Answer: E. Congestive heart failure due to large VSD

Description

The infant in the above vignette has a large ventriculo-septal defect that is now resulting in congestive heart failure. Such infants experience pulmonary overcirculation which increases the size and workload of both left-sided and right-sided heart structures. The chest radiograph findings of cardiomegaly and increased pulmonary vascular markings support this, as does the type and location of the infant's heart murmur. Most infants are asymptomatic early in life due to relatively high pulmonary vascular resistance that is protective in preventing excessive left-to-right shunting. As the child ages, however, the pulmonary vascular resistance will generally continue to decrease. This is accompanied by a resultant increase in left-to-right shunting and subsequent signs of pulmonary overcirculation and heart failure. Typically, the pulmonary vascular resistance does not reach a nadir of sorts until about 8 weeks of age. Tetralogy of Fallot is a cyanotic heart lesion that usually does not cause congestive heart failure and, depending on the degree of right ventricular outflow obstruction, presents much sooner. Hypoplastic left heart usually presents very early and CCAM is associated with characteristic radiographic findings. The murmur in PDA is typically a continuous murmur and not systolic.

Take-Home Message

Signs of poor feeding and suboptimal weight gain in an infant should prompt for a cardiac evaluation. A VSD may not present with an audible murmur at birth because of decreased left-to-right shunting due to higher pulmonary vascular resistance at birth.

ABP Content Specification

Cardiovascular – Congestive heart failure: Differentiate the etiology by age and understand the pathophysiology of congestive heart failure.

Question 18

A 10-day-old term female infant was born via caesarian section secondary to macrosomia to a mother with poorly controlled diabetes. The infant did relatively well in the newborn nursery and was discharged home after a few uneventful days in the nursery. She developed worsening tachypnea over the last 24 hours after being at

home. The mom also states that she is not able to finish a bottle without significant respiratory distress. Her blood pressure is 48/32 mm Hg, and heart rate is 152 beats/minute. She is requiring 2 L of 100% oxygen via nasal cannula to maintain an oxygen saturation of 99%. Capillary refill is more than 4 seconds. There is an S4 gallop appreciated on your examination. Echocardiography is obtained in the emergency department and reveals significant hypertrophic cardiomyopathy.

Of the following, what is MOST likely to improve this infant's cardiac output in this clinical setting?

A. Milrinone
B. Vasopressin
C. Epinephrine
D. Normal saline bolus
E. Dobutamine

Correct Answer: D. Normal saline bolus

Description
The infant as described above is an infant of a diabetic mother, as evidenced by the mother's poor glycemic control and large-for-gestational age status of the baby. Infants of diabetic mothers are at increased risk of cardiac defects, one of which is transient hypertrophic cardiomyopathy. This is a concerning entity as thickening of the ventricular septum leads to consequent reduction in the size of the ventricular chambers and outflow tracts. Many develop significant respiratory distress and reduced cardiac output, secondary to greatly diminished stroke volume and cardiac output. The infant above is also exhibiting signs of hypoperfusion and shock. The initial step should be to provide volume resuscitation with 10 mL/kg of normal saline. This should be administered judiciously as rapid administration of large volumes of fluid may result in fluid overload.

The management of such a condition requires important consideration of the infant's underlying pathophysiology. Agents such as dobutamine and epinephrine will increase contractility and actually worsen the left ventricular outflow obstruction. These should generally be avoided. Milrinone would decrease systemic vascular resistance (afterload reduction), which in turn increases the pressure gradient across the left ventricular outflow tract and would also worsen the infant's status. Of the above choices, a normal saline bolus would be the most appropriate. Optimization of intravascular volume is crucial, as this decreases the left ventricular outflow tract gradient and improves preload. As such, stroke volume and cardiac output are much improved.

Take-Home Message
When possible, the etiology of hypotension and shock in a neonate should be carefully considered, as the treatment modalities may differ.

ABP Content Specification
- Circulatory failure/shock – Etiology: Know major etiologies of circulatory failure/shock.

Question 19

A female infant was born at 37 weeks after a healthy pregnancy and is discharged home after an uncomplicated 48 hour stay in the newborn nursery. She now presents to the emergency department at 4 days of life with seizure activity. The mother reports that she had been having trouble breastfeeding the child at home. On examination, she is having tonic-clonic seizures. Her abdomen is soft but the liver edge is easily palpated 3 cm below the right costal margin. Several initial samples are sent to laboratory, including serum glucose, insulin, lactate, and ammonia. The blood gas shows a pH of 7.19, PCO_2 of 37 mm Hg, PaO_2 of 104 mm Hg, and base excess of −14 mEq/L. The bedside blood glucose is too low to register. Her serum glucose concentration reported as 10 mg/dL. Serum ammonia concentrations return as normal, while her lactate level is 4.2 m.moles/L. Of the following, the MOST likely diagnosis for the infant in the vignette is

A. Insulinoma
B. Glycogen storage disease type I
C. Hypoxic ischemic encephalopathy
D. Neonatal stroke
E. Fatty acid oxidation disorder

Correct Answer: B. Glycogen storage disease type I

Description

The preceding combination of lactic acidosis, seizures, and inability to regulate blood sugar during fasting is very suggestive of glycogen storage disease type I. It is characterized primarily by accumulation of glycogen and fat in the liver with resultant hepatomegaly. Neonates present with severe hypoglycemia and metabolic acidosis very early in life. Glycogen storage disease type I is inherited in an autosomal recessive fashion. Mutations in the gene (*G6PC*) located on chromosome 17q21 (*GSDIa*) cause 80% of this disease. The *G6PC* gene provides instructions for synthesizing glucose 6-phosphatase localized on the inner membrane of the endoplasmic reticulum. Glucose 6-phosphatase works together with the glucose 6-phosphate translocase protein to break down G6P to generate glucose. The lack of either G6Pase catalytic activity (GSDIa) or G6P translocase (transporter) activity in the liver leads to an inadequate conversion of G6P into glucose. The result is always severe hypoglycemia and other associated signs (lethargy, jitteriness, and seizures). Occasionally the associated lactic acidosis can be so severe as to cause a compensatory tachypnea and be mistaken for a primary respiratory problem or even sepsis. Hypoxic ischemic encephalopathy (HIE) is unlikely as the pregnancy and birth history were unremarkable. Hyperinsulinism (i.e., secondary to an insulinoma) is an important cause to consider, but likely would have presented sooner. Neonatal stroke is an important consideration with the history of seizures, but the unrelenting hypoglycemia, acidosis, and hepatomegaly suggest another etiology.

Take-Home Message

Besides remembering the ABCs of stabilization in any acutely ill patient, *always* obtain a rapid glucose level immediately on any seizing neonate, especially if they had been otherwise healthy with a normal pregnancy and delivery history. While the etiology of seizures in neonates is broad, most fall under metabolic and electrolyte causes.

ABP Content Specification

- Glycogen storage disorders: Recognize the general signs and symptoms of glycogen storage disorders.

Question 20

A 1-month-old, full-term male infant presents to the emergency department with worsening respiratory distress over the past few days. The infant's birth history is remarkable for symptomatic lobar emphysema that required resection at 22 days of life; he tolerated the procedure well and recovered quickly. He was discharged home 2 days ago. The infant's mother had good prenatal care, an uncomplicated pregnancy, and normal vaginal delivery. Her prenatal laboratory values were unremarkable except for a positive group B streptococcus swab at 36 weeks' gestation, for which she received appropriate intrapartum antibiotics. On examination, the infant is tachypneic and only saturating 82% on room air. You find it difficult to auscultate breath sounds on the left, but the rest of his examination findings are normal. His complete blood count with differential is normal, as is his c-reactive protein. Arterial blood gas findings reveal mild respiratory acidosis. The infant's chest x-ray in the ED reveals a large left-sided pleural effusion.

Of the following, the MOST likely diagnosis in this infant is:

A. Tension pneumothorax
B. Hemothorax

C. Group B streptococcal pneumonia
D. Mediastinal lymphoma
E. Chylothorax

Correct Answer: D. Chylothorax

Description
The radiograph demonstrates left-sided pleural effusion, and the scenario is most consistent with the diagnosis of chylothorax. In neonates, it is the most common etiology of a pleural effusion and can result in significant morbidity and mortality. Chylothorax, the accumulation of chyle in the pleural space, has several etiologies and commonly occurs after injury or damage to the thoracic duct. Intrathoracic surgeries, especially those to repair congenital heart defects, are very common etiologies. In infants with postoperative chylothorax, it is not uncommon for a period of stability to usually occur between the surgery and the onset of the pleural effusion. Hemothorax should be considered in the differential diagnosis of any pleural effusion, but is seen more as an immediate complication after thoracic surgery. It is also seen in infants who have coagulopathy and uncontrolled bleeding. Group B streptococcal infection can certainly manifest as a pneumonia, and late-onset disease can be seen up to a month of age. However, the infant's CXR is not described as pneumonia, and his CBC results are reassuring. Mediastinal masses in neonates are extremely rare and do not present as an effusion. Furthermore, the chest x-ray findings do not support the diagnosis of a pneumothorax.

Take-Home Message
Pneumothorax and chylothorax should be suspected in any infant presenting with respiratory distress after any intrathoracic procedure. Radiographic findings in pneumothorax consist of a visible visceral pleural edge recognized as a very thin sharp white line with no lung markings peripheral to this line. In contrast, chylothorax findings are similar to that of pleural effusion where there is blunting of the costophrenic and cardiophrenic angles, with fluid within the horizontal or oblique fissures and opacification at these angles and often with loss of lung volume. Lung ultrasound can also detect both pneumothorax and pleural effusion.

ABP Content Outline
- Congenital heart disease: Know the postoperative residual and late complications following the repair of congenital heart defects.

Question 21

A recently discharged 24-week gestation NICU graduate that had a complicated hospital course is brought back to the emergency department for worrisome skin lesions on his arms and back that appear to be worsening. The mother states that initially they started out as what looked like "red bumps" that then turned into blisters, some of which ruptured and drained. You note various scattered bullae on the baby's back, some still bleeding and others that appear ulcerated. Two of the lesions have a necrotic black center. Based on the above information, what is the MOST likely causative organism?

A. *Pseudomonas aeruginosa*
B. *Escherichia coli*
C. Group B streptococcus
D. Herpes simplex virus (HSV)
E. *Candida albicans*

Correct Answer: A. *Pseudomonas aeruginosa*

Description
A newborn infant's skin is an important defense barrier against invasion by infectious organisms. The skin is rapidly colonized after birth, with the initial sites being the umbilicus, groin, and axillae. Most of these organisms are *Staphylococcus epidermidis* and some gram-negative enteric organisms. Bacterial infections of the skin can present in multiple ways. Maculopapular rashes, vesicles, pustules, bullae, and abscesses are all common presenting lesions. The lesion as

described above is very specific for what is known as ecthyma gangrenosum, which occurs in about 5% of infections caused by *Pseudomonas aeruginosa.* The lesions typically start as small red papules and quickly become vesicular. From there the center can become necrotic, and this central black eschar region is surrounded by a rim of erythema. Pseudomonas infections are typically seen in patients that are immunosuppressed. This patient's difficult NICU course and prolonged hospitalization were definite risk factors for acquiring such an infection.

Take-Home Message
Although rare, pseudomonas skin infections may present with necrotizing lesions with central blackening surrounded by a rim of erythema. Infants who remained in the NICU for a prolonged time are at increased risk.

ABP Content Specification
- Skin and soft tissue – Miscellaneous skin and soft tissue infections: Differentiate by age the etiology and understand the pathophysiology of skin and soft tissue infections.

Question 22

A male infant of term gestation is brought to the emergency department at 21 days of life for persistent, projectile vomiting that has been worsening over the past 2 weeks. The mother is very tearful and states that almost every feed is followed by a large emesis and that she is worried he is not gaining adequate weight. On examination, the infant is afebrile with mild tachycardia but with otherwise stable vitals. The abdomen is soft and non-tender with no palpable masses. The most likely electrolyte abnormality in this scenario is

A. Anion gap metabolic acidosis
B. Non-anion gap metabolic acidosis
C. Hypochloremic, hypokalemic metabolic alkalosis
D. Hyperkalemic metabolic alkalosis
E. Compensated metabolic acidosis with respiratory alkalosis

Correct Answer: C. Hypochloremic, hypokalemic metabolic alkalosis

Description
Hypertrophic pyloric stenosis is a condition characterized by persistent projectile emesis in young infants. This is brought on by inappropriate hypertrophy of the pylorus which can sometimes progress to near-complete obstruction of the gastric outlet. It is more commonly seen in first-born male infants (4:1 to 6:1, male/female predominance). It is usually easily diagnosed based on history and ultrasound findings. The palpation of a hypertrophied pylorus or "olive" is seen in 50–90% of cases, although these numbers vary greatly. While the diagnosis is straightforward, it is important to assess the infant's electrolyte status as surgeons will not operate on these patients until metabolic derangements are corrected. Those infants that have had prolonged symptoms are at risk for developing a hypochloremic, hypokalemic metabolic alkalosis. Frequent vomiting leads to acute loss of hydrogen and chloride ions, and a state of relative alkalosis develops. This results in a compensatory mechanism of potassium ions being transported into the intracellular compartment as hydrogen ions are transported out. The reverse is seen in acidosis. Recognition and correction of metabolic abnormalities prior to surgery is paramount to facilitate a safe and expedited surgical outcome.

Take-Home Message
It is important to note that even straightforward surgical problems still require critical medical monitoring before and after the diagnosis.

ABP Content Specification
- Pyloric stenosis: Know the pathophysiology of pyloric stenosis.

Question 23

A 2-day-old term female infant with trisomy 21 presents to the emergency department with bilious emesis that started this afternoon just after discharge home from the nursery. The pregnancy

was normal and delivery uncomplicated. The infant had an echocardiogram in the newborn nursery before going home which only demonstrated a small muscular VSD. She had a stool on the first day of life, latched well on the breast, and was thus discharged home at 48 hours of life. The mother notes that the bilious emesis essentially started as soon as they arrived home and that it has been with the past two feedings. On examination, the infant is afebrile with normal vital signs. The abdomen is slightly full, but non-tender with no palpable masses. Aside from slightly decreased tone overall, the examination is otherwise normal. You obtain a plain abdominal radiograph which demonstrates a double bubble.

What is this infant's most likely diagnosis?

A. Pyloric stenosis
B. Intestinal malrotation
C. Duodenal web
D. Hirschsprung disease
E. Intussusception

Correct Answer: C. Duodenal web

Description
The above scenario is a classic presentation for duodenal web. The history of bilious emesis in an infant with trisomy 21 strongly suggests an intestinal obstruction. The characteristic "double bubble" sign as seen on the abdominal radiograph only further supports this. Approximately 24–28% of newborns with duodenal atresia will have trisomy 21. They will typically have abdominal distention and vomiting that may or may not be bilious. It is important to note that the vomiting may not be apparent as it will not manifest until a certain volume of feeds is reached. Sometimes the diagnosis can even be made prenatally on ultrasound. Pyloric stenosis is not associated with bilious emesis. Although malrotation is an important cause of bilious emesis, there is no "double bubble" sign on x-ray. The "double bubble" of duodenal obstruction is made up of the stomach and the dilated portion of intestine proximal to the obstruction. The infant passed stool on the first day of life, making Hirschsprung disease less likely. Lastly, intussusception is rare before 2 months of age and more often presents with lethargy, irritability, or bloody/mucous stools.

Take-Home Message
Newborns with trisomy 21 can present with problems from a variety of different organ systems. Cardiac and GI anomalies predominate. There should be a heightened level of suspicion for other associated anomalies in any baby with trisomy 21 presenting with even "common" complaints.

ABP Content Outline
- Obstruction: Know the etiology and signs and symptoms of gastrointestinal obstruction.

Question 24

You are seeing an 18-day-old infant for no stool in 3 days, but who is acting otherwise well. She was born at home and has yet to see a pediatrician. You obtain more history from the mother, who states that she had a "positive syphilis test" several months ago, but never followed up with the local health department and received no treatment. Which of the following factors compels you to treat the baby?

A. No maternal treatment
B. The infant has organomegaly
C. The infant has nasal discharge
D. The infant has a CBC with 12% bands
E. The infant has mild tachypnea

Correct Answer: A. No maternal treatment

Description
Syphilis impacts an estimated one million pregnancies around the world. Nearly 40% percent of these pregnancies result in fetal or perinatal death, and the remaining surviving neonates suffer significant physical and developmental deficits. The congenital syphilis rate has been rising during the past decade due to the increase in primary and secondary syphilis rates among women.

Congenital syphilis can be prevented if the mother is treated by the second trimester. Penicillin is the drug of choice, especially during pregnancy as it is especially effective in preventing transmission of infection to the fetus. To be most effective, treatment must be completed at least 4 weeks before delivery. There is even some thought from the American Academy of Pediatrics Committee on Infectious Disease (as published in the *Red Book*) that a single dose of penicillin be given to infants of mothers who were adequately treated for syphilis *during* pregnancy. Therefore, this mother's obvious lack of treatment is the most compelling reason to treat the infant with penicillin. While some of the other remaining choices are certainly worrisome in terms of possible symptoms in the infant, none are absolute indications.

Take-Home Message

While syphilis should be treated in pregnancy, it does pose a significant risk to the fetus and neonate if the mother was not treated. The infant should always be treated after birth if the mother was not treated or if adequate records from the health department indicating treatment are lacking.

ABP Content Specification

Sexually transmitted disease – Syphilis: Differentiate by age the etiology and understand the pathophysiology of syphilis.

Question 25

A full-term infant is brought to the emergency department at 8 hours of life because the parents think he looks "ashen." The mother had an uneventful pregnancy and birthing occurred at home per parent choice with no reported complications. Oxygen saturation levels measured in the emergency department are 60% in the right hand and 70% on the right foot. You provide 100% oxygen via nasal cannula to the infant, and there is no change in the saturations. Despite all this, the infant otherwise appears very comfortable. No murmur is heard. A chest x-ray demonstrates normal lung markings, a globular heart, and a narrow upper mediastinum.

What is the MOST likely condition that explains this infant's findings?

A. Persistent pulmonary hypertension
B. Transposition of the great arteries
C. Tetralogy of Fallot
D. Large ventricular septal defect
E. Meconium aspiration syndrome

Correct Answer: B. Transposition of the great arteries

Description

The infant in the above scenario is hypoxic at both pre-and post-ductal sites. Even when given 100% inspired oxygen, the infant's saturations do not improve. For an infant who is also profoundly hypoxic, there is almost no respiratory distress. This is highly suspicious for cyanotic heart disease. The difference in oxygen saturations from pre- to post-ductal levels suggests the presence of an intracardiac shunt. However, rather than the more expected finding of higher pre-ductal than post-ductal saturations as seen in right-to-left shunts, the opposite is observed. This entity is called "reverse differential cyanosis." The most common explanation for this is transposition of the great arteries with concomitant pulmonary hypertension, a life-threatening emergency. These infants are dependent on a patent ductus arteriosus to maintain some mixing of blood to maintain some forward flow. Persistent pulmonary hypertension, in the absence of any structural cardiac anomalies, would give you a right-to-left intracardiac shunt. You would thus expect the pre-ductal saturations to be much higher. They also typically respond well to oxygen, unless severe. Tetralogy of Fallot is one of many cyanotic heart lesions, but again would not be expected to give you a "reverse differential cyanosis." In addition, there is usually a loud murmur from a VSD and the chest radiograph typically demonstrates a boot-shaped heart. A large VSD is

typically all left-to-right shunting; occasionally reversal of the shunt and hypoxia can occur but this is more of a long-term consequence; these babies are never hypoxic at birth.

Take-Home Message
Transposition of the great arteries causes severe cyanosis with minimal to no respiratory distress.

ABP Content Specification
- Cardiovascular – Congenital heart disease: Recognize signs and symptoms and life-threatening complications of congenital cardiac lesions by age.

Question 26

A 30-day-old female infant is brought to the emergency department by her mother with concerns of poor feeding, limpness, and weak cry. She is a full-term infant and the pregnancy was uncomplicated. Her delivery was routine without issues. She was discharged to home after 48 hours. The infant's father is a construction worker, and the mother is still on maternity leave. On examination, the infant is afebrile with normal vitals. She is drooling excessively and is hypotonic. Of note, she has also not had a bowel movement in 7 days. Which of the following interventions is most likely to help this infant's condition?

A. Human-derived immunoglobulin
B. Broad-spectrum antibiotics
C. High-dose corticosteroids
D. Antiviral therapy
E. Antifungal therapy

Correct Answer: A. Human-derived immunoglobulin

Description
This infant is suffering from infantile botulism. When suspected or diagnosed, the treatment of choice is human-derived immunoglobulin, known as BabyBIG. Botulism is caused by a toxin released by the bacterium *Clostridium botulinum*, an obligate anaerobic, gram-positive, spore-forming organism found very commonly in the environment. Foodborne botulism in children usually results from ingestion of the toxin in prepared foods that were contaminated by the organism. In very young infants that are only breast- or formula-fed as in our scenario, the most likely route of infection is through environmental exposure. The father's occupation as a construction worker may expose him to spores that he could easily bring into the home. The toxin inhibits the fusion of the synaptic vesicle to the presynaptic membrane, thereby blocking the transmission of acetylcholine across the synapse with resultant paralysis. In young infants, it is important to ask about bowel movements as the initial presenting sign can sometimes be constipation. Cranial nerves are then affected next. Human-derived immunoglobulin (BabyBIG) is the treatment modality of choice. This is important because the treatment may need to be ordered and received from a specialized facility, which can delay treatment. Therefore, clinical suspicion must be high. Furthermore, antibiotics are contraindicated in the treatment as killing and lysing of the bacteria releases more toxin and can actually worsen the clinical symptoms.

Take-Home Message
The differential diagnosis of hypotonia in a neonate is very broad. Infectious etiologies such as infantile botulism should always be considered especially given the other historical and clinical findings (i.e., father is a construction worker, lack of stools for 10 days).

ABP Content Specification
- Botulism: Recognize the signs and symptoms of infantile botulism.

Question 27

A 22-day-old, full-term male infant is brought to the emergency department by his parents for decreasing activity and poor feeding for the past

several days. The mother's pregnancy and delivery were uncomplicated. His vitals signs are normal. On examination, he is lethargic and ill appearing. Cardiovascular exam reveals poor perfusion and a grade 3/6 systolic murmur best heard along the left sternal border along with a S3 gallop. The liver edge is palpable below the costal margin. EKG demonstrates generalized low voltage and T wave inversion; an echocardiogram obtained in the ED showed a dilated heart with severely depressed left and right ventricular function. What is the most likely etiology of this infant's presentation?

A. Neuromuscular disease
B. Glycogen storage disease
C. Infectious
D. Retained lung fluid
E. Hypoxic ischemic insult

Correct Answer: C. Infectious

Description
The infant in this scenario presents with respiratory distress, decreased perfusion, hepatomegaly, and cardiomegaly as seen on chest radiograph. In addition, the echocardiogram findings demonstrate a dilated cardiomyopathy. In the neonatal/pediatric population, at least 20% will be secondary to an infectious myocarditis caused by coxsackie B virus. The EKG supports this as T wave, and ST segment changes and low voltage are also common with this condition. Endomyocardial biopsy is the gold standard for diagnosis, but is seldom needed as the above findings are generally enough to make the diagnosis. Neuromuscular diseases, namely, muscular dystrophy, *can* present with cardiomyopathy. However, this rarely happens during the neonatal period. Glycogen storage diseases can also have cardiomyopathy as a presenting feature. Type II disease, also known as Pompe disease, is especially notorious for such a finding. These infants, however, usually have typical coarse facies and a history of fetal hydrops. In addition, they are usually symptomatic very quickly after birth. Retained lung fluid is exclusively a diagnosis only to be considered at birth and is more commonly seen in infants delivered via cesarean section in the absence of labor. While it does present with respiratory distress, the cardiac findings and signs of poor cardiac output are not seen. Finally, an ischemic insult (at birth, for example) could certainly cause cardiac dysfunction. However, there is nothing in the antenatal history to suggest such an occurrence as the delivery was uncomplicated.

Take-Home Message
Several different infectious agents can cause myocarditis and subsequent cardiomyopathy. Most of these agents are viral in origin, and the infant usually presents with nonspecific findings of acute heart failure.

ABP Content Specification
- Myocarditis: Know the etiology and understand the pathophysiology of myocarditis.

Question 28

A 2-week-old, full-term infant boy is brought in to the emergency department by his mother because she wishes for you to examine his umbilical stump. The cord separated earlier in the day and there was some persistent oozing for the first few hours, but it has stopped now. The mother states that the baby did in fact receive vitamin K prophylaxis after birth. On examination, the stump is essentially normal and appears to already be healing well. You take this time to explain to your medical student that factor XIII deficiency, while rare, can usually be quickly detected based on clinical findings. Which of the following findings should raise the most concern for factor XIII deficiency?

A. Diffuse bruising
B. Intracranial bleeding
C. Prolonged umbilical stump bleeding
D. Mucosal bleeding
E. Hematuria

Correct Answer: C. Prolonged umbilical stump bleeding

Description
Factor XIII is known as fibrin stabilizing factor. It is responsible for cross-linking fibrin into a tight mesh once thrombin activates it. Factor XIII deficiency is an autosomal recessive disease and exceedingly rare. It only affects about 1 in 1,000,000 live births. It is relatively easy to detect, however, as upwards of 80% of neonates will have prolonged bleeding from the umbilical stump as the presenting sign. The other presentations are possible with this factor deficiency, but it is not as common as umbilical stump bleeding.

Take-Home Message
Factor XIII deficiency is rare and presents commonly as persistent bleeding from the umbilical stump.

ABP Content Specification
- Inherited disorders of coagulation: Recognize signs and symptoms of inherited disorders of coagulation.

Question 29

A 6-month-old boy is brought by his mother to the emergency department for "a bump on his butt". His perinatal history is remarkable for premature delivery at 35 weeks' gestation and a 2-week NICU stay. You perform a thorough examination and find a moderately sized perianal abscess that is erythematous, tender, and quite fluctuant. He is afebrile and otherwise well on examination. Before you perform an incision and drainage on such an abscess, what important complication must you consider?

A. Bacterial translocation and sepsis
B. Trauma to external anal sphincter
C. Formation of fistula-in-ano
D. Incontinence
E. Secondary infection to surrounding structures

Correct Answer: C. Formation of fistula-in-ano

Description
Perianal abscesses usually arise from infected anal crypt glands secondary to obstruction from debris. Most cases seem to affect male infants. Sometimes symptoms are mild or absent; other times it can cause extreme pain to the infant. While these can resolve on their own, they are often treated with incision and drainage. About one-third of the abscesses that are treated in this manner will develop a fistula-in-ano. This is a connection between 2 different epithelial structures. In this case, it will usually extend from the infected crypt gland(s) in the anus deep to the abscess and then back to the skin of the surrounding perianal region. When incising any abscess, one must be aware of the surrounding structures, and care should be taken not to involve the external anal sphincter as that could cause incontinence, but this is unlikely to happen unless a very deep and large incision is made. Bacterial translocation and sepsis is also unlikely as the child is afebrile and presumed to be immunologically intact. Similarly, secondary infection is unlikely as these are usually localized infections.

Take-Home Message
Fistula-in-ano is a recognized complication of incision and drainage of perianal abscesses, and the risk of occurrence of this complication should be discussed with the patient/family prior to the procedure.

ABP Content Specification
- Abscesses: Recognize complications associated with perirectal abscesses.

Question 30

A 14-day-old, full-term male infant is brought to the emergency department by his parents for persistent bilious emesis. The pregnancy and labor were uncomplicated and the baby was born vaginally. He had fed well in the newborn nursery and was discharged home after two uneventful days. He had a stool on the first day of life. The mother continued to breastfeed at home until the day of presentation when the infant suddenly began copious bilious emesis. The vital signs in triage

were within normal limits. Physical examination is remarkable for a mildly distended and tender abdomen. A plain abdominal radiograph demonstrates nonspecific bowel dilatation. What should you do next?

A. Ultrasound to detect hypertrophic pyloric stenosis
B. IV fluids for acute gastroenteritis
C. IV antibiotics for necrotizing enterocolitis
D. Barium enema for intussusception
E. Upper GI to detect malrotation and possible volvulus and possible malrotation

Correct Answer: E. Upper GI to detect malrotation and possible volvulus

Description

Bilious emesis in a neonate is almost always an ominous sign and requires prompt evaluation. The presence of acute abdominal distention raises the concern for a serious bowel obstruction. Both plain radiographs and ultrasound are largely not helpful to detect volvulus. The diagnostic modality of choice is an upper GI series to better delineate the anatomy and truly determine whether a malrotation with or without volvulus is present.

Since frequently the obstruction in malrotation is at the level of the duodenum (Ladd's bands), a barium enema is not an optimal first choice for study. An upper GI series may demonstrate the classic "corkscrew" appearance of twisted small bowel in malrotation. The most feared complication of a malrotation is the development of a midgut volvulus. This is when the small bowel twists around the superior mesenteric artery, resulting in potentially catastrophic vascular compromise to large regions of the intestines. Unrelenting bowel ischemia and necrosis follow; this can be irreversible if not detected early. The bowel can also perforate and the infant can lose substantial portions of intestine. Pyloric stenosis would present with nonbilious vomiting. Gastroenteritis might present with some mild degree of bilious vomiting, but would not have such a dramatic presentation. A plain abdominal radiograph in necrotizing enterocolitis (NEC) would demonstrate pneumatosis and/or portal venous gas. It would also be exceedingly unusual for a term infant to develop NEC. The patient is too young for intussusception.

Take-Home Message

Bilious emesis in a newborn is an emergency and should be promptly treated. After an initial abdominal x-ray, prompt and careful consideration should be given to either obtaining an upper GI or barium enema.

ABP Content Specification

- Volvulus: Recognize the signs and symptoms and complications of acute midgut volvulus.

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Nephrology

9

Laura Castellanos Reyes

Question 1

A 21-month-old girl presents to the emergency department with 5-day history of poor oral intake, about 6 episodes of loose stools, and 2–3 episodes of vomiting per day. Her activity level is decreased, and she has not voided for the past 12 hours. Vital signs are as follows: temperature 37 °C, heart rate 150 beats/minute, respiratory rate 30 breaths/minute, blood pressure 80/50 mmHg, and weight 9.8 kg. Last weight at her 18-month checkup was 11 kg. On physical examination she is alert but looks tired, with minimal tears, dry lips, and tacky mucous membrane. Her neck is supple, heart exam reveals regular rhythm, there is no murmur, and lungs are clear. Her abdomen is soft and non-tender with hyperactive bowel sounds. Diaper is dry. She moves all her extremities. Her capillary refill time is 2 seconds and her skin turgor is diminished.

What is the next step in the management of this patient?

A. Trial of PO challenge
B. Send laboratory studies including CBC and chemistry to assess the severity of dehydration
C. Give intravenous fluid bolus of 10 cc/kg of normal saline
D. Give intravenous fluid bolus of 20 cc/kg of normal saline
E. Give one dose of Zofran IV

Correct Answer: D

Dehydration is the major cause of morbidity and mortality around the world. Gastroenteritis is the most common source of dehydration accounting for more than 1.5 million office visits and 200,000 hospitalizations in the United Stated in 2003. Other common sites of fluid loss are through the skin and urine. Infants and young children are at increased risk because of the higher frequency of gastroenteritis at this age, the higher surface area to volume ratio with higher insensible losses, and the lack of ability to communicate the thirst mechanism to their caregivers.

Dehydration is characterized based on percentage of water loss. Mild dehydration is defined as 3–5% volume loss, moderate dehydration as 6–10% volume loss, and severe dehydration as more than 10% volume loss. Water loss assessment is very challenging, especially in the ER setting given the lack of a baseline weight to compare. In the given cases, clinical signs and symptoms may be used to assess the degree of dehydration and guide therapy (Table 9.1). Laboratory studies, including serum electrolytes

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_9

Table 9.1 Dehydration scale describing signs and symptoms of mild, moderate, and severe dehydration

Clinical feature	Mild dehydration <5%	Moderate dehydration 6–10%	Severe dehydration >10%
General appearance	Well, alert	Restless, irritable	Lethargic, unconscious
Eyes	Normal	Sunken	Sunken
Skin turgor	Goes back quickly	Goes back slowly	Goes back very slowly
Hear rate	Normal	Increased	Increased
Blood pressure	Normal	Normal	Normal to decreased
Capillary refill	<2 sec	~2 sec	>2 sec
Urine output	Normal or slightly reduced	Reduced	Little or none

Table adapted from the treatment of diarrhea: A manual for physicians and other senior health workers, 4th revision. WHO/FCH/CAH/05.1. World Health Organization, Geneva 2005

and acid/base balance, may be helpful in the assessment of dehydration, but they are typically normal in mild dehydration. Serum bicarbonate level below 17 mEq/L has been shown to be useful in differentiating moderate and severe dehydration. This low level almost always represents metabolic acidosis. In the case of gastroenteritis, this is secondary to loss of bicarbonate in the stools, increased acid production from shock (lactic acidosis), or decreased acid excretion by the kidney if there is a reduction in renal perfusion. The serum sodium is determined by the concentration of sodium salts and water. It is important to measure the serum sodium as this plays an important role in deciding the type and speed of fluid repletion therapy. Potassium may be low or high (low secondary to gastrointestinal K loss or high in the cases of worsening hypovolemia and metabolic acidosis). Laboratory results should not delay treatment.

The goal of therapy is the early recognition of the degree of dehydration in order to restore any water and electrolyte deficits, continue with maintenance needs, and replace ongoing losses if present. Trial of oral rehydration is appropriate for mild to moderate dehydration, while intravenous fluid therapy is indicated in cases of greater than 10% dehydration.

In the case above, the patient is exhibiting signs and symptoms of severe dehydration with weight loss >10%. Waiting for laboratory testing for confirmation of degree of dehydration or trial of PO challenge after providing Zofran should not delay parenteral treatment to replenish the effective circulating volume and prevent further organ and tissue perfusion compromise. Traditional intravenous hydration therapy consists of a 20 ml/kg bolus preferably with normal saline solution over 1 hour.

Take-Home Message

- Dehydration is characterized by percent of water loss (mild 3–5%, moderate 6–10%, and severe >10%) which can be approximated by weight loss if baseline weight is available (1 kg ~ 1 L).
- Signs and symptoms will help determine the degree of dehydration. Laboratory studies could be also helpful in finding low serum bicarbonate level < 17 mEq/L, electrolyte abnormalities, and urine concentration, but the results should not delay assessment and management.
- Fluid resuscitation in the setting of dehydration is always performed using either normal saline or lactated Ringer's solution at 20 mL/kg boluses administered over 1 hour.

Question 2

A 2-month-old infant is brought to the emergency department with chief complaint of lethargy. Mother reports watery stools and difficulty with breastfeeding for the last 3 days. Today he has had only one small wet diaper and seems very tired but becomes irritable when stimulated. On examination, the heart rate is 180 beats/min, respiratory rate is 50 breaths/minute, and blood pressure is 70/40 mmHg. The patient responds only to vigorous stimuli and has mild jaundice with a sunken anterior fontanelle on examination.

Laboratory studies show:

- Sodium, 165 mEq/L
- Potassium, 5.9 mEq/L
- Chloride, 138 mEq/L
- Bicarbonate, 15 mEq/L
- Urea, 30 mg/dL
- Creatinine, 1.2 mg/dL
- Glucose, 70 mg/dL
- Urine shows a specific gravity of 1.020 with no protein or blood and urine osmolality 600 mOsm/kg.

Which of the following statements regarding pathophysiology of hypernatremia is NOT true?

A. Infants are at higher risk of hypernatremia because of lack of free access to water
B. Symptoms are a result of a shift of water out of the brain cells
C. Most commonly it is associated with hypovolemia
D. Urine osmolality of 600 mOsm/kg in this case confirms renal water losses
E. Hypernatremia always indicates hypertonicity

Correct Answer: D

Sodium is an impermeable solute that induces movement of water across cell membranes contributing to tonicity. In the brain capillaries, the tight endothelial junctions and astrocytic foot processes create a blood-brain barrier that sodium cannot cross, promoting water to enter or leave the brain according to the plasma sodium concentration. Hypotonicity makes cells swell, while hypertonicity makes them shrink. Hypernatremia always indicates hypertonicity.

Under normal conditions, the elevated plasma sodium concentration affecting the brain volume stimulates osmoreceptors promoting the mechanism of thirst and vasopressin secretion. Individuals with an impaired sense of thirst and/or inability to request water (such infants or patients with altered mental status) are at higher risk of developing hypernatremia.

Hypernatremia is defined as serum sodium greater than 145 mEq/L and can occur with or without dehydration, but usually presents as hypertonic dehydration. There are two major causes of hypernatremia: insufficient water and/or too much salt. The most common cause of hypernatremia is the failure to replace water losses. Children usually present in the setting of gastrointestinal fluid loss. Urinary or skin loss of free water without adequate water replacement should also be considered a risk factor in the pediatric population. On the other hand, sodium gain as a result of clinical intervention or accidental sodium loading is less common.

Signs and symptoms of hypernatremia are secondary to the dysfunction of the central nervous system. Common symptoms include irritability, restlessness, weakness, vomiting, muscular twitching, and in infants, high-pitched cry and tachypnea. The presence and severity of symptoms correlate with the degree of plasma sodium elevation and rate of rise. Patients may also have manifestations of hypovolemia, but they may appear less hemodynamically compromised because the hypertonicity of the intravascular space facilitates fluid shifts from the cells into the intravascular space. This results in brain shrinkage, which can cause vessel tears and intracranial hemorrhage. Mortality can be high, ranging from 3% to 20%, and neurologic morbidity is up to 40% to 50%.

The management goal is to treat the underlying etiology to limit further water loss and correction of the water deficit. Goal is to decrease sodium by 10–12 mEq/L per day (0.5 mEq/L per hour). These patients should be monitored frequently every 4–6 hours to guarantee a slow correction over 48 hours. Seizures are typically absent except in cases of inadvertent sodium loading or aggressive rehydration.

Take-Home Message

- Hypernatremia is defined as serum sodium above 145 mEq/L and always indicates hypertonicity.
- The most common cause of hypernatremia is failure to replace water losses and can present as dysfunction of the nervous system (irritability, restlessness, weakness, vomiting, tachypnea, muscular twitching, and even brain

shrinkage due to fluid shifters leading to vessel tears and intracranial hemorrhage).
- In treating hypernatremia, the goal is to decrease sodium by 10–12 mEq/L per day (0.5 mEq/L per hour) and should be corrected over at least a 48-hour period to minimize fluid shifts. Monitoring should be performed frequently during correction (every 4–6 hours).

Question 3

You are evaluating an 8-month-old boy with vomiting and diarrhea for 1 week. Today he looks very tired and has not had a wet diaper in the last 12 hours. On physical examination, he is lethargic and has dry mucous membranes and decrease skin turgor. His heart rate is 170 beats/min and blood pressure 72/40 mmHg. You are calculating a water deficit of 10% based on current weight and most recent weight at pediatrician's office. Laboratory studies show a sodium concentration of 128 mEq/L, a potassium concentration of 3.5 mEq/L, a plasma osmolality of 270 mOsm/kg H2O, a urine sodium of 20 mEq/L, and urine osmolality of 600 mOsm/kg H2O. Which of the following is the appropriate sodium disorder diagnosis of this patient?

A. Isosmotic hyponatremia
B. Hypertonic hyponatremia
C. Euvolemic hypo-osmotic hyponatremia
D. Hypovolemic hypo-osmotic hyponatremia
E. Hypervolemic hypo-osmotic hyponatremia

Correct Answer: D

Sodium is the major cation that contributes to the extracellular fluid (ECF) osmotic pressure and ECF compartment volume. Hypernatremia defined as serum sodium above 145 mEq/L always denotes hypertonicity, but hyponatremia (defined as serum sodium below 135 mEq/L) can be associated with low, normal, or high tonicity.

Iso-osmotic hyponatremia (A) is characterized by low sodium with normal serum osmolality and can present in the case of pseudo-hyponatremia in which reduction of sodium is a result of the displacement of plasma water by the excess of lipids or proteins. Hypertonic hyponatremia (B) results from the movement of water from cells to the extracellular compartment driven by effective osmoles like glucose or mannitol. In severe hyperglycemia, the serum osmolality is high but the sodium is low because of transcellular shifting.

Hypo-osmotic hyponatremia, also known as true hyponatremia, is the most common form of hyponatremia. Here, the serum sodium concentration is primarily determined by changes in water metabolism, and low serum sodium may denote a relative sodium deficit and/or a relative water excess. The Rose modification of the Edelman equation shows how hyponatremia may occur from a decrease in the numerator (sodium and/or potassium) or an increase in the denominator (total body water).

$$\left[\text{Serum Na}^+\right] = \frac{\text{eNa}^+ + \text{eK}^+}{\text{TBW}}$$

Regulation of water homeostasis is dependent on an intact thirst mechanism, appropriate renal water handling, and antidiuretic hormone (ADH) release. Both thirst and ADH secretion are inhibited when serum sodium is below 135 mEq/L, decreasing urine osmolality as low as 50 mOsm/kg. But ADH may also be secreted in response to an impairment in renal water excretion due to reduced effective arterial blood volume or in the syndrome of inappropriate ADH secretion (SIADH). Assessment of the volume status of the patient is important in establishing the source of the ADH. Other laboratory studies that are helpful in the diagnosis of hypo-osmotic hyponatremia is the urinary excretion of sodium and urine osmolality. Normal urine sodium excretion varies from 20 to 200 mEq/L in response to intravascular volume rather than the serum levels.

Excretion of urine sodium increases with volume expansion and decreases with volume depletion; thus a urinary excretion of <20 mEq/L with urine osmolality of 600 mOsm/kg suggests the patient is dehydrated and trying to retain sodium. Additional findings include dry mucous membranes, decreased skin turgor, and tachycardia, which are consistent with hypovolemic hypo-osmotic hyponatremia (D). Euvolemic hypo-osmotic hyponatremia (C) is due to an inappropriate

ADH release that results in the retention of free water causing a drop in plasma sodium concentration. It can be present in pulmonary, central nervous system, or oncologic disorders and can be triggered by certain medications (e.g., cyclophosphamide, vincristine, opiate derivate). Hypervolemic hypo-osmotic hyponatremia (E) is a result of edematous conditions (nephrotic syndrome, cirrhosis, or heart failure) in which there is a third space component with a decreased effective circulating volume.

Take-Home Message

- Hyponatremia is defined as a serum sodium below 135 mEq/L and can be associated with low, normal, or high tonicity.
- True hyponatremia (hypo-osmotic hyponatremia) is the most common form of hyponatremia and is characterized by a sodium deficit or relative water excess, hypovolemic or hypervolemic, respectively.
- Water homeostasis is dependent on an intact thirst mechanism, appropriate renal water handling, and antidiuretic hormone release.

Question 4

You are evaluating a 15-month-old girl brought in by mother with chief complaint of 4 days of poor oral intake, vomiting, and diarrhea. Her older sister had similar symptoms, and the pediatrician instructed the mother to provide plenty of fluids to avoid dehydration. The older sister is already feeling better tolerating diet, but the 2-year-old girl is only tolerating ginger ale. Earlier today she was complaining of headache, weakness, and nausea. On physical examination, she appears disoriented with depressed reflexes. Her heart rate is 150 beats/min, respiratory rate 35 breaths/min, and blood pressure 85/45 mmHg.

Laboratory studies show:

Sodium, 125 mEq/L	Urine sodium, 10 mEq/L
Potassium, 3.2 mEq/L	Urine osmolality, 400 mOsm/kg
Chloride, 100 mEq/L	
Bicarbonate, 15 mEq/L	
Urea, 25 mg/dL	
Creatinine, 0.8 mg/dL	
Glucose, 65 mg/dL	

Which of the following statements about management of hyponatremia is NOT true:

A. Correcting hypokalemia can help improve hyponatremia
B. Goal is to increase sodium by 10–12 mEq/L per day
C. For severe neurologic symptoms associated to hyponatremia, infusion of 3% saline is indicated
D. Treatment of seizures is with solution with sodium concentration 513 mEq/L at 3 to 5 mL/kg
E. Patients with hypokalemia and liver disease are not at risk of developing central pontine myelinolysis (CPM)

Correct Answer: E

Hyponatremia is defined as a serum sodium less than 135 mEq/L. Hyponatremia can occur with or without dehydration, although it typically occurs in older infants and children with gastrointestinal losses that are replaced with low sodium content fluids such water, juice, ginger ale, sodas, or tea (like in this case).

The symptoms of hyponatremia are related to the level of injury to the central nervous system and the severity of these symptoms is associated with the degree and rapidity of the fall in the serum sodium. Headaches, nausea, vomiting, muscle cramps, lethargy, restlessness, and disorientation are some symptoms of hyponatremia, but it is also important to include signs of extracellular volume depletion in this case, such as decreased skin turgor, tachycardia, and orthostatic hypotension.

Appropriate management of hyponatremia in children requires an understanding on the etiology of the electrolyte disturbance given that the treatment choices vary depending on the underlying condition. In pseudo-hyponatremia the patient is not symptomatic because the osmolality is normal and no treatment is required. In patients with euvolemic hypo-osmotic hyponatremia secondary to inappropriate ADH release, the management is water restriction and treatment of the underlying disease. Patients with hypovolemic hypo-osmotic hyponatremia may need to replace volume deficit to remove the

stimulus of ADH secretion. Patients that present with hypervolemia may require diuresis.

Potential complications of treatment of hyponatremia is the devastating neurologic syndrome central pontine myelinolysis, in which there is destruction of myelin sheaths of pontine neurons resulting in flaccid quadriplegia, dysarthria, dysphagia, coma, and even death. It is associated with rapid correction of hyponatremia. The recommendation is to increase sodium by 10–12 mEq/L per day (0.5 mEq/L per hour) to prevent this complication. In patients with liver disease, CPM may develop even when correction is less than 10 mEq/day because in liver failure, glutamine accumulation in the brain contributes to cerebral edema increasing susceptibility to CPM. Another risk factor for developing CPM is the treatment of hypokalemia. When potassium is repleted, sodium will move out of the cell, increasing its concentration. Failure to slow the correction of hyponatremia after treatment of hypokalemia is a risk factor for developing CPM.

Patients with seizures or with hyponatremic encephalopathy should be treated with 3% saline in order to raise the sodium concentration by 4–6 mEq/L or until the seizure stops.

Take-Home Message

- Cerebral pontine myelinolysis (CPM) is characterized by destruction of myelin sheaths of pontine neurons which can be caused by rapid correction of hyponatremia.
- CPM can result in flaccid paralysis, quadriplegia, dysarthrias, dysphasia, coma, or even death.
- If a patient presents with seizures or encephalopathy secondary to hyponatremia, treatment involves hypertonic saline (3%) administration in 3–5 mL/kg bolus to raise the serum sodium by 4–6 mEq/L or until seizures resolve.
- Goal of treatment is to increase sodium by 10–12 mEq/L per day (0.5 mEq/L per hour).

Question 5

A 5-year-old girl with history of focal segmental glomerulosclerosis on tacrolimus, enalapril, calcium carbonate, and vitamin D was brought to the emergency department with worsening vomiting and diarrhea for 4 days. She is now unable to tolerate fluid intake. On arrival to the ER, she appears lethargic, with sunken eyes and poor capillary refill. The heart rate was 180 bpm, respiratory rate 30 breaths/minute, and blood pressure 90/55 mmHg. Complete blood count, blood culture, and serum electrolytes were sent, and she received normal saline bolus while waiting for results. EKG is obtained and the tracing is shown below.

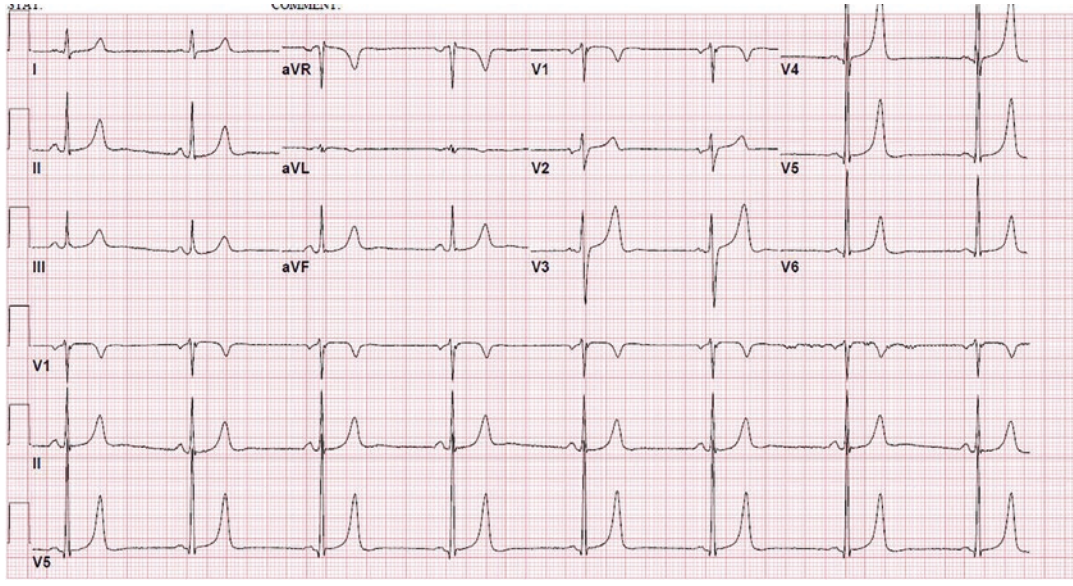

Image. Electrocardiogram trace showing normal sinus rhythm with diffuse non-specific ST changes, peaked T waves, and QT segments appear shortened

What is the most common cause of the above ECG findings?

A. Hypocalcemia
B. Hyperkalemia
C. Hypokalemia
D. Hypercalcemia
E. Hypomagnesemia

Correct Answer: B

The electrocardiogram (ECG) trace is showing narrowed T base waves making them look sharp and thin ("peaked" T waves) and QT shortened, which are characteristic ECG findings of hyperkalemia. Tall peaked T waves with shortened QT are usually first findings, presenting later with lengthening of the PR interval, widening of QRS complex, and loss of P waves. Hyperkalemia can also lead to conduction abnormalities that may include right and left bundle branch block, atrioventricular block and sinus bradycardia, ventricular fibrillation, and even asystole. Severity of ECG changes may not correlate with serum potassium concentration, but the likelihood of identifying EKG changes increases with increasing potassium levels.

Hyperkalemia is defined as serum plasma potassium greater than 5.5 mEq/L, although in newborns and infants the cutoff may be as high as 6–6.5 mEq/L depending on the age. Under regular conditions the kidney and the gastrointestinal tract regulate the potassium balance. Hyperkalemia may be due to excessive potassium intake, transcellular movement of potassium into the extracellular space, and/or decrease in renal excretion of potassium.

In the case above, the cause of hyperkalemia is multifactorial. Hyperkalemia may be secondary to the reduced effective arterial blood volume due to dehydration leading to poor tissue perfusion and metabolic acidosis promoting shift of potassium out of the cell, as well as the reduction in urinary potassium excretion, in combination with the impaired renin-angiotensin-aldosterone system secondary to the use of enalapril, and finally the impaired tubular response to aldosterone caused by the nephrotoxic effect of tacrolimus.

Other EKF findings associated with electrolyte abnormalities are listed below:

- Hyperkalemia, tall peaked T wave, widened QRS complex, prolonged PR interval, and flat or absent P wave
- Hypokalemia, flat or inverted T wave, appearance of U wave, and depressed T wave
- Hypocalcemia and prolonged ST and QT intervals
- Hypercalcemia and short QT interval
- Hypermagnesemia, prolonged PR interval, and widened QRS complex
- Hypomagnesemia, tall T wave, and depressed ST segment

Take-Home Message

- Hyperkalemia can be characterized on ECG by "peaked" T waves and shortened QT segments followed by prolonged PR intervals, widened QRS, and loss of P waves and finally arrhythmia.
- Tacrolimus has nephrotoxic effects which can lead to electrolyte disturbances including hyperkalemia.
- Management of hyperkalemia includes inhaled beta agonists (albuterol), sodium bicarbonate, insulin (administered with glucose to prevent hypoglycemia), kayexalate, and, if refractory, dialysis. Calcium carbonate should also be administered in the setting of EKG changes related to hyperkalemia as a cardioprotective measure.

Question 6

A 9-year-old girl was brought to the emergency department by her mother with a chief complaint of brown-colored urine. Two weeks ago, she had an upper respiratory infection and was sent from school with fever and sore throat. At the time, her sister was also sick with flu. She is up to date with immunizations, including influenza vaccine 1 month ago. Vital signs include temp 98.6 °F, heart

rate 85 beats/minute, respiratory rate 17 breaths/minute, and blood pressure 130/85 mmHg. Physical examination reveals a well-appearing girl with only mild periorbital edema. Urinalysis shows protein greater than 300 mg/dL, large blood with more than 100 red blood cells/high-power field, and red blood cell casts. Laboratory studies showed blood urea nitrogen and creatinine mildly elevated for age, normal electrolytes, low serum complement 3 level, and normal serum complement 4 levels.

Everything is true about the natural history of the above condition *except*:

A. Self-limited with good prognosis, as most patients have full clinical recovery
B. Microscopic hematuria may persist for several months
C. C3 concentration returns to normal in 6–8 weeks
D. Hypertension improves with diuresis within 1 week
E. May present relapsing episodes triggered by viral syndromes

Correct Answer: E

Acute glomerulonephritis is characterized by hematuria, hypertension, and acute kidney injury. It may present also with proteinuria and peripheral edema. Poststreptococcal glomerulonephritis (PSGN) is the most common cause of acute nephritis in children, with an estimated 470,000 new cases annually.

In poststreptococcus glomerulonephritis (PSGN), the glomerular immune complex disease is induced by a specific nephritogenic strain of group A beta-hemolytic streptococcus (GAS) that triggers complement activation and inflammation. Several other infectious agents have been associated with glomerulonephritis (post-infectious glomerulonephritis), like *Staphylococcus aureus*, presenting with more rapid onset and more systemic manifestations.

PSGN usually presents 1–2 weeks after an upper respiratory infection and 3–5 weeks after a skin infection. The clinical presentation can vary from asymptomatic to microscopic hematuria, acute nephritic syndrome, nephrotic syndrome, or rapidly progressive glomerulonephritis. Acute nephritic syndrome is the classical presentation with macroscopic hematuria in 33% of patients, hypertension in 60–80% of patients, edema in up to 90% of patients, and oliguria in <50% of patients. Laboratory studies that help with the diagnosis are an elevation of anti-streptolysin O (ASO) titers and depression of serum complement C3 level. ASO titers are higher in pharyngitis-associated PSGN than pyoderma-associated PSGN.

The diagnosis, as in the case above, is based on clinical findings supported by serologic markers and with evidence of a recent GAS infection. Only in the setting of an atypical presentation would a biopsy be indicated. PSGN is usually self-limited with good prognosis, and most patients have full clinical recovery. Diuresis occurs mostly within a week with improvement of hypertension, and creatinine also improves in 2–4 weeks. Complement C3 level should normalize in ~8 weeks; if not, alternative diagnosis should be considered. Microscopic hematuria and mild proteinuria may persist for several months. Recurrent episodes of PSGN are very rare but few cases have been reported.

Take-Home Message

- Poststreptococcus glomerulonephritis can be distinguished by other causes of glomerulonephritis by history of preceding throat or skin infection and presence of complement 3 and normal complement 4.
- Natural history PSGN is the resolution of symptoms like hypertension, gross hematuria, and AKI within 1–2 weeks and C3 back to normal in 6–8 weeks, and microscopic hematuria may persist for up to 1 year.
- The management is mainly supportive and usually has full recovery. Recurrence is extremely rare.

Question 7

A 10-year-old boy with a history of seizure disorder well controlled on valproic acid presents with 1 week of muscle weakness and muscle cramps. Vital signs are stable and physical exam-

ination is within normal limits. His serum laboratory results reveal sodium 140 mEq/L, potassium 2.5 mEq/L, chloride 120 mEq/L, bicarbonate 12 mEq/L, BUN 8 mg/dL, creatinine 0.5, glucose 80 mg/dL, calcium 9 mg/dL, and phosphorus 2.2 mg/dL. A urinalysis shows a specific gravity of 1.005, protein 2+, glucose 2+, and negative for blood.

Of the following, what is the most likely underlying cause of this child's condition?

A. Diabetes insipidus
B. Dehydration
C. Type II renal tubular acidosis
D. Type I renal tubular acidosis
E. Type IV renal tubular acidosis

Correct Answer: C

The patient is presenting with clinical manifestations of hypokalemia, muscle weakness, and muscle cramps, as a result of neuromuscular effects of potassium on excitable cells. Hypokalemia symptoms and severity depend on degree and rapidity of onset, mostly presenting with serum K < 3 mEq/L. Inadequate dietary intake of K is unlikely to cause hypokalemia but may occur in the presence of other conditions. Another possible etiology of hypokalemia could be an increased cellular uptake of K in the presence of insulin or catecholamines (an example would be exogenous administration of insulin during treatment of ketoacidosis). Gastrointestinal K+ loss and increased renal K+ excretion are 2 other important causes of hypokalemia. Increased gastrointestinal loss is the most common cause of pediatric hypokalemia, and the history of present illness would guide you to this diagnosis with symptoms of acute gastroenteritis and dehydration, which are not present in this case. Additionally, the patient's urine is diluted instead of concentrated.

The presence of a normal anion gap hyperchloremic metabolic acidosis, hypophosphatemia, and renal glycosuria suggests the diagnosis of proximal type II renal tubular acidosis, as seen in this case.

Type II RTA is characterized by a defect in the ability to reabsorb HCO3- in the proximal tubule that can present as isolated defect or associated with Fanconi syndrome, which causes urinary wastage of solutes like phosphate, uric acid, glucose, amino acids, and low-molecular-weight proteins. Inherited tubular disorders may cause proximal RTA but it may also be induced by a variety of drugs, including ifosfamide, valproic acid, and various antiretroviral drugs.

Distal type I renal tubular acidosis is not associated with Fanconi syndrome and type IV renal tubular acidosis presents with hyperkalemia.

Take-Home Message

- Renal tubular acidosis (RTA) is defined by a normal anion gap metabolic acidosis.
- Type II RTA (proximal RTA) is characterized by a defect in bicarbonate reabsorption in the proximal tubules and can be associated with other tubular defects in reabsorption of phosphate, uric acid, glucose, amino acids, and low-molecular-weight proteins (Fanconi syndrome).
- Type II RTA can be due to an inherited disorder or induced by medications such as valproate, antiretrovirals, or ifosfamide.

Question 8

A 15-year-old teenager is brought to the emergency department for generalized weakness and muscle cramps. She denies use of any medications or drugs. Mother reports that she is a victim of bullying at school and tends to overeat when anxious. Vital signs are heart rate 80 beats/minute, respiratory rate 30 breaths/minute, and blood pressure 100/60 mmHg. The BMI is 23 kg/m^2. She has multiple dental caries but otherwise normal examination. Laboratory studies show serum sodium 139 mEq/L, potassium 2.8 mEq/L, chloride 90 mEq/L, bicarbonate 32 mEq/L, calcium 9 mg/dl, and phosphate 4.5 mg/dL and arterial blood gas pH 7.50 (7.35–7.45), PaCo2 45 mmHg (35–45 mmHg), PO2 90 mmHg (75–100 mmHg), O2 saturation 98%, and bicarbonate 32 mEq/L. Urine studies show pH 6.2, sodium 28 mEq/L, potassium 38 mEq/L, chloride < 10 mEq/L, and urinary Ca2+/creatinine ratio of 0.2.

What is the most likely diagnosis of this patient?

A. Renal tubular acidosis
B. Surreptitious vomiting
C. Gitelman syndrome
D. Milk-alkali syndrome
E. Bartter syndrome

Correct Answer: B

The first step in analyzing any acid-base disturbance is to determine the blood pH value. In this case, the patient has a blood pH of 7.55 consistent with alkalosis, and because bicarbonate is high, this is metabolic alkalosis. The next step in the evaluation of metabolic alkalosis is to further subdivide into chloride-responsive or chloride-resistant. This is accomplished by measuring the urinary chloride, in which patients with chloride-responsive metabolic alkalosis present with urine chloride <20 mEq/L, and patients with chloride resistance have urine chloride >20 mEq/L. The most common causes of chloride-responsive metabolic alkalosis are diuretics and vomiting. This patient presents with hypokalemic hypochloremic metabolic alkalosis most likely from recurrent vomiting which is confirmed with the finding of dental caries due to exposure of low pH gastric juice.

Patients with persistent vomiting have significant loss of hydrogen chloride and, in a less concentration, sodium chloride and potassium chloride. For each hydrogen secreted, a bicarbonate molecule is generated, resulting in alkalosis from the bicarbonate generated during gastric acid production. There is also an obligate urinary loss of sodium and potassium intensified by bicarbonaturia. Chloride depletion also increases renin secretion resulting in aldosterone secretion promoting potassium wasting, seen in this case, in which increased urine potassium in the setting of hypokalemia suggests renal potassium wasting.

Take-Home Message

- The first step in analyzing acid-base disturbances is determining the blood pH.
- Vomiting can lead to a hypochloremic hypokalemic metabolic alkalosis (contraction alkalosis).
- A urine chloride >20 mEq/L suggests chloride-responsive causes of metabolic acidosis including diuretic use and vomiting.

Question 9

A 5-year-old girl with recent diagnosis of nephrotic syndrome on prednisone therapy presents with vomiting, worsening abdominal pain, and distention. Vital signs are temperature 101 °F, heart rate 120 beats/minute, and blood pressure 115/75 mmHg. The physical examination is remarkable for generalized edema, distended abdomen, and diffuse tenderness. Abdominal ultrasound shows significant ascites and complete blood count reveals leukocytosis. Paracentesis was performed in the ED, with preliminary results showing neutrophils > 400 cells /mm^3 and pending fluid culture.

The most common organism that causes spontaneous bacterial peritonitis in patients with this condition is:

A. *Escherichia coli*
B. *Haemophilus influenzae*
C. Varicella zoster virus
D. *Streptococcus pneumoniae*
E. *Staphylococcus aureus*

Correct Answer: D

Nephrotic syndrome is characterized by proteinuria, hypoalbuminemia, edema, and hyperlipidemia. Nephrotic syndrome can affect children of any age, but is most commonly seen in school-aged children. Minimal change disease is the most common cause of idiopathic nephrotic syndrome in children and >90% respond to steroid therapy.

The primary feature of nephrotic syndrome is nephrotic-range proteinuria defined as urinary excretion >50 mg/kg/day. This impressive level of proteinuria is due to an increased permeability of the glomerular filtration membrane allowing urinary loss of albumin, coagulation cascade regulators (such as antithrombin III), and immuno-

globulins. The loss of these factors puts patients with nephrotic syndrome at risk of thrombosis and infections. There is an increased risk for serious bacterial infections and even sepsis caused by encapsulated bacteria such as *Streptococcus pneumoniae*, *Haemophilus influenzae*, and group B streptococcus. The loss of the protective factors plus the accumulation of fluids (ascites creates the perfect environment for bacterial growth) predisposes patients to peritonitis. Multiple causative microorganisms like *Streptococcus hemolyticus*, alpha-hemolytic streptococcus, and *Escherichia coli* have been identified, but *Streptococcus pneumoniae* is the most common infectious agent. Viral infections, like varicella, may be observed in patients with nephrotic syndrome but do not cause peritonitis.

Given the increased risk of serious infections, it is recommended that patients with nephrotic syndrome receive the 23-valent polysaccharide (PPSV23) pneumococcal vaccine.

Take-Home Message

- Nephrotic syndrome is characterized by proteinuria (>3 g per 24 hours), hypoalbuminemia, edema, and hyperlipidemia.
- Urinary loss of immunoglobulins predisposes patients with nephrotic syndrome to serious infections by encapsulated organisms (such as streptococcus) including spontaneous bacterial peritonitis.
- Spontaneous bacterial peritonitis is diagnosed with a positive ascitic fluid bacterial culture and an absolute polymorphonuclear leukocyte count $\geq$250 cells/mm^3.
- Patients with nephrotic syndrome, considered at high risk, should receive the 23-valent polysaccharide (PPSV23) pneumococcal vaccine.

Question 10

A 16-year-old athletic boy presents to the emergency department with diffuse musculoskeletal pain and tea-colored urine for 2 days. His past medical history is remarkable for a streptococcal throat infection 2 months ago. Physical examination is significant for tenderness over calf muscles. Vital signs include heart rate 80 beats/minute and blood pressure 115/70 mmHg. Urinalysis reveals red-brown-colored urine, specific gravity > 1.030, pH 6.5, blood 3+, ketones 2+, and no protein. Urine microscopy reveals < 5 WBC/hpf, and no casts or RBCs.

Of the following, what is the next best test to obtain for diagnosis of his condition?

A. Renal ultrasound
B. Urine culture
C. Complement levels
D. Creatinine kinase level
E. Urine calcium to creatinine ratio

Correct Answer: D

Discolored urine suggestive of hematuria with absent red blood cells in the urine is consistent with myoglobinuria. Myoglobinuria is the presence of myoglobin, a heme-containing protein, in the urine resulting from the breakdown of muscle fibers and myocytes. Myoglobinuria is most commonly caused by rhabdomyolysis but it can also occur after strenuous physical exertion. The most sensitive laboratory finding of muscle injury is an elevated creatinine kinase level, which in the case of rhabdomyolysis usually presents at least 5 times the upper limit of normal. However, in the setting of physical exertion, it may present with only mild elevation. When physical exertion is extreme, it can cause myolysis with severe rhabdomyolysis. This is especially likely to occur when the test is performed under conditions of high temperature and humidity. Part of the evaluation of this patient should also include a serum chemistry given that during muscle necrosis, there is also the release of intracellular contents into the circulation that may cause electrolyte imbalances, acute renal failure, and disseminated intravascular coagulation.

Workup for microscopic or macroscopic hematuria includes a urine culture to rule out infection, renal ultrasound if suspicious of stones, or urine calcium creatinine ratio to evaluate for hypercalciuria. Complement levels (C3 and C4) would be part of workup for glomerulonephritis, but the presentation is with macroscopic hematuria and not myoglobinuria (as in this case).

Take-Home Message

- Rhabdomyolysis is characterized by the presence of myoglobinuria secondary to muscle breakdown.
- It is characterized by a urinalysis positive for blood but negative for red blood cells.
- Treatment for rhabdomyolysis involves supportive care (including fluid hydration to protect the kidneys).

Question 11

A 13-year-old girl was brought to the emergency department with altered mental status. The girl was recently diagnosed with systemic lupus erythematous after presenting with severe anemia, proteinuria, and elevated creatinine. Pending biopsy results, the girl was started on prednisone 60 mg/m^2. She initially presented with 2 days of nasal congestion and then this morning with headaches and disoriented after a nap. Denies fever or seizure activity. On physical exam, she was afebrile with a heart rate of 104 beats/minute and BP of 140/95 mmHg. Laboratory studies show serum sodium 140 mEq/L, potassium 5.5 mEq/L, chloride 100 mEq/L, bicarbonate 19 mEq/L, BUN 30 mg/dL, creatinine 1.8 mg/dL, calcium 7.6 mg/dl, phosphate 4.5 mg/dL, and albumin 2 g/dL. Complete blood count is normal and urine toxicology is negative. Head CT negative for hemorrhage or mass and MRI images are shown below.

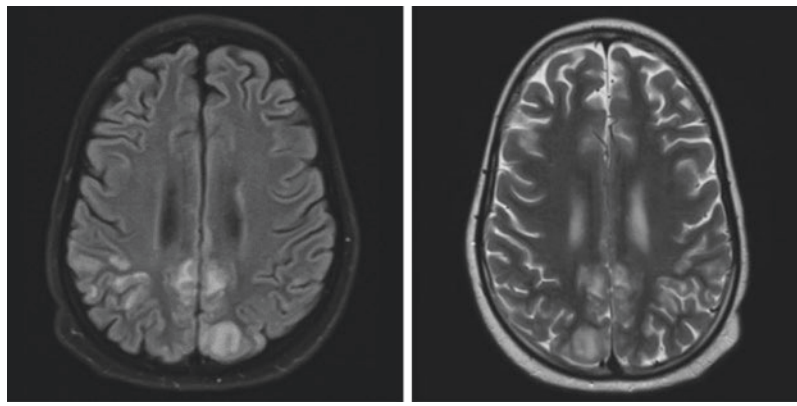

Image. MRI images showing symmetrical regions of T2 prolongation involving the cortex and subcortical white matter of the cerebral hemisphere, most pronounced in the parietal and occipital lobes

Of the following, what is the most likely mechanism associated to her findings on MRI?

A. Failure of cerebral autoregulation
B. Hypocalcemia
C. Uremic encephalopathy
D. Meningitis with cerebral abscess
E. Rapid rise in body temperature

Correct Answer: A

The clinical presentation of altered mental status and MRI findings of symmetrical white matter edema in the posterior cerebral hemispheres is most likely due to posterior reversible encephalopathy syndrome (PRES). The pathogenesis appears to be related to disordered cerebral autoregulation and endothelial dysfunction that causes cerebral edema. The major risk factor associated with PRES is acute elevation of blood pressure. However, the percent elevation of blood pressure over baseline is an important risk factor as well and could be the reason why PRES may occur in normotensive patients too. PRES appears to be more common in chronic conditions like systemic lupus erythematous or hemolytic uremic syndrome and in patients on immunosuppressive and immunomodulatory therapies. PRES should be promptly recognized because despite usually being a reversible condition with treatment, permanent neurological sequelae and even

death may occur. Treatment consists of management of hypertension, antiepileptic medications, and removal of cytotoxic agents if possible.

Symptoms of hypocalcemia range from confusion and disorientation to lethargy and even coma. This patient has a normal calcium level when corrected for hypoalbuminemia. Uremic encephalopathy may present with similar symptoms although it develops in patients with acute or chronic renal failure, most often when estimated glomerular filtration rate falls <15 ml/min/1.73 m^2. MRI is sensitive for cerebral abscesses and will show ring enhancement.

Take-Home Message

- Posterior reversible encephalopathy syndrome (PRES) is a cause of altered mental status caused by disordered cerebral autoregulation and endothelial dysfunction in the setting of abrupt elevation of blood pressure.
- PRES is more common in patients with chronic conditions such as SLE, HUS, and those taking immunosuppressive/immunomodulatory medications.
- Treatment consists of antihypertensive therapy, antiepileptic medications, and removal of cytotoxic agents.

Question 12

A 12-year-old boy presents with fever, sore throat, nausea, vomiting, and decreased oral intake for 3 days. He has been taking Tylenol alternated with ibuprofen for fever. His temperature is 100.4 °F, heart rate 120 beats/minute, and blood pressure 85/60 mmHg. The physical examination shows oropharyngeal erythema. Urinalysis showed specific gravity of 1.010, no protein, +blood, +muddy brown granular casts, urine sodium 60 mEq/L, and FeNa > 2%. Throat swab for rapid strep is negative. Laboratory evaluation reveals serum sodium 140 mEq/L, potassium 5 mEq/L, bicarbonate of 16 mEq/L, BUN 34 mg/dl, and creatinine 1.5 mg/dl. He has normal complete blood count.

What is the most likely etiology of acute kidney injury?

A. Acute glomerulonephritis
B. Acute tubular necrosis
C. Prerenal acute kidney injury
D. Obstructive kidney injury
E. Thrombotic microangiopathy

Correct Answer: B

Acute kidney injury (AKI) is defined as the decrease in glomerular filtration rate (GFR) causing rise in serum creatinine and/or decrease in urine output. Etiology of AKI is classified into 3 categories based on the location of the initial injury: prerenal AKI, in which a decrease of GFR occurs as a consequence of reduced renal blood flow (secondary to dehydration) or reduced renal perfusion pressure (in the setting of sepsis); postrenal AKI, in which the decrease in GFR is a result of an obstruction to urine flow, for example, in the setting of nephrolithiasis or in male adults with prostatic hyperplasia; and intrinsic AKI, where the injury is a result of direct parenchymal injury in the kidney, often divided in various compartments including vasculature, glomerulus, interstitium, and tubules.

Acute tubular necrosis is the most common form of intrinsic renal azotemia and is the result of multiple insults acting together to induce renal injury. Prolonged renal hypoperfusion causes tubular cell injury, which persists even after the underlying hemodynamic insult resolves. The injured cells eventually slough off into the tubular lumen and can clump together to form a classic "muddy brown" cast seen on urine microscopy. The history and physical exam will help identify the etiology. To distinguish prerenal AKI from ischemic ATN, the urinalysis may be very helpful. In addition to muddy brown casts, there is a defect in concentration capacity and an inappropriate sodium excretion due to impaired tubular function induced by tubular injury in ATN. Fractional excretion of sodium (FeNa) is more accurate given that it is not affected by water content of urine, being <1% in prerenal disease showing the reabsorbing capacity of the tubules to conserve volume at >2% in ATN. In severe

cases, the muddy brown casts may obstruct the tubular lumen resulting in an obstructive uropathy.

Take-Home Message

- Acute tubular necrosis (ATN) is the most common form of intrinsic renal azotemia which can result from hypoperfusion to the tubular cells resulting in sloughing off and tubular dysfunction.
- Urinalysis can be helpful in distinguishing ATN from ischemic AKI. Patients with ATN may have "muddy brown" casts on urine microscopy.
- Fractional excretion of sodium is <1% in prerenal AKI and >2% in ATN due to tubular dysfunction.

Question 13

An 8-year-old boy was referred to the emergency department from his pediatrician's office with fatigue and lethargy. The boy presented initially with 1 week of abdominal pain, vomiting, and diarrhea. Last weekend he and his family were at a picnic. He has no travel history or sick contacts. Vital signs are temperature 98.6 °F, heart rate 90 beats/minute, respiratory rate 25 breaths/minute, and blood pressure 125/75 mmHg. He is pale on examination with an otherwise unremarkable examination. Initial laboratory evaluation reveals a hemoglobin of 7.5 g/dL, platelet 20,000 mm^3, reticulocyte count 4%, lactate dehydrogenase 600 IU/L, a serum creatinine 3 mg/dL, blood urea nitrogen 50 mg/dL, and stable electrolytes. His urine showed protein/creatinine ratio of 1, and the sediment does not show cells. A peripheral smear showed many schistocytes.

What is the next best step in the management of this patient?

A. Platelet and PRBC transfusion
B. Start corticosteroids
C. Start eculizumab
D. Start antibiotic treatment
E. Supportive treatment

Correct Answer: E

This patient is presenting with the classic triad of hemolytic uremic syndrome: microangiopathic hemolytic anemia, thrombocytopenia, and acute kidney injury. HUS has been divided into diarrhea-positive (typical) and diarrhea-negative HUS (atypical). Enterohemorrhagic *E. coli* (EHEC 0157:H7) is the most common cause of pediatric HUS.

The initial management of HUS secondary to EHEC infection is supportive care. The cornerstone of treatment is fluid management to prevent further worsening of acute kidney injury, intravascular depletion or electrolyte abnormalities. In a retrospective study of 29 patients with EHEC HUS, the patients who became oligoanuric and needed dialysis had received significantly less intravenous fluid therapy, concluding that early parenteral volume expansion is important. Platelet and red blood cell transfusions are usually avoided because they may aggravate hemolytic process. However, they can be considered only if the patient develops symptomatic anemia or hemoglobin <6 g/dL and, in the case of platelets, if there is active bleeding. Antibiotic therapy is generally not beneficial in patients with EHEC. Eculizumab is a humanized monoclonal antibody that is a terminal complement inhibitor FDA approved for the treatment of complement-mediated (atypical) HUS.

Take-Home Message

- Hemolytic uremic syndrome (HUS) is characterized by microangiopathic hemolytic anemia, thrombocytopenia, and acute kidney injury.
- Enterohemorrhagic *E. coli* is the most common cause of pediatric HUS.
- Treatment involved supportive care, including early institution of fluid therapy. Antibiotics are not beneficial and transfusions may precipitate the hemolytic process.

Suggested Reading

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Pediatric Neurology

10

Sagarika Nallu

Question 1

A previously healthy 5-year-old boy is brought to the ED by his parents because he was noticed to be limping slightly for the past 4 days. The parents initially attributed these symptoms to a fall at his daycare 4 days ago. The mother states that his limping has progressively worsened since yesterday and believes that his left hand is weaker than the right. Past history is significant for cold symptoms, headache, and low-grade fever 2 weeks ago. The patient is developmentally normal and otherwise healthy. While in the ED, he had 4 to 5 brief staring episodes that lasted for few seconds. During the episodes, the child did not respond to his name and appeared confused. A brief twitching of the left lower extremity was also noted.

On examination, he was alert and complains of headache. Vital signs are normal except for the temperature of 100.5 °F. He is speaking in full sentences and has an unremarkable general examination. He is able to follow brief commands. His visual fields are intact with equal and reactive pupils. Fundoscopy is difficult to perform. He is noted to have difficulty abducting his left eye. Mild flattening of his left nasolabial fold is also noted. The tongue is in the midline. His left upper and lower extremity are hypotonic with slightly decreased strength. His reflexes are brisk on the left side with extensor plantar. He is ambulating without support but noticed to circumduct his left leg. There is no other joint pain, swelling, or redness. The rest of the examination is unremarkable. What is the likely cause of his symptoms?

A. Complex migraine
B. Simple partial seizures
C. Concussion
D. Cerebral venous thrombosis
E. Cluster headache

Correct Answer: D

This is a previously healthy 5-year-old boy who presents with a 2-week history of low-grade fever, URI symptoms, emesis, and headaches and later developed subacute left-sided weakness. The presence of a nonspecific systemic illness with focal seizures and neurologic deficits indicates involvement of the central nervous system. As the patient's symptoms gradually worsened and remained sustained, complex migraine and cluster headache are unlikely as these are paroxysmal events. As seizures were associated with altered mental status, these would be complex rather than simple partial seizures. His presentation is more suggestive of an infectious

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_10

cause since there is no other history of head trauma.

In a child with a viral syndrome, fever, headache, vomiting, focal deficits, and focal seizures, the high likelihood of infection leading to cerebral venous thrombosis (CVT) with venous infarction should be considered.

The differential diagnosis of limp includes musculoskeletal causes. Limp due to left-sided weakness associated with headache, partial seizure, and abducens palsy suggests an intracranial cause. In the presence of fever and cold symptoms, an infectious etiology such as brain abscess and CVT should be pursued. Weakness with monoparesis or hemiparesis is the most frequent focal deficit associated with CVT.

CVT is an important cause of stroke in children with 40% occurring in neonates. Risk factors for older children with CVT include dehydration, infections, anemia, hypercoagulable states, and metabolic disorders. Patients with CVT can present with headache, focal stroke-like manifestations, seizures, altered mental status, and papilledema. However, CVT may present without focal signs. CT venography and MRI with venography (MRV) are the methods of choice for evaluating CVT. The use of MRI has improved the recognition of this condition. The thrombosed vessel may appear hyperintense on both T1- and T2-weighted imaging.

Acute treatment consists of appropriate antibiotic therapy (vancomycin, third-generation cephalosporin ± clindamycin or metronidazole), seizure control, anticoagulation therapy, and supportive care. Cerebral venous infarction is the most serious complication of CVT.

Take-Home Message

Cerebral venous thrombosis should always be considered in the presence of headache, seizures, altered mental status with focal weakness.

ABP Content Specification

- Recognize signs and symptoms of cerebral venous sinus thrombosis (CVST).

Question 2

A previously healthy 10-year-old girl is brought to the ED by her parents for unsteady gait. She complained of weakness and inability to stand today. Her past medical history is noncontributory. Her immunizations are up to date. The mother reports that the girl woke up this morning and urinated on herself. On examination, she is alert and responsive to all questions. She has difficulty standing up without support. Her pupils are equal and reactive. Extraocular movements are intact and there is no facial asymmetry. Sensory examination reveals numbness up to the midthoracic level. What is the most likely diagnosis?

A. Tick paralysis
B. Botulism
C. Poliomyelitis
D. Transverse myelitis
E. Multiple sclerosis

Correct Answer: D

The acute onset of rapid asymmetric neurological deficits and a discernable sensory level is most likely due to acute transverse myelitis (TM). It is a rare acquired neuroimmune spinal cord disorder that can present with the rapid onset of weakness, sensory alterations, and bowel or bladder dysfunction.

The typical presentation is motor and sensory deficits below the lesion. This presents as a pure lower extremity paraplegia or paraparesis with a sensory loss clearly defined by a level. The abnormalities usually are bilateral but may be asymmetrical. The most common involved area is the thoracic region. The progression occurs rapidly; the time to maximal disability varies from 4 hours to 21 days. Younger children may develop spinal cord dysfunction more rapidly from over hours to a few days.

CSF usually shows pleocytosis. MRI shows focal or extensive inflammatory demyelinating

lesions. The swelling of the spinal cord over one or more segments and gadolinium-enhanced, T_2-weighted hyperintense lesions may be evident. MRI of the brain and entire spinal cord should be obtained to confirm the diagnosis and to exclude any compressive cord lesion. Poliomyelitis may cause asymmetric weakness. Since the sensory examination is almost always normal, the presence of a sensory level excludes this.

Given the presence of a clear sensory level, tick paralysis is unlikely as sensation is intact in patients with tick paralysis. Botulism does not have any sensory component. TM may be associated with optic neuritis in Devic disease and with multiple sclerosis in childhood. Children generally have a better outcome than adults. Some clinical features may predict the development of MS after transverse myelitis such as severe weakness, sensory disturbance at cervical level, spinal shock, and incontinence.

Take-Home Message

A rapid development of both motor and sensory deficits at any level of the spinal cord suggests transverse myelitis.

ABP Content Specification

- Recognize the signs and symptoms of acute transverse myelitis.

Question 3

A 13-year-old girl is brought to the ED by her parents for multiple vomiting for the past 3 hours accompanied by severe throbbing headache. Her parents noticed she was wobbly when walking. She reports numbness to her face, fingers, and toes and weakness of her right hand. She also complains of a spinning sensation. Her past medical history reveals that she had two similar episodes for which she was seen by a neurologist 3 months ago. Outpatient workup including CT scan of the head and routine EEG were reported to be normal. Family history reveals an uncle with migraines. Examination reveals a girl with a discomfort lying in the bed with her face covered. She has difficulty getting up from bed due to nausea, headache, and dizziness. Her vitals are within normal limits for age. The next best approach to this patient is?

A. Obtain a head CT scan
B. Administer IV fosphenytoin
C. Symptomatic treatment
D. Order an EEG
E. Obtain MRI of brain with contrast

Correct Answer: C

The patient in the vignette is suffering from migraine. It is characterized by recurrent headaches associated with nausea and vomiting and hypersensitivity to light, sound, and smell. Migraine headaches are classified primarily into migraine with and without an aura.

1. Migraine without an aura (common migraine):
   - The most common type in children and adolescent
   - It has the following criteria:
     - More than five attacks that last 2–72 hours
     - Nausea and vomiting
     - Photophobia or phonophobia
2. Migraine with an aura (classic migraine):
   - Usually at least two headache episodes that fulfill the criteria of migraine with sensory warning symptoms, such as flickering lights, loss of vision, and tingling or numbness

Basilar migraine is common in adolescent girls. It consists of an aura followed by a severe headache. It is manifested with a combination of visual symptoms such as transient bilateral blindness, or blurred vision (in both temporal and nasal fields of both eyes), vertigo, ataxia,

decreased level of consciousness, and bilateral paresthesia or paresis without any motor weakness.

The duration of her symptoms, lack of alteration of consciousness, and absence of other abnormal movements exclude seizures in this patient. History of similar attacks 3 months ago with previously normal studies suggests a more benign cause such as migraine. Hence, symptomatic treatment with antiemetics and pain medications should be considered first.

Vestibular migraine is a term used to describe episodic vestibular symptoms such as rotational vertigo in patients with a history of migraine or with other clinical features compatible with migraine syndromes.

Also, one of the following symptoms is present during at least two vertiginous attacks:

- Migrainous headache
- Photophobia
- Phonophobia
- Visual or other auras

Abortive treatment tried for acute vestibular migraine attack include triptans (meclizine), benzodiazepines, and analgesics, but have not been very effective particularly in relieving dizziness. Reduction of risk factors such as smoking, hypoglycemia, excess coffee ingestion, stress, and anxiety may help reduce attacks. Prophylactic medications that are somewhat more effective in preventing attacks include beta blockers, calcium channel blockers, antidepressants, and anticonvulsants (topiramate, valproic acid, and lamotrigine).

Take-Home Message

Vestibular symptoms alone are not adequate to establish the diagnosis of vestibular migraine. The vestibular episodes should be accompanied by one or more of the following features: headache, photophobia and phonophobia, and visual aura.

ABP Content Specification

- Recognize signs and symptoms of various migraine syndromes.

Question 4

An 11-year-old boy presents to the ED with 4-month history of increasingly severe headache that disturbs his sleep at night. He complains of almost daily headaches with only partial relief with over-the-counter medications. He vomits occasionally in the morning, and his pain worsens with movement. During the last week, he has experienced double vision intermittently. Past medical history includes behavioral issues which required counseling. His medications include acetaminophen with codeine and multivitamins with iron. On examination, he reports diffuse frontal headache which he rates 8/10 in intensity. There are no speech difficulties and he otherwise appears comfortable. His weight is in the 95th percentile and his height at the 45th percentile. His vitals are within normal limits for age. He wears eyeglasses. His pupils are equal and reactive; he complains of diplopia on extreme lateral gaze to either side. He is not cooperative for a fundus examination. The remainder of his examination is unremarkable. His head CT scan and initial laboratory evaluation including complete blood count and basic metabolic profile were normal.

The next step in diagnosing this patient is:

A. Obtain an MRI of the brain
B. Discharge him with stronger pain medication with an outpatient follow-up with a pediatric neurologist
C. Perform lumbar puncture
D. Consult child psychiatry serviceDiscontinue his medications as they are likely causing rebound headache

Correct Answer: C

This patient has a 4-month history of gradually worsening headache and episodes of diplopia. Fundoscopy may reveal blurring of disc margin suggestive of papilledema consistent with increased intracranial pressure. His diplopia is likely from 6th nerve palsy. The diagnosis of pseudotumor cerebri/idiopathic intracranial hypertension (IIH) should be suspected when there are signs suggestive of increased intracranial pressure such as headache, papilledema, and vision loss, but the CT of the head

is normal without evidence of dilated ventricles or a mass lesion. Although some posterior fossa masses are better visualized on MRI, with the duration and severity of symptoms, it is unlikely that the CT would not demonstrate an existing lesion. This is a diagnosis of exclusion. A CT or MRI scan of the brain must be obtained to exclude hydrocephalus or a mass lesion.

Another common symptom is transient visual loss. Other symptoms may include visual obscurations, photophobia, neck pain, blurred vision, and tinnitus. Imaging of the brain is necessary to exclude elevated CSF pressure due to other causes such as brain tumor, dural sinus thrombosis, or hydrocephalus. Papilledema is the diagnostic hallmark and is present in almost all patients.

The abducens nerve palsy is common.

Lumbar puncture with opening and closing pressures should be performed. Normal CSF composition and a normal brain with normal or small ventricles on brain imaging studies are seen in these patients. The visual changes, along with the duration of symptoms, raise the concern for permanent visual damage if treatment is not initiated soon. The goals of the therapy are to relieve headaches and preserve vision. The usual treatment in children is acetazolamide 10 mg/kg/day. Acetazolamide is a carbonic anhydrase inhibitor which reduces the rate of cerebrospinal fluid production. Serial lumbar punctures have also been advocated and can be used to relieve the symptoms.

Take-Home Message

Any headache associated with sixth nerve palsy should be assumed to be organic in nature. The diagnosis of pseudotumor cerebri should not be made without both neuroimaging and a lumbar puncture.

ABP Content Specification

- Recognize signs and symptoms of increased intracranial pressure.
- Recognize signs and symptoms of pseudotumor cerebri.
- Plan the management of acute pseudotumor cerebri.
- Know the complications of prolonged idiopathic intracranial hypertension.
- Recognize and interpret relevant laboratory and imaging studies for pseudotumor cerebri.

Question 5

A 5-month-old boy presents to the ED by his parents for a "possible seizure." The infant stiffens his whole body, flexes all four extremities, stares briefly, and appears dusky around the mouth. These episodes occur multiple times a day especially after he wakes up from naps. Immediately following an episode, the baby cries and appears irritable for 5–10 minutes. These episodes have been increasing in frequency and intensity over the last 3 days. The baby was born at term via normal spontaneous vaginal delivery. The pregnancy and birth were unremarkable. He is receiving physiotherapy for hypotonia and had feeding difficulties. Currently, he feeds both on breast and formula, but spits up after the feeding. On examination, there are no dysmorphic features. The baby is awake and alert, but no spontaneous smile is noted. No babbling or cooing is noted. He has little interest in playing or grabbing toys. The parents report that he had started to roll over 2 weeks ago but has not done so in the last week. The remainder of the examination is unremarkable. The next best approach to this patient is

A. Perform a sepsis workup including lumbar puncture for suspected meningitis
B. Discuss GE reflux management with parents and schedule outpatient GI evaluation
C. Obtain EEG
D. Provide a home apnea monitor
E. Obtain a head sonogram

Correct Answer: C

Infantile spasm (IS) is a serious and intractable epilepsy syndrome that occurs exclusively in infants less than 1 year of age. Typical age of presentation is between 3 and 7 months. The typical presentation consists of a triad of typical seizures (head drops and brief flexor and/or extensor spasms), disorganized multifocal EEG pattern called hypsarrhythmia, and developmental delays.

Spasms typically occur in clusters and most commonly occur after an affected infant awakens. Spasms may involve flexor, extensor, or mixed flexor-extensor musculature. It is common for infants with spasms to experience plateauing or regression of developmental milestones prior to or at the onset of infantile spasms.

Differential diagnoses of IS include non-epileptic events such as colic, gastroesophageal reflux, Sandifer syndrome, hyperreflexia, and breath-holding spells. Underlying etiologies may include various causes such as cerebral malformations, infections, genetic syndromes, neurocutaneous disorders, hypoxic ischemic disease, inborn errors of metabolism, and trauma. Approximately two-thirds of infants may have brain lesions. Infants who have brain lesion may present with asymmetric spasms. Infants suspected of having IS require a detailed history, complete physical examination, and further evaluation including EEG and MRI. A typical EEG pattern known as hypsarrhythmia consists of very high voltage; random, slow waves; and spikes in all cortical areas.

This is an intractable epilepsy syndrome. The prognosis for seizure control and development is very poor. Traditional seizure medications do not control these seizures. Two treatment modalities are approved by the FDA including corticotropin (ACTH) and vigabatrin. ACTH is considered the best treatment option for these seizures. Vigabatrin is the treatment of choice for patients with tuberous sclerosis.

Lack of fever along with the duration of symptoms makes infection unlikely. Head sonogram provides very limited data, CT scan of the head may be considered, but an MRI would be the preferred imaging modality.

Take-Home Message

Untreated or delayed treatment of children with infantile spasms is associated with devastating neurological impairment.

ABP Content Specification

- Differentiate the major causes of seizures by age.
- Plan diagnostic evaluation and initial intervention for patients with seizures.
- Review of infantile spasms, its symptomatology, differential diagnosis, and treatment options.

Question 6

A 7-month-old baby boy is brought to the ED by his mother for poor feeding, droopy eyelids, and increased drooling for the past 3 days. The mother is also concerned that the baby is urinating less and has not had a bowel movement in 4 days. Past medical history reveals that the infant was born at 39 weeks' gestation with no complications during the pregnancy or birth. He is up to date on immunizations and has suffered no previous illnesses.

Vital signs were as follows: temperature 98.6 °F (37.0 °C), heart rate 114 beats/minute, respiratory rate 22 breaths/minute, and blood pressure 98/62 mm Hg. Both weight and height are at 50th percentile. He is awake and nontoxic appearing, with expressionless facies and a weak cry. He topples over when placed to sit. He has a weak suck and pooling of oral secretions. His neck is supple without adenopathy. Heart and lungs are normal. His abdomen is soft, full, and nontender, with decreased bowel sounds throughout. There is no hepatosplenomegaly. Rectal examination shows no stool in the rectal vault and decreased anal sphincter tone. He has decreased muscle tone throughout and diminished deep tendon reflexes. What would be the next step in the evaluation of this child?

A. Obtain MRI of brain with and without gadolinium
B. CSF studies for oligoclonal bands
C. Admit for botulism immunoglobulin
D. Nerve conduction velocity studies
E. Stool cultures

Correct Answer: C

The classic picture of infant botulism is an initial presentation of constipation, listlessness, and poor feeding. The typical patient often has an expressionless face, feeble cry, ptosis, poor head control, symmetric descending symmetrical weakness (or paralysis), and floppiness or hypotonia. Patients are most often afebrile unless a secondary infection is

present and initial laboratory tests are usually normal. This can affect muscles of respiration which can progress to respiratory failure. Botulinum neurotoxin blocks presynaptic acetylcholine release thereby affecting skeletal muscle, smooth muscle, and autonomic function.The botulinum toxin acts peripherally and does not cross the blood-brain barrier.

It has been reported to occur with ingestion of honey, corn syrup, canned food, and vacuum or environmental dust. The differential diagnoses include sepsis (the most common admitting diagnosis), dehydration, constipation, hypothyroidism, other neurologic diseases, and inborn errors of metabolism or poisoning. The most sensitive confirmatory test is via mouse bioassay. The diagnosis is best confirmed with isolation of *C. botulinum* organism in the stool, but this may take several days; thus the treatment should be initiated based on the clinical presentation. *Intestinal colonization* occurs in infantile botulism.

Serum assays for botulinum toxin are often negative, although the electromyographic (EMG) findings in infant botulism are unique such as low-amplitude motor potentials of reduced duration. This procedure is painful and may be unnecessary unless the diagnosis is in question. MRI and CSF studies are not indicated with a classic presentation of botulism. Treatment is IV botulism immunoglobulin.

Take-Home Message

The treatment of infantile botulism should be initiated based on the clinical suspicion and should not wait for results of the bioassay.

ABP Content Specification

- Know the etiology and understand the pathophysiology of infantile botulism.
- Plan the management of infantile botulism.
- Recognize signs and symptoms of botulism.

Question 7

A 6-year-old boy presents to the ED for abnormal movements for 3 days. His mother noticed that his movements have worsened and now have become uncontrollable. His mother describes the movements as rolling at his wrist and rotating at his shoulders. Neither past medical history nor family history is significant. There is no history of developmental delay. He is right-handed. The mother denies any recent illness, recent travel, or sick contacts. He is unable to suppress the movements, although they disappear during sleep. He has been easily upset and having outbursts of anger in the last 3 weeks for no known reason.

On examination, he is alert. Vital signs are within normal limits. Cardiac examination is significant for a blowing systolic ejection murmur loudest at the apex. Motor examination is significant for abrupt, involuntary, irregular dance-like movements of the right arm and foot and subtle piano movements in the fingers and toes. Sensation is intact. Which of the following will be most helpful in delineating the cause of these symptoms?

A. Obtain an EEG
B. Order a head CT scan
C. Perform a lumbar puncture
D. Anti-streptolysin antibodies and anti-DNAse antibodies
E. Ask about drug use

Correct Answer: D

Sydenham chorea (SC) is the most common acquired chorea and is the neuropsychiatric manifestation of the post-streptococcal autoimmune disease, rheumatic fever. This may be the only manifestation of rheumatic fever. The latent period is typically longer and occurs 6–8 weeks after group A streptococcus (GAS) pharyngitis. The diagnosis of SC is clinical. No laboratory study is diagnostic of SC; however, ASLO and anti-DNAse antibodies can aid in the diagnosis. Clinical manifestations of SC are divided into neurologic and psychiatric.

Neurologic manifestations include chorea, muscle weakness, and other motor symptoms. Chorea is described as abrupt, involuntary, irregular dance-like movements that flow from one body part to the next randomly. They are nonstereotyped and usually improve during sleep. Other motor manifestations include grimacing, dysarthria, difficulty with writing, and hypotonia. These purposeless movements interfere with voluntary activities.

Psychiatric symptoms include mood lability and obsessive-compulsive disorder (OCD) and usually start 2 to 4 weeks before the movement symptoms.

The Jones criteria for RF (major, migratory arthritis, carditis, SC, erythema marginatum, subcutaneous nodules; minor, fever, arthralgia, prolonged PR interval, and elevated inflammatory markers, i.e., C-reactive protein level, erythrocyte sedimentation rate) should be kept in mind, and a thorough cardiac examination should be performed.

Imaging, EEG, and CSF studies, while not helpful in the diagnosis of SC, can help rule out other etiologies. The constellation of symptoms with the murmur on exam and young age makes drug use an unlikely cause. Symptomatic treatment of chorea is not necessary unless it is debilitating. Multiple medications have been used to control chorea.

Valproic acid is frequently used as first-line therapy. Haloperidol and pimozide are typically second-line therapies. Diazepam in non-sedating doses may be helpful.

Take-Home Message

It is important to differentiate choreiform movements from seizure-like movements. SC is a pure chorea, although hypotonia, dysarthria, and emotional lability are also common.

ABP Content Specification

- Recognize signs and symptoms of acquired chorea.
- Plan the management of acute Sydenham chorea.
- Understand the pathophysiology of Sydenham chorea.

Question 8

A 16-year-old boy is brought to the ED for evaluation of his confusion and agitation. The family reports that he has not been himself recently and has been more withdrawn. He has vomited 3–5 times per day for the past 3–4 days, but parents deny fever or URI symptoms. On the day of presentation, he became more confused and paranoid which prompted the ED visit. His past medical history is unremarkable.

On examination, patient is awake but irritable and clearly disoriented to place and time. His speech is slightly dysarthric, and he is jaundiced. You notice a slight tremor in his hands when he reaches for objects. You ask him to stretch his hands and notice flapping tremor of both hands. Chest auscultation reveals normal breath sounds and no heart murmur. Abdominal examination reveals a firm liver edge and a full abdomen. The rest of his examination is unremarkable. His vital signs were as follows: temperature 98.9 °F (37.2 °C), heart rate 112 beats/minute, respiratory rate 20 breaths/minute, and blood pressure130/80 mmHg.

His initial laboratory results showed normal WBC, hemoglobin 12.2 g/dL, total bilirubin 60.8, direct bilirubin 41.2 mg/dL, alanine aminotransferase (ALT) 498 units/L, aspartate aminotransferase (AST) 637 units/L, alkaline phosphatase 320 IU/I, serum sodium132 mEq/L, potassium 3.2 mEq/L, blood urea nitrogen (BUN) 38 mg/dL, serum albumin 2.5 g/dL, prothrombin time (PT) 13.1 seconds, INR 2.8, and partial thromboplastin time (PTT) 30.4 seconds. Which of the following would be most helpful in confirming your diagnosis?

A. EEG
B. CT scan of chest and abdomen
C. Ultrasound of the abdomen
D. Urine toxicology screen
E. Serum ceruloplasmin levels and slit lamp examination

Correct Answer: E

The patient is presenting with acute liver failure. Although in this age group toxins should be considered, a standard urine toxicology screen does not include toxins that will cause acute liver failure. Wilson's disease is the more likely cause of his liver failure. Wilson's disease is an autosomal recessive disorder of copper metabolism, characterized by toxic accumulation of copper principally in the liver, brain, and eye, hence the designation "hepatolenticular degeneration." The gene for Wilson's disease ATP7B has been mapped to chromosome 13. The presence of Kayser-Fleischer rings and ceruloplasmin levels of less than 20 mg/dL in a child with neurologic

manifestations suggest a diagnosis of Wilson's disease. Most patients who present with neurologic symptoms have cirrhosis as the liver is the primary site of copper accumulation. Imaging of the abdomen and an EEG would not be helpful in the diagnosis of Wilson's disease.

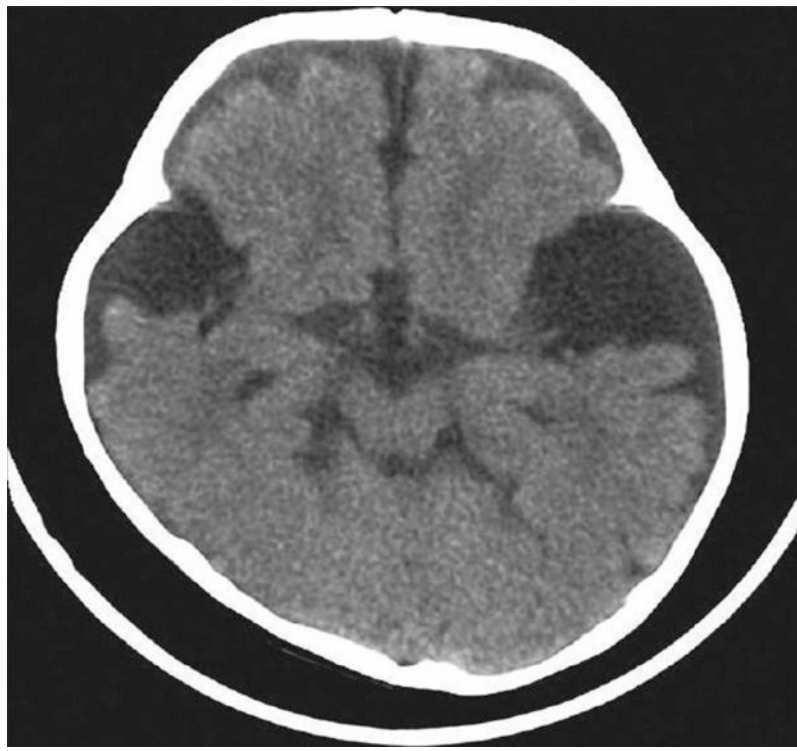
Take-Home Message
Wilson's disease should be considered in the presence of an unexplained hepatic, neurological, or psychiatric manifestation. The psychiatric manifestations may precede hepatic or neurological symptoms.

ABP Content Specification
- Recognize signs and symptoms of Wilson's disease in patients presenting with altered mental status.
- Know the appropriate diagnostic workup and management of Wilson's disease.
- Understand the pathophysiology of other metabolic emergencies.
- Recognize the signs and symptoms of other metabolic emergencies.

Question 9

An 8-month-old baby boy is brought to the ED with altered mental status. He had mild "flu-like symptoms," poor oral intake, and fussiness for the past 3 days and became more "sleepy" than usual for 2 days. Past medical history is significant for mild developmental delay. Parents report that baby was born with a "big head."

On examination, the baby appears lethargic with macrocephaly and a prominent fontanel. He has diffuse hypotonia. No gross dysmorphic features or skin lesions/bruises are noted. Vital signs are within normal range. The initial metabolic panel demonstrates Na 139 mEq/L, K 4.0 mEq/L, HCO_3 13 mEq/L, chloride 100 mEq/L, BUN 23 mg/dL, creatinine 0.8, and glucose 99 mg/dL. His head CT is shown below.



Which of the following will most likely yield the cause of this presentation?

A. Neurosurgery consultation for hydrocephalus
B. Arrange admission for suspected child abuse
C. Genetic evaluation
D. Evaluation for sepsis and antibiotics
E. Referral to child protection services

Correct Answer: C

Brain CT scan reveals the appearance of frontoparietal brain atrophy with widening of the Sylvian fissures. This reflects abnormal brain growth during intrauterine life in a child with developmental delays and macrocephaly since birth. The reduced amount of brain tissue within an enlarged head has been called microencephalic macrocephaly. This is more suggestive of an inborn error of metabolism, e.g., glutaric aciduria type 1 (GA1).

GA1 is an autosomal recessive disorder resulting in deficiency of glutaryl-CoA dehydrogenase. Most patients with GA1 have no clinical symptoms and relatively normal at birth. Approximately 40% are born with macrocephaly and, over a few months, gradually cross toward the 97th percentile.

Acute neurological deterioration occurs most frequently between 6 and 18 months of age. This can occur acutely if triggered by a febrile illness with some degree of dehydration or more insidiously without any triggering event.

MRI finding includes selective frontotemporal atrophy, involving subcortical white matter, with prominent extra-axial CSF collections and, in some cases, subdural hemorrhage.

When triggered by fever and dehydration, children become acutely hypotonic, lose head control, and can have abnormal movements similar to seizures. Veins can stretch in the enlarged collection of CSF and are subject to rupture to cause acute subdural hemorrhages. In some cases, these are accompanied by retinal hemorrhages, raising the suspicion of non-accidental trauma, and initiating a child protective services investigation considering these findings would be appropriate. Laboratory evaluation will show a metabolic acidosis with normal lactate and may show an increased urinary concentration of glutaric acid and 3-hydroxyglutaric acid.

Take-Home Message

Glutaric aciduria type 1 (GA1)may present with subdural hemorrhage. Therefore, GA1 testing should be included in the evaluation of abusive head trauma.

ABP Content Specification

- Recognize signs and symptoms of clinical conditions characterized by the inherited organic aciduria disorders.
- Evaluation of patient with altered mental status and abnormal neuroimaging. Differentiating between hydrocephalus and cerebral atrophy.

Question 10

A 13-year-old boy presents to ED with a history of headache, nausea, and vomiting. The family reports that the patient has become "sleepier" for the past 2 days. They also noticed a slight tremor involving both hands. Past medical history is significant for seizure disorder, and the patient is taking valproic acid and levetiracetam. He is followed by a pediatric neurologist who increased medication dose 7 days ago. On examination, the patient is drowsy but responds appropriately to all questions. His vital signs and neurologic examination are otherwise unremarkable except for mild asterixis. He has no jaundice and no stigmata of chronic liver disease. What further test would reveal the cause of his symptoms?

A. Order brain MRI
B. Obtain urine toxicology screen
C. Obtain brain CT scan
D. Schedule EEG
E. Obtain serum ammonia and anticonvulsant drug levels

Correct Answer: E

Valproate is commonly prescribed for the treatment of seizure disorders, psychiatric conditions, including bipolar disorder, and chronic pain syndromes. Valproate-related hyperammonemia encephalopathy is a rare, but a serious adverse event reported with valproate therapy. The typical

presentation is the acute onset of impaired consciousness, confusion, and lethargy. These initial signs may progress to ataxia, stupor, and coma. These patients can have normal serum valproate and normal liver function tests. This problem may be missed if ammonia level is not obtained. The indications for valproate therapy extend beyond convulsive disorders; thus, physicians in all areas of practice must be aware of this potentially serious adverse effect. The management of valproate-related hyperammonemia encephalopathy is generally supportive, with discontinuation of valproate therapy, frequent monitoring, seizure precautions, and follow-up electroencephalograms. The other tests listed would not be helpful in confirming the diagnosis.

Take-Home Message
Serum ammonia levels should be obtained in all patients developing altered mental status who are receiving valproate therapy.

ABP Content Specification
- Recognize signs and symptoms of valproic acid toxicity.

Question 11

A 3-year-old boy is brought to the ED after a fall on his outstretched hand. He cried immediately and complained of pain in his right wrist. Examination shows a well-appearing child playing with his toys on the floor with both hands. No apparent bruises or open wounds are seen. Mild tenderness and swelling are appreciated at the right wrist. You note that he has difficulty standing up from the floor and has a "waddling gait." Examination reveals hypertrophy of both calves. Further questioning reveals that he is a "clumsy child," and the mother reports frequent falls. X-ray of the right wrist is normal, but the family asks you if you have any thoughts regarding why he walks the way he does. What should be the next evaluation in this child in ED?

A. Consult pediatric rheumatologist
B. Arrange for physical therapy services
C. Recommend muscle biopsy
D. Obtain a creatinine kinase (CK) level
E. Schedule an outpatient pediatric neurology appointment

Correct Answer: D

Duchenne muscular dystrophy (DMD) is a rapidly progressive form of muscular dystrophy that occurs primarily in boys. It is due to a defective gene located on the X chromosome, which is responsible for the production of dystrophin. It has X-linked recessive inheritance.

The symptoms usually appear before 6 years of age and may appear as early as infancy. The usual age of onset of weakness occurs between 2 and 3 years of age. Typically, the first noticeable symptom is delay of motor milestones, including independent sitting and standing. The mean age for walking in boys with DMD is 18 months. There is progressive muscle weakness of the legs and pelvic muscles, causing a waddling gait and difficulty climbing stairs and Gower's sign (difficulty arising from the floor). Calf muscles initially enlarge and the enlarged muscle tissue is eventually replaced with fat and connective tissue (pseudo-hypertrophy).

Patients with DMD have severe clinical presentation and often become wheelchair dependent by about 12 years of age. Subsequently death occurs in late teens or twenties due to respiratory compromise or cardiomyopathy. The initial investigation is serum creatinine kinase (CK) level: In DMD the CK level is very high (10 to 100 times normal from birth). CK level is elevated even before the appearance of clinical signs of DMD.A normal CK at presentation excludes DMD. More precise diagnosis is established by a combination of genetic analysis, which can identify most (but not all) of the DMD mutations, and muscle biopsy with assay for dystrophin protein. All the other interventions may delay the diagnosis.

Take-Home Message
The characteristic presentation is required to place one hand on the knee to assume an upright position in order to rise from the floor. Obtain

plasma levels of creatine kinase level in children with weakness.

ABP Content Specification

- Recognize signs and symptoms of Duchenne muscular dystrophy.

Question 12

A 15-year-old boy presents to the ED with leg discomfort and difficulty in walking. It all started with mild stiffness in his legs this morning. He initially attributed it to being tired since he went out last night to a restaurant with his friends to celebrate his birthday. As the day went on, the weakness and pain increased. Past medical history is significant for ADHD and allergies. He has a prior history of a similar episode a year ago which resolved with over-the-counter medications and rest. His medication list includes methylphenidate and cetirizine. He denies other symptoms including headache, diplopia or visual symptoms, difficulty with chewing/swallowing or speech, respiratory symptoms, chest pain, or vertigo. Initial vital signs are all normal. Neurological examination reveals symmetric weakness which is more prominent proximally in all 4 extremities. Deep tendon reflexes are 1+ and symmetric. What additional laboratory test would be helpful in making the diagnosis?

A. Obtain head CT scan
B. Draw a sample for serum electrolytes and creatinine phosphokinase
C. Schedule MRI of the spine
D. Request thyroid function test
E. Obtain an EKG

Correct Answer: B

Periodic paralysis is a rare group of genetic disorders that lead to episodic paralysis due to defect in muscle ion channels. These are often described as skeletal muscle channelopathies.

Primary hypokalemic periodic paralysis results from mutations in genes which encode components of voltage-gated ion channels in skeletal muscle. A calcium channel mutation (CACN1AS) on chromosome 1 is the most common cause of the primary form. In general, these episodes occur suddenly with generalized weakness. Hypokalemia precedes the onset of muscle weakness by a few hours. It usually affects the proximal muscles more than the distal and the legs more than the arms. Weakness usually starts during sleep and becomes apparent in the early morning on awakening.

These episodes can be triggered by high carbohydrate meals, high sodium intake, increased exertion, and cold temperature. Weakness of axial and appendicular musculature with sparing of the face is seen. Respiratory muscle weakness is uncommon, but may be life-threatening. During episodes, hyporeflexia is common; however, sensation remains intact.

Myalgias are common during attacks with elevations in serum creatinine phosphokinase level. Serum potassium is low during the attack. Electromyography (EMG) may demonstrate decreased amplitude of the compound muscle action potential (CMAP). Treatment during attacks requires careful correction of hypokalemia in order to avoid iatrogenic hyperkalemia. A potassium-sparing diuretic such as spironolactone or carbonic anhydrase inhibitor such as acetazolamide can be effective. It is important to confirm the hypokalemia before potassium administration. These patients should be on cardiac monitor. Potassium level should also be monitored.

Take-Home Message

Since the total body amount of potassium remains normal, potassium correction should be performed carefully.

ABP Content Specification

- Recognize signs and symptoms of periodic paralysis.
- Appropriate diagnostic workup and management of patients with hypokalemic periodic paralysis.

Question 13

An 18-year-old male is brought to the ED by his parents, with speech problems and severe headache. This is his third visit to the ED in the last 10 days. He was seen for a "bad cold"10 days ago. Two days later he returned to the ED with fever and a frontal headache with mucopurulent rhinorrhea. At that time, he was started on antibiotics for presumed sinusitis. His symptoms improved initially but he woke up this morning with slurred speech and worsening of the headache. On arrival, his temperature is 100.8 °F, and the vital signs are otherwise within the normal limits for age. He is awake, alert, and attentive. He is unable to follow commands completely. He tends to perseverate on words and is confused about date and place. He is not fully cooperative with the examination. Cranial nerves 2–12 are otherwise intact. He has increased tone in his right leg, decreased strength in his right arm and leg, and a right pronator drift. He withdraws all four extremities to noxious stimuli. The rest of the physical examination is unremarkable. What is your next step?

A. CT head with IV contrast
B. Lumbar puncture
C. Start IV dexamethasone
D. Head CT without contrast
E. CT of sinuses without contrast

Correct Answer: A

The patient in the above vignette most likely presents with acute subdural empyema as a complication of sinusitis. Subdural empyema is a collection of pus in the potential space between the dura mater and the arachnoid membrane. It is a neurosurgical emergency.

Patients typically present with fever, vomiting, meningismus, and focal neurological signs. Most cases result from direct extension of infection from adjacent structures (i.e., paranasal sinuses, middle ear). An enhanced CT scan lacks sensitivity and may miss findings. Lumbar puncture is contraindicated given the risk of herniation. If CSF is obtained, it may be normal or may show a low-grade pleocytosis unless the subdural empyema is associated with meningitis. A select group of low-risk patients may be treated with antibiotics and serial imaging; however, most patients require surgical evacuation of the pus through either a burr hole or a craniectomy. Although >90% of patients with subdural empyema survive, 15–44% of them have permanent neurologic deficits. Dexamethasone would not be an appropriate treatment for this entity.

Contrast MRI with gadolinium can also detect the subdural empyema but contrast-enhanced head CT scan is more easily available in the emergency department.

Take-Home Message
Intracranial empyema is a serious complication of sinusitis particularly in children.

ABP Content Specification
- Recognize signs and symptoms of intracranial infectious fluid collection.
- Appropriate diagnostic workup and management of acute subdural empyema.

Question 14

A 3-year-old previously healthy boy presents with a 2-day history of inability to stand and more clingy behavior. There is a history of a minor fall 5 days prior at which time he complained of back pain and was treated with acetaminophen. Since then, his mother has noticed difficulties with standing up and walking independently and his back hurts when touched. There was also an episode of urinary incontinence on the day of presentation and he has not moved his bowel for 4 days. There is no history of fever or recent illness. Examination reveals an anxious child who wants to be held. When asked to stand, he cries and sinks to the floor. Deep tendon reflexes are2+ in both upper extremities and 4+ in the patellar and Achilles tendons bilaterally. Physical examination is significant for abdominal distention. Which study would be most helpful in establishing the diagnosis in this child?

A. X-rays of thoracic and lumbar spine
B. CT scan with contrast of spine
C. Lumbar puncture
D. MRI of thoracic and lumbar spine
E. Creatinine phosphokinase

Correct Answer: D

The presentation in this child is consistent with spinal cord tumor. The presentation of spinal cord tumors depends on their size and location. The most common presenting symptoms include back or neck pain, radicular pain, weakness, paresthesia, gait disturbance, and bowel and bladder dysfunction. Motor deficits can initially be seen as clumsiness, weakness, or frequent falls. In young infants, this may manifest as motor regression such as refusal to stand or crawl after having learned to walk. Gait disturbance is common with spinal cord tumors. In children, behavioral change may be a subtle sign of increased ICP. Primary spinal cord tumors are rare in children. Overall, these represent 5–10% of central nervous system tumors in children.

X-rays and CT scan primarily provide information about the bony structures. MRI is the imaging modality of choice for the diagnosis of spinal cord tumors. It is also more sensitive to diagnose posterior fossa tumors. The spinal cord compression is an indication for emergent MRI. Lumbar puncture and creatine phosphokinase would not be helpful in this scenario.

Take-Home Message
Beware that children may initially present with nonspecific signs and symptoms with CNS tumors.

ABP Content Specification
- Recognize signs and symptoms associated with spinal cord lesions.
- Appropriate diagnostic workup and management of spinal cord tumors.

Question 15

A 19-year-old student is evaluated in the ED for paresthesia that began in the left side of the face and spread within 30 minutes to the left arm and leg. She now has clumsiness of the left hand and right-sided throbbing headache. She is otherwise healthy with no significant medical problems. She has a family history of migraine. She is on oral contraceptive pills and multivitamins. Physical examination reveals temperature 98.6 °F, heart rate 110 beats/minute, respiratory rate 22 breaths/minute, blood pressure 140/82 mmHg, and BMI 30. Her neurological examination did not show any abnormalities. Initial laboratory evaluation and head CT scan were also unremarkable. Which of the following is the most likely diagnosis?

A. Migraine with aura
B. Multiple sclerosis
C. Sensory seizure
D. Transient ischemic attack
E. Alternating hemiplegia of childhood

Correct Answer: A

The above patient is most likely experiencing a migraine with aura. Migraine is a recurrent headache which is common in children. There are periodic episodes of paroxysmal headache with nausea, vomiting, and abdominal pain. A typical aura includes visual, sensory, and/or speech symptoms but usually no motor weakness. A typical aura lasts longer than 5 minute and less than 60 minutes. Although this can mimic a stroke, certain features – young age, absence of vascular risk factors, family history of migraine, and the presence of sensory symptoms – may support the diagnosis of migraine.

Multiple sclerosis (MS) is less likely in this patient given the acute onset of symptoms. MS is typically diagnosed by finding demyelinating evidence on MRI and abnormal CSF studies.

A sensory seizure is a form of simple partial seizure. Sensory seizure symptoms are often brief unlike an aura and reflect the anatomic organization of the sensory homunculus on the contralateral primary sensory cortex, whereas migraine symptoms are related to transient vasospasm.

Alternating hemiplegia of childhood is characterized by paroxysmal episodes of hemiplegia,

quadriplegia, choreoathetotic movements, and nystagmus that disappear immediately after sleep, along with progressive mental retardation and development of permanent neurological deficits such as choreoathetosis, dystonia, and ataxia.

Alternating hemiplegia of childhood is characterized by episodes of unilateral weakness with:

- Motor deficits such as dyskinesias and stiffness
- Oculomotor abnormalities such as nystagmus

These episodes manifest in infancy, usually in the first 18 months. These usually last for minutes but may last for weeks and resolve spontaneously. These children are normal prior to the diagnosis; the events occur during sleep. Most outgrow by mid-childhood without significant long-term neurologic sequela. However, some may develop ataxia, developmental delay, or choreoathetosis.

Take-Home Message
An aura lasting longer than 5 minute is helpful to differentiate the migraine aura from a seizure.

ABP Content Specification
- Recognize signs and symptoms of migraine headaches and how to differentiate migraines from other causes of headache.
- Differentiating migraine symptoms from stroke.

Question 16

A 16-year-old boy is evaluated in the ED with a 3-day history of confusion and frequent falls that are progressively getting worse. He has a history of severe Crohn's disease with multiple complications which required a partial small bowel resection. In the past few months he has lost significant weight due to persistent diarrhea. He is currently on prednisone and azathioprine. Physical examination reveals a temperature of 96.8 °F, heart rate 90 beats/minute, respiratory rate 14breaths/minute, blood pressure 140/72 mmHg, and BMI 17. Physical examination reveals a confused cachectic appearing with deep sunken eyes, temporal muscle wasting, and sunken eyes. He is disoriented to name and unable to state the location. No obvious motor weakness is noted. There is no nuchal rigidity but marked nystagmus is present. Deep tendon reflexes are reduced and plantar reflexes are flexor. When asked to walk, marked ataxia is also present. What is the best initial management for this patient?

A. Obtain EEG
B. Provide thiamine
C. Administer lorazepam
D. Administer a broad-spectrum antibiotic
E. Schedule colonoscopy

Correct Answer: B

Wernicke encephalopathy is a rare disease in children and is caused by thiamine (vitamin B1) deficiency. It is a cofactor for many enzymes involved in energy metabolism, such as transketolase, alpha-ketoglutarate dehydrogenase, and pyruvate dehydrogenase.

This is characterized by ataxia, altered level of consciousness, and oculomotor dysfunction ophthalmoparesis. The initial presentation ranges from burning feet to muscle weakness.

Gastrointestinal surgery, total parenteral nutrition for short bowel syndrome, and alcoholism are common risk factors for Wernicke encephalopathy. The magnetic resonance imaging (MRI) findings include selective symmetrical signal changes in the mammillary bodies, medial thalamus, tectum, periaqueductal region, cranial nerves, cerebellum, red nucleus, dentate nucleus, fornix, splenium, cerebral cortex, and putamen. If not recognized and promptly treated, the disease may be fatal. Wernicke-Korsakoff psychosis responds well to the administration of thiamine.

Take-Home Message
Wernicke encephalopathy is primarily a clinical diagnosis and should be considered and treated particularly if risk factors are identified. Since the diagnosis is difficult to confirm immediately, the thiamine should be promptly administered based on clinical suspicion.

ABP Content Specification

- Recognizing neurological complications associated with GI/short bowel syndrome.
- Appropriate diagnostic workup and management of Wernicke encephalopathy.

Question 17

An 18-year-old young woman is evaluated in the ED for a 2-day history of severe headache, nausea, and vomiting. She has a history of migraines, as do her mother and aunt. In the ED, intravenous fluid is administered and prochlorperazine was provided to control her symptoms. Shortly after, the nurse calls you to inform that the patient is having a reaction to the medication. On reaching her room, you find that she is crying due to pain in her neck and jaw. She is also having trouble with enunciation. Examination reveals that her head turned to the right with sustained contraction of the right sternocleidomastoid muscle. The rest of the examination is unremarkable. What is the best treatment for this patient?

A. Tetanus immune globulin
B. Phenytoin
C. Diphenhydramine
D. Recombinant tissue plasminogen activator
E. Botulinum toxin

Correct Answer: C

The patient is experiencing a prochlorperazine-induced dystonic reaction. These are involuntary contractions of major muscle. This is best treated with diphenhydramine. Prochlorperazine blocks dopaminergic receptors in the extrapyramidal system. Acute dystonic reactions more commonly involve the muscles of the face, tongue, jaw, neck, or throat. They can be characterized as torticollis (twisted or turned head, neck, or face) or buccolingual (involves tongue muscles) or opisthotonic (trunk or entire body spasms) movements. Neuroleptics (antipsychotics), antiemetics, and antidepressants are the common causes. Intravenous anticholinergic agents, such as benztropine or diphenhydramine, are the treatment of choice.

Take-Home Message

Acute dystonic reactions are common adverse reactions to antipsychotic and antiemetic drugs through antagonism of dopamine D2 receptors. Diphenhydramine and benztropine can reverse these symptoms.

ABP Content Specification

- Recognize signs and symptoms of dystonias.
- Appropriate management of medication-induced dystonias.

Question 18

A 12-year-old boy is brought to the ED with seizure. His mother says that he was having a generalized tonic-clonic seizure when she woke up 30 minutes ago. She called the paramedics when his seizure continued for more than 5 minutes. She reports that the jerking decreased in route to the hospital and he has a history of seizure disorder and being treated with Depakote. He had 3 brief seizure episodes yesterday which consisted of lip smacking and eye rolling that lasted for 2 minutes each. He has an average of 3–5 episodes of seizure each year.

On examination, the patient is unresponsive with occasional lip smacking. His vital signs were as follows: temperature 99 °F, heart rate 120 beats/minute, respiratory rate 24 breaths/minute, blood pressure 130/70 mmHg, and oxygen saturation 95%. Which of the following is the most appropriate next step in management?

A. CT of the head
B. Electroencephalography
C. Measurement of serum Depakote level
D. Intravenous administration of lorazepam
E. Intubation

Correct Answer: D

The above patient is in non-convulsive status epilepticus (NCSE) which refers to a prolonged seizure that manifests primarily as altered mental status. The clinical hallmarks include a comatose state and the absence of prominent motor features.

However, subtle muscle twitching such as eye fluttering and automatism such as lip smacking may be present.

The gold standard for diagnosis is an EEG; this should be obtained in patients with altered mental status. Initial management should be the same as convulsive status epilepticus.

The usual first-line agent is intravenous benzodiazepines followed by intravenous fosphenytoin. CT of the head, EEG, and Depakote levels, although may be needed, would not address the present symptoms. The intubation may not be immediately indicated as his respiratory status is adequate.

Take-Home Message

Non-convulsive status epilepticus (NCSE) should be suspected in the presence of unexplained alteration in behavior or mental status. It should also be considered if the postictal state is prolonged. Since EEG is required for diagnosis, a high index of suspicion is needed to obtain EEG studies.

ABP Content Specification

- Recognize signs and symptoms of non-convulsive status.
- Plan the management of acute seizures and the potential complications associated with these treatment modalities.

Question 19

A 7-year-old girl is brought to the ED with a sudden onset of facial weakness. This morning, the patient was noted to have difficulty while drinking liquids and was dribbling food from the right side of her mouth. The patient has been previously healthy. There has not been any exposure to ticks. Her vitals reveal normal temperature 98.9 °F, heart rate 78 beats/minute, respiratory rate 20 breaths/minute, and blood pressure 110/68 mmHg. On examination, the child appears comfortable. On smiling and puffing out of the cheeks there is weakness of the right side. There was incomplete closure of the right eye even after maximum effort and there is absence of creases over the forehead. The rest of the examination is unremarkable. What is the best next step in her management?

A. Obtain CT of the head
B. Perform lumbar puncture
C. Intravenous ceftriaxone
D. Obtain CBC and ESR
E. Administer prednisone

Correct Answer: E

The patient's symptoms are consistent with Bell's palsy. The first step in the diagnosis is to determine whether facial weakness is central or peripheral. Peripheral facial palsy involves all the facial muscles ipsilateral to the side of facial nerve involvement, whereas central weakness involves lower facial muscles contralateral to the lesion in the brain stem above the pons and cerebral hemisphere. Since the forehead has bilateral innervation, in central (upper motor neuron) lesion, there will be sparing of the forehead muscles. Since the trigeminal nerve supplies sensory innervation to the face, there is no cutaneous sensory loss.

Since the presentation is typical for Bell's palsy, there is no need to obtain brain imaging or laboratory studies. Facial nerve palsy may be associated with acute otitis media, temporal bone fracture, facial trauma, local neoplasms, or Lyme disease. If any of these underlying causes of facial nerve palsy are suspected based on careful history and physical examination, further evaluation should be performed.

MRI may be a better choice but should not be obtained routinely. However, it should be considered to determine other possible causes for acute facial paralysis, especially if there is little or no recovery of function. Diagnosis of Bell's palsy in a patient with unilateral peripheral facial weakness of unknown cause is primarily clinical. The treatment with prednisolone improves outcome in patients with Bell's palsy and shortens the time to recovery. Prednisolone should be used in all patients with facial palsy of less than 72-hour duration, who do not have contraindications to steroid therapy.

Artificial tears are recommended for eye protection, to avoid corneal damage. If blinking is not possible, the affected eye should be covered with an eye patch.

Take-Home Message

The innervation to the muscles of the upper face (frontalis) originates from both sides of the brain, whereas the innervation to the muscles of the lower face comes from the opposite side of the brain only. Facial weakness due to cortex involvement (upper motor neuron lesion) causes weakness to the contralateral lower face sparing the upper facial involvement. Lower motor neuron lesions involving facial nerve result in weakness of both upper and lower face ipsilaterally.

ABP Content Specification

- Recognize signs and symptoms of Bell's palsy.
- Appropriate diagnostic workup and management of patients with Bell's palsy.

Question 20

A 19-year-old girl is evaluated in the ED for head injury after colliding with another player during her soccer match. She immediately fell to the ground and had a brief loss of consciousness. Afterward, she was conversant but dazed. Head CT in the ED did not show any significant injuries. The patient complains of dizziness and headache but does not appear to be in distress. Her neurological examination does not reveal any abnormalities. Prior to the discharge, the patient asks when she can return to soccer participation. What is the most appropriate advice?

A. Restrict from all sports
B. Return to her usual activities
C. Return to sports only when she is headache-free
D. Return to sports when symptom-free without the use of any medications
E. Abstain from sports for 1 week

Correct Answer: D

Patients with concussion may present with a wide range of clinical signs and symptoms, including physical signs (e.g., loss of consciousness, amnesia), behavioral changes (e.g., irritability), cognitive impairment (e.g., slowed reaction times), sleep disturbances (e.g., drowsiness), somatic symptoms (e.g., headaches), cognitive symptoms (e.g., feeling "in a fog"), and/or emotional symptoms (e.g., emotional liability).

According to the recently published AAN guideline "Update: Evaluation and Management of Concussion in Sports," a patient should not begin a graded RTP (return to play) program until he/she is symptom-free and off medication for this concussion. The patient should also be advised to avoid any contact-risk activity, to protect from repeat injury. Further monitoring should include avoiding activities that exacerbate the symptoms. A follow-up visit with her primary physician should be recommended before returning to contact-risk activity.

Take-Home Message

Symptomatic children following head trauma should not be allowed to return to play. No symptomatic child should be allowed to return to sport**.**

ABP Content Specification

- Appropriate management of patients with concussion.

Question 21

A 2-year-old girl is being evaluated in the ED for gait difficulties. She has no significant past medical history except that she had varicella 10 days ago. She was treated with acetaminophen alone and now all the lesions are in the process of healing. She denies headaches or vomiting. She takes no other medications. The mother is her only caretaker and in good health. She denies possible exposure to any drugs or medications. The mother states that her daughter was well prior to her nap and "started walking like she was drunk" only after she got up. Her vital signs are normal. She was well appearing, alert, and cooperative. Neurological examination is significant for an unsteady wide-based gait and difficulty standing with her feet together without falling over. She has slight dysmetria. Cranial nerves, strength, and deep tendon reflexes are all intact. When discussing the workup, the mother asks you what the most likely diagnosis is. What do you tell her?

A. Drug ingestion/toxicity
B. Acute cerebellar ataxia
C. Posterior fossa tumor
D. Guillain-Barre syndrome
E. Miller Fisher syndrome

Correct Answer: B

The patient's history and examination is consistent with the diagnosis of acute cerebellar ataxia, which is the most common cause of childhood ataxia. The onset is often rapid but the condition is self-limited and most children have a full recovery. It is often a postinfectious condition, and varicella has been the most common cause. Generally, neuroimaging is not required, but should be considered if there is altered sensorium, focal weakness, sensory loss, or hyperreflexia. Progressive ataxia, symptoms of increased intracranial pressure such as worsening of headache, and vomiting are likely to be present with posterior fossa tumors. Guillain-Barre syndrome presents as an acute ascending flaccid paralysis (with symmetric weakness) following a viral infection. A characteristic finding is areflexia. Miller Fisher syndrome is a variant of GBS and is characterized by ataxia, ophthalmoplegia, and areflexia. Cranial nerve VII (facial nerve) involvement is common. Lumbar puncture demonstrates albuminocytologic dissociation in GBS. It is possible that the symptoms are caused by ingestion; thus, a good history is important.

Take-Home Message
Acute cerebellar ataxia is commonly seen in previously healthy children occurring after an acute febrile illness. Other serious causes of ataxia should be considered before making the diagnosis of acute cerebellar ataxia.

ABP Content Specification
- Differentiate by age the etiology and understand the pathophysiology of ataxia.
- Plan diagnostic evaluation and initial intervention for patients with ataxia.
- Recognize serious and/or life-threatening causes of ataxia.
- Recognize signs and symptoms of cerebellar ataxia.

Question 22

A 15-month-old child is brought to the ED with a chief complaint of "passing out." The mother reports that the child was with her at the store where he tripped and fell. He immediately stood up and started to cry and then suddenly "passed out and turned blue." He was limp as a "rag doll" for a few seconds prior but was back to his usual self within 1 minute. His eyes were closed during the episode. Past medical history is significant for another similar episode a few months ago. His family history is negative for sudden death, seizures, or early pacemaker placement. What is the most likely diagnosis?

A. Breath-holding spells
B. Simple partial seizure
C. Concussion
D. Absence seizure
E. Long QT syndrome

Correct Answer: A

The history is consistent with breath-holding spells. Breath-holding spells are common in infants and toddlers and may be mistaken for seizure. A key to breath-holding is that the spells usually begin with crying.

It occurs in two different forms:
- Pallid – due to reflex vagal-cardiac bradycardia usually starts with a cry or may occur with a "silent" cry with marked pallor
- Cyanotic – due to prolonged expiratory apnea and intrapulmonary shunting

The typical presentation is a frightened infant who begins to cry and then becomes apneic and cyanotic, subsequently becoming unconscious, stiff, or limp.

In cyanotic breath-holding spells, the child usually cries and forcibly exhales and becomes cyanotic and limp.

Unlike seizures, the eyes are typically closed during the attack, and the episodes are brief and are not accompanied by postictal confusion. The attacks can be precipitated by minor events such

as blows to the head, fright, and frustration. The prognosis is excellent, with the vast majority of children outgrowing spells. The trivial nature of the injury and lucid interval make concussion an unlikely diagnosis. Arrhythmias are an important consideration in the diagnosis of breath-holding spells, but a negative family history for sudden death or known arrhythmias makes this much less likely. EKG should be considered when in doubt.

The treatment is reassurance of the family of the benign nature of these spells.

Take-Home Message
Breath-holding spells are differentiated from a seizure episode by the nature of the trigger, brief duration, and rapid recovery without any postictal phenomena.

ABP Content Specification
- Know the seizure-like events that mimic epilepsy.
- Differentiate by age the etiology and the pathophysiology of apnea.

Question 23

A 5-year-old girl is evaluated in the ED with an episode of transient left-sided weakness involving the face and arm. The family reports that the patient was at a birthday party, blowing balloons when she suddenly developed symptoms. The history is significant for 3–4 similar but brief episodes a few months ago. Her symptoms resolved spontaneously. Her previous evaluation includes both a normal head CT scan and EEG. Her physical examination reveals mild left-sided weakness involving the face and arm. The rest of her examination is unremarkable. A repeat head CT scan and EEG in the ED do not show any gross abnormalities. What is the most likely diagnosis?

A. Todd's paralysis
B. Complex migraine
C. Moyamoya disease
D. Neurofibromatosis
E. Concussion

Correct Answer: C

Moyamoya disease is a chronic occlusive cerebrovascular disorder of unknown origin. It is an increasingly recognized cause of stroke in children. It is characterized by progressive stenosis of the bilateral internal carotid arteries resulting in the formation of tortuous arterial collaterals at the base of the brain, which reconstitute the distal branches of the cerebral circulation. This also includes the proximal anterior cerebral arteries (ACAs) and middle cerebral arteries (MCAs). This results in development of an anastomotic capillary network. The term *moyamoya* means something hazy, like a puff of smoke, and is described as the characteristic angiographic appearance of abnormally dilated collateral vessels.

Moyamoya disease is a relatively uncommon neurovascular complication of sickle cell anemia. Patients typically present with recurrent transient ischemic events (TIA), strokes, and seizures. Behavior such as blowing balloons, whistling, and crying (behaviors that result in hyperventilation and consequent hypocapnia) can precipitate these symptoms. Children under 2 years of age are at higher risk for a fulminant presentation. The diagnosis is established by MR angiography, which shows a cluster of small abnormal blood vessels.

Todd's paralysis is a neurological condition experienced by individuals with epilepsy, in which a generalized seizure is followed by a brief period of temporary paralysis.

Take-Home Message
Moyamoya disease should be suspected in children presenting with transient ischemic attack or stroke, which is due to bilateral occlusion of the arteries around the circle of Willis with prominent arterial collateral circulation. A transient ischemic event with sensorimotor paralysis involving unilateral face and arm should prompt a suspicion for a vascular etiology.

ABP Content Specification

- Know the causes of strokes in children.
- Plan the management of stroke in children.
- Recognize and interpret relevant laboratory and imaging studies for stroke in children.

Question 24

A 4-year-old boy is being evaluated in ED with bilateral leg pains and abnormal gait. The parents have always noticed that this child's gait was more awkward than that of his siblings. For the past few months he has begun walking on his toes and started complaining of discomfort in his legs. He is not toilet trained. Neurological examination reveals increased tone and brisk reflexes in both lower extremities. He walks on his toes and has difficulties walking on his heels. Sensory examination reveals patchy sensory loss in his calves. What is the most likely diagnosis?

A. Tethered cord syndrome
B. Cerebral palsy
C. Peripheral neuropathy
D. Transverse myelitis
E. Scoliosis

Correct Answer: A

The history and constellation of findings are suggestive of a tethered spinal cord. A tethered cord is often diagnosed as a "low conus." The conus medullaris (or lower termination of the spinal cord) normally terminates at or above the L1–L2 disk space. After about 3 months of age, a conus below the L2 disk space indicates a tethered cord. As the spinal column elongates, stretching and tension develops within the cord tissue.

Symptoms and signs vary from being asymptomatic to severe lower extremity neurological deficits with bladder and bowel involvement. Inspection of the back reveals cutaneous stigmata such as sacral dimples, hairy nevus, angiomas, or lipomas in 70% of cases. Children can also have gait abnormalities resulting from scoliosis or asymmetric growth in the foot or leg associated with talipes cavus deformities. Typically, children may start to stumble after they have learned to walk normally. This progressive neurological dysfunction develops due to traction on the cord or nerve roots.

Some children present with diffuse pain in the lower extremities or urological symptoms such as recurrent urinary tract infections, enuresis, and dribbling, or delayed toilet training. The spine MRI is the appropriate diagnostic test and is very helpful in defining the anatomical abnormalities. It is also the gold standard for diagnosing a tethered cord. Surgical correction of the tethering prevents further deterioration of neurological function.

Take-Home Message

A spinal MRI, showing the conus medullaris caudad to the lower endplate of L2, is an evidence of tethering. Spine MRI should be obtained in the presence of the following:

- Cutaneous lumbosacral spine lesions
- Subcutaneous mass
- Neurologic manifestations

ABP Content Specification

- Plan diagnostic evaluation and initial intervention for patients who limp.
- Recognize signs and symptoms of tethered cord in children.

Question 25

A 17-year-old right hand dominant girl is brought to the ED because of altered mental status. According to her boyfriend, the patient was upset with him when she suddenly complained of shortness of breath and chest pain and became unresponsive. No other symptoms were noticed during the episode. The episode lasted for 45 minutes; she then became responsive and started answering questions and following commands.

Her physical examination reveals normal vital signs. Her electrocardiogram, comprehensive metabolic panel, complete blood cell count, thyroid-stimulating hormone test, and urine drug screen were all normal. She complains of right

arm weakness in the ED and does not withdraw to painful stimuli. The remainder of her neurological examination is normal. Past medical history is significant for 4 similar episodes in last 3 months, ADHD, and depression. Her prior workup includes normal brain MRI and EEG. What is the gold standard to provide a definitive diagnosis for this patient?

A. Repeat EEG for seizures
B. Echocardiogram
C. Stress test
D. Serum prolactin level
E. Video EEG

Correct Answer: E

The patient in the above vignette has psychogenic non-epileptic seizures (PNES) or pseudoseizures. Clinical features can help distinguish between non-epileptic and epileptic seizures. The preictal features suggestive of PNES include pseudo-sleep and a triggering mechanism (emotional or situational).

Ictal features indicative of PNES include resistance to observers opening their eyelids vocalizations and asynchronous, non-stereotypical movements, lack of urinary/bowel incontinence, and tongue bite.

Postictal features such as a lack of confusion, a short duration of an irregular breathing pattern, and the ability to recall events during the episode are highly suggestive of PNES.

The video-EEG is the gold standard for definitive diagnosis of PNES. Beware that routine EEG may not be adequate to differentiate epileptic seizures and PNES. It is often associated with psychiatric conditions and may be seen in patients with epilepsy.

Take-Home Message

The gold standard for the diagnosis of PNES is video electroencephalographic (EEG) monitoring. Failure to suspect this diagnosis can result in unnecessary evaluation and intervention.

ABP Content Specification

- Recognizing and differentiating signs and symptoms of non-epileptic versus epileptic seizures.

Question 26

An 8-year-old girl presents with a history of "dizziness." She reports 2 episodes this morning, where she suddenly felt like the room was spinning around her. These episodes lasted about 30 minutes and then resolved. She reports nausea and difficulty walking during these episodes and had to lie down for relief. The mother witnessed one of her episodes and reports that her eyes were darting to the child's left during it. The patient denies other associated symptoms including headache, tinnitus, and hearing loss.

Past medical history is significant for an upper respiratory infection 3 weeks ago. On examination, the patient has horizontal nystagmus with the fast phase toward the left. The nystagmus fatigues with fixation. The remainder of her neurologic examination is normal. Her ear and tympanic membrane examination are normal. What is the best approach for this patient?

A. Admit for video EEG
B. Obtain EKG
C. Urgent ENT consultation
D. Obtain head CT scan
E. Meclizine for vestibular neuritis and arrange for prompt follow-up appointment with pediatric neurology

Correct Answer: E

Vertigo is the perception of movement when no movement really exists. It is a false sense of motion. Typical history: "the room is spinning."

Vertigo may be caused by peripheral or central lesions.

Peripheral vertigo = disorders affecting the vestibular apparatus and the eighth cranial nerve

Central vertigo = disorders affecting the brainstem and cerebellum

Peripheral causes of vertigo include vestibular neuritis and benign paroxysmal positional vertigo. The central causes include stroke and an intracranial mass. Hearing loss usually suggests a peripheral cause. The type of nystagmus is helpful to differentiate between peripheral and central causes of vertigo.

Nystagmus due to a peripheral cause

- Unidirectional (always in the same direction)
- Horizontal
- Suppressed by visual fixation

Nystagmus due to a central cause

- Bidirectional; changes direction
- May be vertical or torsional
- Not suppressed by visual fixation

Although patients with vestibular neuritis may have difficulty in ambulating, the inability to walk suggests a central cause. MRI is the best modality for central causes because it can identify lesions in the posterior fossa. CT scan does not visualize the brainstem and therefore not adequate.

In this patient, the vertigo is only horizontal, in one direction, and it fatigues. It is also not associated with any other symptoms. This all points towards a peripheral cause. The most common cause of an episode of acute peripheral vertigo, often preceded by an upper respiratory infection and associated with nausea, vomiting, and dysequilibrium, is termed vestibular neuritis. The condition lasts from a few days to several weeks, with decreasing duration and intensity over time.

Acute treatment consists of hydration, bed rest, and symptomatic treatment of the vertigo with meclizine, scopolamine, or diphenhydramine, and antiemetics. Follow-up with neurology is appropriate; failure to improve warrants further evaluation for central causes

Perilymphatic fistula is a connection between the inner ear and the tympanic cavity. Risk factors include a history of surgery, penetrating middle ear trauma, and barotrauma. Given the normal findings on otoscopy, perilymphatic fistula is unlikely.

Take-Home Message

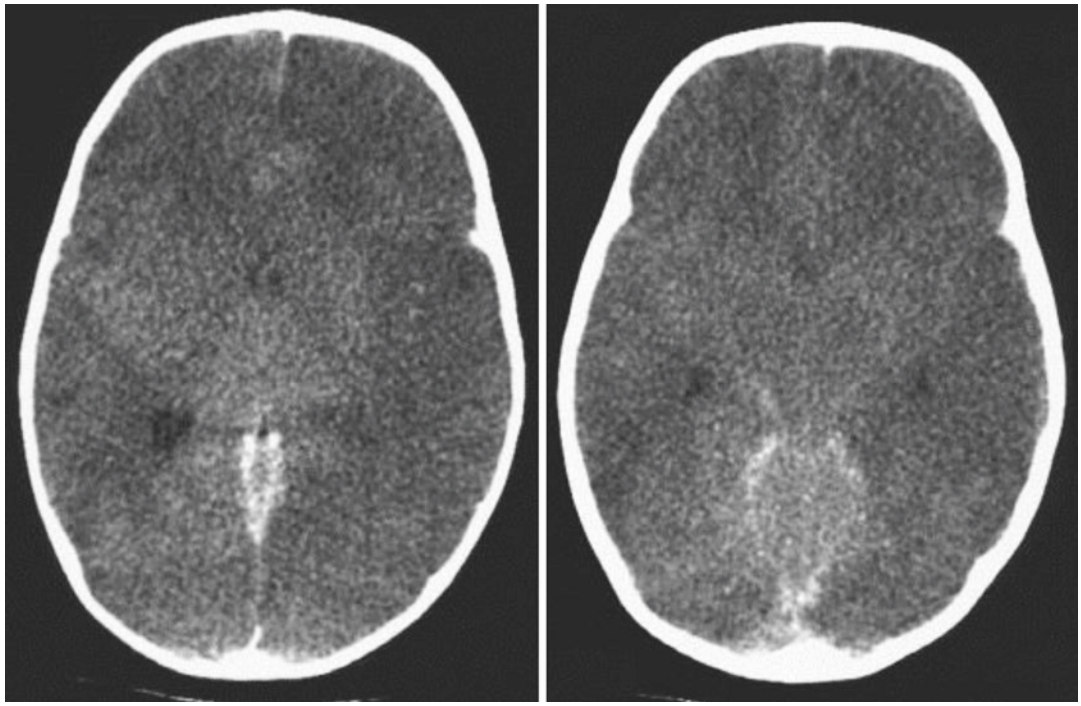
Vertigo can be due to central or peripheral causes. Progressive hearing loss and progressive involvement of other cranial nerves should prompt to evaluate for central cause.

ABP Content Specification

- Differentiate by age the etiology and the pathophysiology of vertigo.
- Plan diagnostic evaluation and initial intervention for patients with vertigo.
- Recognize serious and/or life-threatening causes of vertigo.

Question 27

An 8-month-old baby girl is brought to the ED for vomiting for the last few hours. The mother reports that the baby was doing well until a few hours ago. She denies any trauma or other symptoms of illness over the past few days and reports normal feeding patterns and urinary output. On requestioning, the mother reports that the baby felt warm to touch last night and reports giving some acetaminophen. Past medical history is significant for unremarkable pregnancy and birth history. Initial vital signs reveal the following: temperature 100.4 °F, heart rate 160 beats/minute, and respiratory rate 22 breaths/minute with oxygen saturation of 94% on room air. On examination, the baby is lethargic with poor spontaneous movements. The anterior fontanel is slightly full. Pupils are sluggishly reactive. Head CT in the ED is shown below. What is likely the cause of the patient's condition?



A. Sepsis
B. Inborn error of metabolism
C. Child abuse
D. Congenital arteriovenous malformation (AVM)
E. Ingestion

Correct Answer: C

The head CT scan reveals hypodensity of the cerebral hemispheres with loss of white-gray matter differentiation suggesting cerebral edema. There is also blood in the interhemispheric fissure and basal cisterns consistent with subarachnoid hemorrhage.

Head trauma is the most common cause of death in child abuse victims. This can be difficult to diagnose in infants and young children, and the presentation may be subtle. It is important to consider this diagnosis especially in children presenting with nonspecific clinical symptoms. The initial clinical presentation can be highly variable and includes irritability, vomiting, apnea, seizures, and obtundation. The history provided by the parents or caregivers is often vague and changes with time. The diagnosis may be delayed as these children often present without a history of trauma and may not have external signs of injury.

Although it is important to keep ingestion, sepsis, inborn errors of metabolism, and other congenital causes on the differential, they are not likely the primary cause of the condition given the CT findings and history. Infants and young children can have a normal mental status even in the presence of intracranial injury. Neuroimaging such as computed tomography (CT) or magnetic resonance imaging (MRI) and a thorough dilated eye examination to evaluate for retinal hemorrhage should be performed in these children.

Congenital AVMs are collections of blood vessels resulting in abnormal communication between the arterial and venous circulatory systems. Computed tomography of the head often reveals AVM. There is a high risk of rupture resulting in hemorrhage. The other presentations include headaches, seizures, or focal neurological deficits. Sometimes this may be an incidental finding.

Take-Home Message
Physicians must maintain a high index of suspicion for non-accidental head trauma in infants and young children. The diagnosis is often missed since no history of head trauma is provided, and the signs and symptoms may be nonspecific.

ABP Content Specification
- Recognize signs and symptoms of non-accidental trauma in children and infants.

Question 28

A previously healthy 5-year-old girl presents to the ED with a history of progressively worsening "clumsiness." As per her mother, she has started bumping into things on her right side. There is no history of headaches, dizziness, weakness, or confusion. The child reports difficulty seeing out of her right eye. Her past medical history is significant for mild developmental and speech delays. On examination, multiple brown macules are noted on her trunk and freckles in her axillary regions. Neurological examination reveals visual acuity of 20/20 in left eye and 20/200 in the right eye. Her pupils are equal and react to light when light is shown in the left eye, but the right pupil dilates when light is quickly moved to the right eye. The rest of the examination is unremarkable.

What is the most likely diagnosis?

A. Multiple sclerosis
B. Neurofibromatosis
C. Tuberous sclerosis
D. Vitamin A deficiency
E. Lead poisoning

Correct Answer: B

In a child with developmental delays, café au lait spots and axillary freckling, diagnosis of neurofibromatosis type1 (NF1), should be suspected. NF 1 most commonly affects the skin (café au lait spots, axillary/inguinal freckling, neurofibromas), the eyes (optic gliomas, Lisch nodules), and musculoskeletal system (pseudoarthrosis, scoliosis).

Neurofibromatosis type I is a progressive disorder. Many features are age dependent. Café au lait spots are flat, light, or hypopigmented lesions which are present at birth and increase in size and number in the first few years of life. The presence of six or more lesions is considered diagnostic, which usually occurs by age 6 years. Lisch nodules are pigmented iris hamartomas. These may not be apparent initially; absence of Lisch nodules does not exclude the diagnosis of NF1.

Learning and developmental delays are common in NF1. Decreased visual acuity and afferent pupillary defect suggest optic pathway glioma, which is the most common intracranial tumor in NF1 patients. Other features include macrocephaly, short stature, and hypertension.

Although visual loss from optic neuritis may present similarly, the patient is too young for multiple sclerosis, and optic neuritis is usually painful. None of the others would produce visual changes.

Take-Home Message
Patients with NF1 tend to develop intracranial tumors such as optic pathway glioma resulting in decreased visual acuity and afferent pupillary defect.

A careful and full examination is indicated with all patients with neurological findings.

ABP Content Specification
- Diagnostic criteria of neurofibromatosis.

Question 29

A 4-year-old girl presents to the ED with generalized weakness and difficulty walking. Her parents report a history of otitis media diagnosed a week ago. She is currently on antibiotics and was doing well until 1 day before presentation. Her parents report that she went to bed early as she appeared to be tired and had to be helped walking to the bathroom last night. She woke up this morning and was unable to get out of the bed. Her examination reveals symmetric 3/5 lower and upper extremity weakness, absent ankle and patellar reflexes, and 1+ biceps reflex. She is able

to reply to questions with 1–2-word sentences and appears to have difficulty while talking. She is only able to count to 5 in one breath. Routine laboratory evaluation, chest x-ray, and head CT scan are all normal. What is the next best test to provide a diagnosis in this patient?

A. Obtain electrolytes
B. Order stat MRI and MRA of head and neck
C. Send stool sample for campylobacter
D. Perform lumbar puncture
E. Schedule EMG

Correct Answer: D

Guillain-Barré syndrome (GBS) is an acute, rapidly progressive immune-mediated polyneuropathy with weakness/paralysis that typically begins symmetrically in the lower extremities, spreads upwards, and may involve the arms, chest, and cranial nerves. GBS may be preceded by a respiratory or gastrointestinal infection (classically, *Campylobacter jejuni*). Clinical diagnosis can be confirmed with a lumbar puncture, which will show increased protein but normal white blood cell count (albuminocytologic dissociation).

Although the weakness may initially be mild and non-disabling, symptoms can progress rapidly over a few days. Continued progression may result in a neuromuscular emergency with profound paralysis, respiratory insufficiency, and/or autonomic dysfunction with cardiovascular complications. Since respiratory failure is common and up to 1/3 of patients may require mechanical ventilation, vigilance is essential and close respiratory monitoring with bedside forced vital capacity is recommended. Hypercarbia is a relatively late finding.

EMG studies may support the diagnosis by demonstrating demyelinating features, but it is not readily available in the ED. Routine blood work is generally normal in patients with GBS, as is neuroimaging.

The preferred treatment is intravenous immunoglobulin. Plasmapheresis is considered as alternate treatment when IVIG therapy cannot be administered.

Take-Home Message

The typical presentation is hyporeflexia and symmetrical ascending weakness that can lead to respiratory failure.

ABP Content Specification

- Recognize signs and symptoms of Guillain-Barre syndrome.

Image

Question 9 Image from http://www.indianradiologist.com/neuroradiology39.htm. Dr Santosh Rai, Consultant Radiologist, Manipal Hospital, Mangalore

Question 27 Image from Intracranial Hemorrhage In Children Radiology Cases in Pediatric Emergency Medicine, Volume 5, Case 7. Lynette L. Young, MD, Kapiolani Medical Center For Women And Children, University of Hawaii John A. Burns School of Medicine https://www.hawaii.edu/medicine/pediatrics/pemxray/v5c07.html

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Pediatric Gynecology

11

Ameer Hassoun

Question 1

A 13-year-old girl was brought by EMS for a fainting episode at school that began with feeling dizzy. She denies sexual activity or past medical conditions. She is currently menstruating and described her periods as irregular and prolonged. On arrival to the emergency department, she appeared alert but pale and diaphoretic. Vital signs are as follows: heart rate 120 beats/minute, respiratory rate 20 breaths/minute, blood pressure 100/60 mm Hg, and oxygen saturation 99% on room air. Pelvic examination revealed visible clots. The rest of her medical examination was unremarkable. Fluid bolus is initiated and laboratory evaluation reveals glucose of 69 mg/dl and hemoglobin of 8 g/dl with normal WBC and platelet counts. Of the following what is the next best step in managing this patient:

A. Initiate oral contraceptive pills
B. Obtain endocrinologist consult
C. Urine ®-HCG
D. Initiate packed red blood cell infusion
E. Emergent pelvic ultrasound

Correct Answer: C

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The patient described in this scenario is experiencing abnormal (dysfunctional) uterine bleeding (AUB) with signs and symptoms of compensated shock. It occurs due to abnormal pituitary hormonal stimulation of the ovary, abnormal ovarian hormone production, or abnormal response of the endometrium to normal hormonal stimulation. It is defined as abnormal uterine bleeding in the absence of organic disease.

All patients of reproductive age presenting with abnormal uterine bleeding should receive initial evaluation for pregnancy. The most common cause of abnormal uterine bleeding is an anovulation. It occurs in postpubescent girls due to immaturity of hypothalamic function. It is characterized by irregular intervals of alternating heavy and light flow. The ovulatory DUB is characterized by regular intervals of increased menstrual flow.

The American College of Obstetricians and Gynecologists recommends pregnancy testing on all adolescents presenting with abnormal uterine bleeding regardless of their sexual history. The differential diagnosis is broad. Patients with severe bleeding are at a 20–30% increased risk of having a concomitant coagulopathy, most commonly Von Willebrand disease. Sexual trauma and sexually transmitted diseases should be considered in the initial evaluation. Patients should be evaluated for signs and symptoms of polycystic ovary syndrome (acne, hirsutism, and obesity)

M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_11

and thyroid abnormalities (TSH level). Patients with negative pregnancy testing and normal platelet count, but experiencing anemia (Hb < 10 g/dL) or severe bleeding, should be further evaluated for coagulopathy and considered for inpatient care. Other indications for hospital admission include continued heavy bleeding despite appropriate treatment. Hormonal therapy with combined oral contraceptives is the mainstay of therapy in most patients and should only be instituted after excluding pregnancy. Iron supplementation is also indicated for patients with anemia. Patients with mild bleeding may benefit from nonsteroidal anti-inflammatory drugs (NSAIDs) as increased levels of prostaglandin E2 and F2α in the endometrium occurs in women with heavy menstrual bleeding.

Take-Home Message

Pregnancy testing is recommended for adolescents presenting with abnormal uterine bleeding regardless of their sexual history.

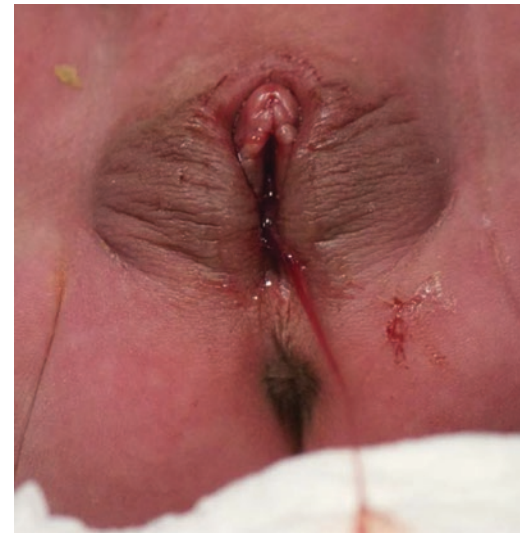
Combined oral contraceptives is the mainstay of therapy in most cases. NSAIDs are helpful in mild cases.

ABP Content Specification

- Know the etiology and understand the pathophysiology of dysfunctional uterine bleeding.
- Recognize the signs and symptoms and complications of dysfunctional uterine bleeding.
- Know the indications for and interpret results of ancillary studies in dysfunctional uterine bleeding.
- Plan the management of acute dysfunctional uterine bleeding.

Question 2

A terrified mother brings her 1-week-old girl for evaluation after noticing blood in the baby's diaper. The mother reports no other symptoms, as the baby was well when her primary care physician last saw her. She is feeding well and has regained her birth weight. Physical examination reveals a well-hydrated, alert baby, with a strong suck and flat anterior fontanel. The abdomen is soft, not tender, and the genital examination is shown. The remainder of the physical examination is within normal limits.



All of the following statements about this condition are correct, *EXCEPT:*

A. Further workup with urinalysis is indicated for this infant.
B. Maternal hormonal withdrawal is responsible for >90% of cases.
C. Bleeding duration of more than 1 week requires further evaluation.
D. Bilateral breast enlargement is common.
E. No treatment is required.

Correct Answer: A

Physiologic endometrial bleeding is the most common cause for neonatal vaginal bleeding in the first few weeks of life. More than 90% of infants with vaginal bleeding may experience this condition. High levels of placental estrogen stimulate growth of both the uterine endometrium and breast bud tissue. This hormonal stimulation wanes after birth leading some infants to experience endometrial sloughing with vaginal bleeding. The bleeding spontaneously resolves and the condition requires no treatment except

parental reassurance. This condition is diagnosed clinically and requires no further testing unless the bleeding persists for more than 1 week.

Take-Home Message
Vaginal bleeding in neonatal girls is common and is due to maternal estrogen withdrawal.

ABP Content Specification
- Differentiate by age the etiology and understand the pathophysiology of vaginal bleeding.

Question 3

A 13-year-old girl presents with severe abdominal pain for the past 2 hours and one episode of vomiting. She denies fever, cough, shortness of breath, ingestion of medications, vaginal bleeding, sexual activity, or suicidal ideation. There is no history of exposure to sick contacts with similar symptoms, eating something out of the ordinary, or change in urinary habits. She had the onset of menarche 8 months prior to this visit and has experienced irregular menstruation since then. She has had two similar episodes in the past that usually occur around the time of her menses. Vital signs are the following: temperature 98.6 °F, heart rate 100 beats/minute, respiratory rate 20 breaths/minute, and blood pressure 100/65 mm Hg. She is an alert active girl who is crying due to pain. The abdomen is soft, without tenderness, rebound, or guarding. All of the following are potentially indicated in the management of this patient *EXCEPT*:

A. Pregnancy testing
B. Urinalysis
C. NSAIDS
D. Bimanual pelvic examination
E. Abdominal ultrasound

Correct Answer: D

The patient in this question is experiencing severe abdominal pain with a clinical picture suggestive of primary dysmenorrhea. It is characterized by the absence of any specific pelvic pathologic condition. Secondary dysmenorrhea occurs due to underlying condition such as anatomic abnormality or infection such as pelvic inflammatory disease. However, endometriosis is the most common cause of secondary dysmenorrhea in adolescents.

The painful menstrual cramps are the most common menstrual complaint in adolescents. The onset of this cramping abdominal pain is within 12 months of menarche. Patients classically experience pain within several hours before or at the time of menstruation, which may be accompanied by nausea, vomiting, diarrhea, headache, backache, thigh pain, or bloating. Patients presenting with classical symptoms and signs require only history and physical examination without the need for pelvic or laboratory evaluation. Patients presenting with severe pain require further evaluation with pregnancy testing (even without a history of sexual activity), urinalysis, recto-abdominal examination (to detect pelvic masses), and pelvic ultrasound to exclude other pathologies (e.g., ovarian torsion). Pain control with nonsteroidal anti-inflammatory drugs (ibuprofen, naproxen, mefenamic acid) is the initial line of treatment, as it reduces the level of prostaglandin F2α (which increases myometrial tone and contractility). NSAIDs are most effective when they are started 1–2 days prior to onset of menstruation and should be tried for at least three menstrual periods. Other treatment modalities include oral contraceptive pills that should be offered if treatment with NSAIDs is not effective.

Take-Home Message
Adolescents presenting with abdominal pain during the initial cycles of menstruation do not need extensive laboratory or imaging evaluation as this is frequently due to primary dysmenorrhea.

ABP Content Specification
- Recognize the signs and symptoms and complications of dysmenorrhea.
- Know the indications for and interpret results of ancillary studies in patients with dysmenorrhea.
- Plan the management of acute dysmenorrhea.

Question 4

A 17-year-old girl presents to the emergency department with a 1-day history of sudden onset of worsening lower abdominal pain. She denies nausea, vomiting, diarrhea, or constipation. She is sexually active with multiple partners and has a history of Chlamydia infections. On arrival to the ED, she notices scant vaginal bleeding and the nurse hands you a paper with her vital signs: heart rate 92 beats/minute, respiratory rate 18 breaths/minute, blood pressure 110/60 mmHg, and temperature 99.5°F. Physical examination shows an alert, active teen. Her abdominal examination reveals tenderness at the right lower quadrant and suprapubic area. Pelvic examination reveals a right-sided adnexal tenderness and a small amount of bloody discharge coming from the cervical os. You have placed a large-bore IV and sent basic labs, which revealed normal values and a positive urine pregnancy test. Pelvic ultrasound reveals a 4-cm right adnexal mass. After consultation with gynecologists, the best treatment option for this patient is:

A. Methotrexate
B. Emergent laparotomy
C. Admission to the hospital for observation
D. Urgent laparoscopic linear salpingostomy
E. Discharge the patient with next-day follow-up

Correct Answer: D

This girl is experiencing symptoms, signs, and findings consistent with ectopic pregnancy, a life-threatening cause of abdominal pain and vaginal bleeding in adolescents. Up to 12% of adolescent pregnancies are ectopic, carrying the risk of rupture, the leading cause of morbidity and mortality during the first trimester. Risk factors for ectopic pregnancy include intrauterine device, tubal surgery, pelvic inflammatory disease, in utero exposure to diethylstilbestrol, *Chlamydia trachomatis* infections, and cigarette smoking. All teenage girls presenting with pelvic pain, amenorrhea, or vaginal bleeding must be evaluated for pregnancy status even without a history of sexual activity. Patients with unstable hemodynamic status (ruptured ectopic pregnancy) require emergent laparoscopic surgery or laparotomy with ongoing fluid resuscitation. A patient deemed to have stable hemodynamic status could be managed expectantly, medically, or surgically. Pelvic ultrasound is a valuable tool in identifying adnexal masses. If a pelvic ultrasound is equivocal, it is essential to evaluate patients with suspected ectopic pregnancy with serum beta-hCG level, complete blood count, liver function test, blood urea nitrogen, creatinine, and blood type and screen. Ectopic pregnancy is more likely when serum beta-hCG is higher than the discriminatory zone (1500 mIU/ml) and intrauterine pregnancy cannot be visualized on transvaginal ultrasound. Expectant management is indicated for cases with serum beta-hCG < 1000 mIU/ml with progressively decreasing levels and an adnexal mass < 3 cm on ultrasound with absence of fetal heartbeat. Treatment with methotrexate has shown to be effective in some cases. Close attention should be paid to associated medical conditions (immunodeficiency, breastfeeding, kidney disease, liver disease, active pulmonary disease, blood or bone marrow abnormalities, and peptic ulcer disease) that preclude methotrexate use. Finally, laparoscopic linear salpingostomy is the procedure of choice to manage ectopic pregnancy when other modalities are not appropriate or have failed.

Take-Home Message

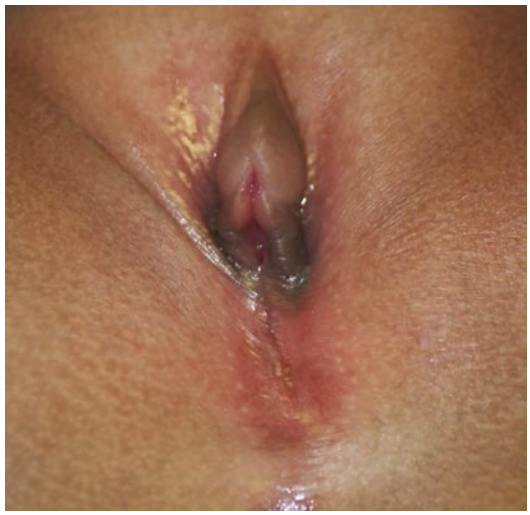
There should be a high index of suspicion to detect ectopic pregnancy among teens presenting with vaginal bleeding and abdominal pain.

ABP Content Specification

- Recognize the signs, symptoms, and complications of ectopic pregnancy.
- Know the indications for and interpret results of ancillary studies in patients with ectopic pregnancies.
- Provide management for a patient with an ectopic pregnancy and the potential complications of this condition.
- Identify the risk factors for ectopic pregnancy.

Question 5

A 4-month-old girl is brought by EMS for evaluation of decreased activity. Mother reports that she was in her usual state of health until today but is now refusing to feed and has become less active. The infant was born at 28 weeks of gestation, had assisted ventilation for 1 week after birth in the neonatal intensive care unit, and was discharged from the hospital 1 week prior to this visit. Vital signs on arrival are: temperature 100.6 °F, heart rate 160 beats/minute, respiratory rate 50 breaths/minute, and oxygen saturation 96% on room air. The patient is sleepy yet arousable with weak cry. She has a flat anterior fontanel and rhinorrhea, with normal chest and abdominal examinations. Genital examination is shown.



You have established intravenous access, ordered complete blood count, blood culture, nasal aspirate viral culture, and chest X-ray. What is the next best step in the management of this infant?

A. Urethral catheterization after manual separation
B. Suprapubic bladder aspiration
C. Urine bag placement
D. Admission to the hospital for observation
E. Topical estrogen cream

Correct Answer: B

The child in the image has labial adhesion. Labial adhesion is a common gynecologic condition affecting 2–7% of prepubertal girls between 3 months and 6 years of age. This occurs predominantly in the first 2 years of life. The hypoestrogenism may play a role in adhesion of the labia minora. It can be easily diagnosed with inspection of the genital area which shows fused labia with a pathognomonic thin narrow vertical raphe. Fusion of the labia minora starts at the posterior fourchette and progresses toward the clitoris. The first line of therapy for this condition is reassurance if asymptomatic, as about 80% of cases resolve spontaneously. Many physicians offer estrogen cream application for several weeks to treat symptomatic patients (local irritation, urinary symptoms, or infection). Prolonged use of topical estrogen cream may be associated with reversible complications such as breast budding, vulvar pigmentation, and vaginal bleeding. Other treatment modalities include betamethasone cream (0.05%), which has shown similar results to estrogen. Girls with urinary obstructive symptoms should be evaluated with urinalysis and urine culture to rule out a urinary tract infection. When urethral catheterization is not possible due to labial adhesions, suprapubic bladder aspiration is indicated to obtain the needed urine culture. Manual separation should not be attempted, as it is a painful procedure with high recurrence rate.

Adhesions may rarely be associated with sexual abuse; however, additional physical findings are often present in children with sexual abuse. A possibility of sexual abuse should be considered in children with new-onset labial adhesions beyond 6 years of age.

Take-Home Message

Labial fusion is common in early infancy and can predispose to UTI. In general, no specific

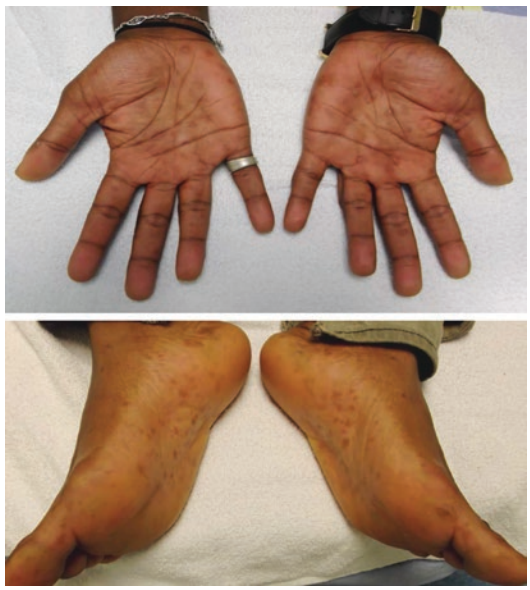
treatment is required unless the labial adhesion causes significant symptoms.

ABP Content Specification

- Know how to evaluate and manage labial adhesions.
- Know the indications and contraindications for suprapubic bladder aspiration.

Question 6

An 18-year-old male presents to the emergency department with a 3-day history of generalized rash. The rash is associated with fatigue, eye redness, pharyngitis, and headache. He denies any medication use or travel history. He is sexually active with multiple partners of both genders. Vital signs on arrival are as follows: temperature 102.2 °F (39 °C), heart rate 110 beats/minute, respiratory rate 18 breaths/minute, and blood pressure 110/70 mmHg. The patient is alert and oriented with disseminated maculopapular rash as shown in the figure. Right eye examination is significant for eye redness and a small hypopyon. The patient has palpable axillary and inguinal lymph nodes. The remainder of the physical examination is unremarkable.



All the following are indicated in the management of this patient *EXCEPT*:

A. HIV testing
B. FTA-ABS
C. CSF fluid analysis
D. Ophthalmologic consultation
E. Single dose of IM penicillin G benzathine

Correct Answer: E

This patient presents with classical signs and symptoms of secondary syphilis. Although ocular involvement can occur in syphilis, it is observed in late syphilis. The presence of ocular involvement should also raise the possibility of HIV coinfection. Infection with syphilis is on the rise in the United States especially in men having sex with men. HIV coinfection is not uncommon.

The initial presentation (primary syphilis) characterized by a firm painless ulcer (chancre) at the site of acquisition can persist for several weeks. Secondary syphilis can present several weeks or months after the initial infection with disseminated maculopapular rash that involves the palms and soles. Other symptoms may include fever, lymphadenopathy, pharyngitis, and headache. Late (tertiary) syphilis is uncommon in children as it takes many years before manifesting with neurologic and cardiac findings (aortic aneurysm) and gummas. This sequence of events is disrupted when patients are immunocompromised. Neurologic involvement has been reported with secondary stage, and almost 31% of syphilitic uveitis occurs in primary and secondary stage syphilis.

The clinical diagnosis is usually supported with nontreponemal antibodies (RPR or Venereal Disease Research Laboratory [VDRL]) and treponemal antibodies (*T. pallidum* passive particle agglutination assay (TPPA) or fluorescent treponemal antibody absorbed test [FTA-ABS]). The use of one type of serologic test is insufficient. Darkfield examination is the definitive diagnostic test for primary syphilis. A lumbar puncture and cerebrospinal fluid (CSF) analysis should be performed

in patients with ocular or neurologic (such as headache, hearing loss, cranial neuropathies) signs/symptoms. Ophthalmologic involvement as in this patient is managed and treated as neurosyphilis. Penicillin G is the treatment of choice for all stages of syphilis. Penicillin G benzathine 2.4 g IM is used to treat primary, secondary, and early latent syphilis. Treatment of ocular or neurosyphilis is with aqueous crystalline penicillin G 18–24 million units per day administered as 3–4 million units intravenously every 4h or by continuous infusion for 10–14 days. Alternative regimens suggested for penicillin allergic individuals include doxycycline, tetracycline, or ceftriaxone with doses and periods tailored according to presentation.

Take-Home Message

Syphilis is increasing in prevalence and can present with systemic symptoms.

Syphilis should be included in the differential diagnosis in all patients with rashes, particularly if they are sexually active.

Patients diagnosed with syphilis should be screened for HIV.

ABP Content Specification

- Recognize signs and symptoms of syphilis.
- Plan the management of acute and chronic syphilis.
- Recognize and interpret relevant laboratory studies in acute and chronic syphilis.

Question 7

A 15-year-old girl presents to the emergency department with history of abdominal pain for the past 2 days. She denies nausea, vomiting, fever, or diarrhea. The pain was described as dull in nature and slowly getting worse, which prompted the emergency department visit. Her last menstrual period was 10 days ago. She denies sick contacts, medication use, or similar episodes in the past. She is sexually active with one male partner for the past 3 months and uses oral contraceptive pills as the method of choice in contraception. Vital signs are within normal limits. Abdominal examination reveals suprapubic tenderness with rebound tenderness. Vaginal examination is significant for vaginal discharge and cervical motion tenderness. Urine pregnancy test is negative and pelvic ultrasound is normal. All of the following findings can support the diagnosis *EXCEPT*:

A. Positive urinalysis for leukocyte esterase
B. Fever
C. Elevated ESR
D. Elevated C-reactive protein
E. WBC seen on vaginal swab saline microscopy

Correct Answer: A

Pelvic inflammatory disease (PID) refers to a spectrum of disorders that affect the upper reproductive tract. Many organisms have been implicated in the pathogenesis of this disease. While it has been classically associated with *C. trachomatis* and *N. gonorrhoeae* infections, up to 70% of female patients with mild to moderate disease have non-*C trachomatis*/non-*N. gonorrhoeae* PID. Other organisms include *Mycoplasma genitalium*, *Ureaplasma urealyticum*, genital flora, and enteric organisms. Diagnosis is usually made with a history of lower abdominal pain in a sexually active female with no other cause identified and one of the following physical findings:

1. Uterine tenderness OR
2. Cervical motion tenderness OR
3. Adnexal tenderness

Centers for Disease Control also suggested some supportive findings that include:

1. Fever (temperature > 100.9 °F or 38.3 °C)
2. Abnormal vaginal or cervical discharge
3. White blood cell on saline microscopy
4. Elevated sedimentation rate *or* C-reactive protein
5. Known positivity for *C. trachomatis* and *N. gonorrhoeae* infections

Other important laboratory studies to consider are those for pregnancy, HIV, and syphilis testing. Wet KOH prep along with swabs or urine test for *C. trachomatis* and *N. gonorrhoeae* is also important. Urine should be evaluated with analysis and culture to identify any concomitant urinary tract infection. More specific testing might include transvaginal Doppler and ultrasonography or MRI to detect fluid-filled fallopian tubes, free fluid in the abdomen, or tubo-ovarian abscesses. Laparoscopy and endometrial biopsy can help detect inflammatory tissue changes.

The majority of patients who experience mild to moderate PID might benefit from oral outpatient treatment with a single dose of 250 mg IM ceftriaxone and a 14-day course of 100 mg twice daily doxycycline. Alternative inpatient treatment (cefoxitin 2 g IV every 6 hours or ampicillin/sulbactam 3 g IV every 6 hours, in conjunction with a 14-day course of 100 mg of oral doxycycline twice daily for 14 days) is recommended for patients with severe disease, systemic symptoms (such as fever, nausea, and vomiting), tubo-ovarian abscess, pregnancy, surgical emergency, or failed or unable to tolerate an oral regimen.

Take-Home Message

PID is a clinical diagnosis and a low threshold for empiric treatment based on minimal criteria is usually recommended.

ABP Content Specification

- Know the etiology of pelvic inflammatory disease.
- Recognize the signs and symptoms of pelvic inflammatory disease.
- Plan the management of pelvic inflammatory disease.

Question 8

A 17-year-old girl presents with vaginal bleeding after a sexual encounter earlier in the day. Her STD and PAP smear results a month ago were within normal limits. She has had two sexual partners in the past 2 months, and today after unprotected vaginal intercourse, she noticed a small amount of blood in her underwear. Her last menstrual period was a week prior. She denies abdominal pain, vaginal discharge, fever, nausea, vomiting, or change in urinary or bowel habits. She also denies medication or other drug use, but admits to using marijuana occasionally. Vital signs and physical examination are within normal limits, except for speculum vaginal examination, which reveals vaginal discharge and a friable cervical os. She denies suprapubic, cervical motion, or adnexal tenderness on bimanual vaginal examination. Pregnancy test is negative and pelvic ultrasound shows no abnormality. All of the following are likely cause of this patient's postcoital bleeding *EXCEPT*:

A. *N. gonorrhoeae*
B. Herpes simplex virus
C. *Candida albicans*
D. *Trichomonas vaginalis*
E. Human papilloma virus

Correct Answer: E

The patient described in this clinical vignette is experiencing postcoital bleeding and vaginal discharge and has a friable cervical os. These findings are consistent with the diagnosis of cervicitis, an infection of the lower genital tract. Many causative organisms have been implicated in this disease, including *N. gonorrhoeae*, *C. trachomatis*, *Trichomonas vaginalis*, *Candida albicans*, and herpes simplex virus. Symptoms of vaginal discharge, postcoital bleeding, and postcoital pain are suggestive of this condition. Patients usually lack cervical motion and pelvic and adnexal tenderness. In 2010, the Centers for Disease Control and Prevention updated their existing guidelines for treating uncomplicated cervicitis. A single oral dose of azithromycin (1 g) should be an adequate treatment for Chlamydia cervicitis. Alternative treatment with 100 mg doxycycline twice a day for 7 days is also

acceptable. Patients living in regions where gonorrhea is prevalent should also receive one dose of 250 mg IM ceftriaxone. Patients presenting with recurrent or resistant infection should be evaluated for possible reinfection. Sexual partners of patients with cervicitis should be treated as well. Patients suspected to have Trichomonas vaginalis should be treated with a 2-g single oral dose of metronidazole. Human papilloma virus (HPV) can lead to genital warts and cervical cancer, an unlikely cause for this patient's symptoms, especially with a recent normal Pap smear result prior to this visit. Treatment for Candida vaginitis is most appropriately achieved with oral fluconazole, butoconazole, clotrimazole, or miconazole.

Take-Home Message

Postcoital bleeding among teenage girls is often due to cervicitis.

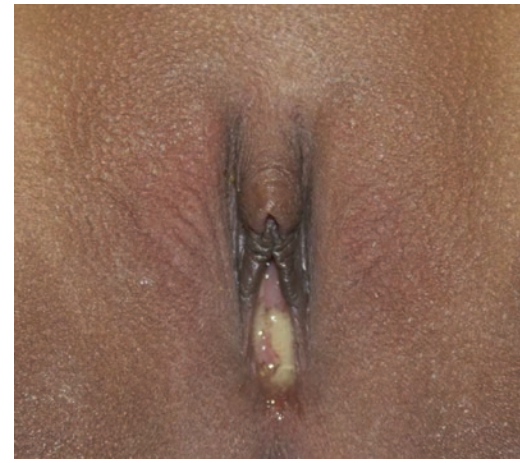
Chlamydia trachomatis infection is a most frequently reported sexually transmitted infection which can coexist with gonorrhea infections.

ABP Content Specification

- Know the etiology of cervicitis.
- Recognize the signs and symptoms of cervicitis.
- Plan the management of cervicitis.

Question 9

A mother brings her 3-year-old girl to the emergency department after she noticed yellowish staining in the underwear. There are no other associated symptoms. She is toilet trained and having normal urinary and bowel habits. The mother is separated from the father and they share legal custody of the child. Vital signs in the emergency department are within normal. Complete physical examination shows no injuries or abnormalities. Knee-to-chest vaginal examination is shown in this image.



All of the following are indicated in the management of this patient EXCEPT?

A. Sitz baths
B. Culture for gonorrhea
C. Oral cephalexin
D. Bacterial culture
E. Sexual abuse evaluation

Correct Answer: C

Vaginal discharge in prepubertal girls is a diagnostic challenge for pediatric emergency physicians. It is unusual for girls at this age group to experience vaginal discharge, and a closer look is indicated to identify the possible cause. While vulvovaginitis is the most common cause of vaginal discharge in prepubertal girls, purulent vaginal discharge is concerning for sexually transmitted diseases, specifically gonorrhea. Patients with vulvovaginitis usually experience scant clear vaginal discharge most commonly due to local irritation (soaps, poor hygiene, and tight-fitting clothing) or bacterial infections (group A beta-hemolytic streptococcus, *Haemophilus influenzae*, *Escherichia coli*). Salmonella and Shigella species are also implicated, but they usually present with bloody vaginitis. Foreign body can lead to a foul smelling, bloody, or brownish vaginal discharge in

prepubertal girls. Girls with retained vaginal foreign body have a higher rate of being sexually abused. Careful questioning about this possibility should be incorporated in the management. While sitz baths and local hygiene are indicated in all prepubertal girls with vaginal discharge, patients with persistent symptoms should be evaluated with cultures. Antibiotics should not be initiated without identification of the organism involved and follow-up in the ED or with PCP should be ensured. Urine DNA or RNA amplification for Chlamydia might be indicated for patients with negative cultures and persistent discharge. Patients with positive results for gonorrhea (like the patient in the case described) or Chlamydia should be evaluated by a child abuse specialist and reported to child protective services.

Take-Home Message
Have a high index of suspicion for sexual abuse among prepubertal children presenting with purulent vaginal discharge.

ABP Content Specification
- Differentiate by age the etiology and understand the pathophysiology of vaginal discharge.
- Plan the diagnostic evaluation and initial intervention for patients with vaginal discharge.

Question 10

A 17-year-old girl presents to the emergency department with joint pains for the past 10 days. Initially, the right knee was affected; however, the pain resolved with NSAID use. Two days prior to the visit she developed right wrist pain that prevented her from doing her homework. She also noted that prior to the appearance of these symptoms, she had an episode of fever and fatigue that resolved spontaneously. Her last menstrual period was 3 weeks ago. She is sexually active with one partner. She denies any other associated symptoms, past medical conditions, family history of similar condition, or recreational drug or medication use. Physical examination reveals a swollen, tender right wrist. She also has three pustules on her right ankle. A swollen left index finger is noted, with tenderness along the tendon during active movement. What is the most likely diagnosis?

A. Gonococcal infection
B. Rheumatoid arthritis
C. Disseminated Chlamydia infection
D. Disseminated Gardnerella infection
E. Dermatomyositis

Correct Answer: A

Gonorrheal infection is the second most common reportable bacterial infection (after Chlamydia) in the United States. Hematogenous dissemination occurs in 1–3% of patients with gonococcal infections. It can disseminate from any mucosal site causing a disseminated gonococcal infection.

The common manifestations are asymmetric arthralgia, petechial or pustular acral skin lesions, tenosynovitis, and suppurative arthritis. The early phase of disseminated gonorrhea usually lasts 2–5 days and involves fever, chills, and polyarthralgia. The characteristic skin lesions start as small erythematous papules or petechiae and evolve to form pustules surrounded by red halos. If not treated, the disease may progress to a second phase, characterized by monoarticular arthritis effusion or tenosynovitis. Host factors may play a role, especially complement deficiencies. Up to 13% of patients with disseminated gonococcal infection have a complement deficiency. Other risk factors include current or recent pregnancy, recent menstruation, and systemic lupus erythematosus.

Diagnosis is usually made by history, clinical examination, and supportive laboratory findings. Synovial fluid analysis usually reveals a leukocyte count around 50,000 cells/mm^3, low glucose level, and an elevated lactate dehydrogenase level in patients with purulent arthritis. Blood

cultures should also be obtained to differentiate this condition from other disseminated bacterial infections (*N. meningitidis* or *Staphylococcus aureus)*. Synovial, skin, urethral or cervical, rectal, and pharyngeal specimens should be obtained in all patients with suspected disseminated gonorrhea. These samples should be submitted for nucleic acid amplification testing (NAAT) or culture for *N. gonorrhoeae*. Testing for other sexually transmitted diseases (HIV, syphilis, hepatitis B) and connective tissue disorders (rheumatic fever, systemic lupus, complement deficiencies) would be helpful in identifying similar or associated conditions. Inpatient treatment with 1 g parenteral ceftriaxone is recommended for these patients. This treatment should continue for 24–48 hours after improvement begins, after which outpatient therapy with cefixime 400 mg orally twice daily should be instituted for 1 week.

Take-Home Message

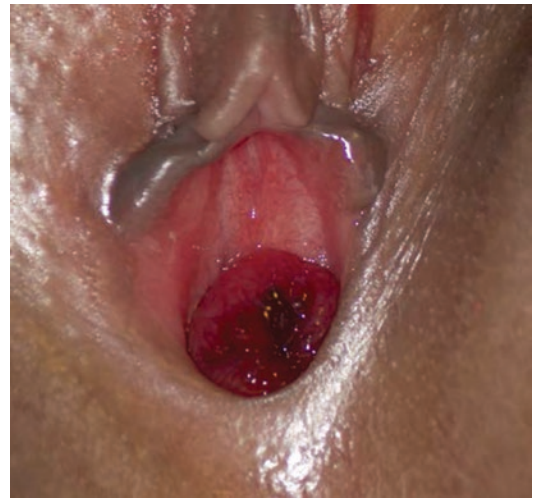
Disseminated gonococcal infections classically present with either a suppurative arthritis or a triad of tenosynovitis, dermatitis, and migratory polyarthralgia.

ABP Content Specification

- Recognize the signs and symptoms of gonorrhea.
- Recognize the complications of gonorrhea.
- Recognize and interpret relevant laboratory studies in acute gonorrhea.

Question 11

A worried mother brought her 5-year-old girl with vaginal bleeding. The mother is terrified that someone might have touched the girl inappropriately. She denies any fever, body odor, other vaginal discharge, and breast or body hair growth. She is doing well at school and the parents are the caretakers when she is not at school. General physical examination is within normal limits; vaginal knee to chest position examination is displayed.



All of the following can be contributing factors to this condition *EXCEPT*:

A. Estrogen deficiency
B. Coughing
C. Seizure
D. Constipation
E. Vulvovaginitis

Correct Answer: E

The prepubertal child in this question presents with vaginal spotting and a doughnut-shaped mass at the introitus; these findings are consistent with urethral prolapse.

This is usually seen in African-American girls between the ages of 5 and 8 years. This may be mistaken for sexual abuse particularly when the presenting complaint is vaginal bleeding or the prolapse is hemorrhagic which may be confused with acute trauma to the hymen.

Many factors can contribute to weakness in the supporting tissues of the urethra. It has been epidemiologically linked to estrogen deficiency. It commonly occurs in two groups: postmenopausal women and prepubertal girls. Other factors related to an increase in intra-abdominal pressure such as coughing, seizure, and lifting heavy objects may play a role. In children, it is often due to Valsalva voiding or constipation.

The most common initial presentation is bleeding from the friable mucosa resulting in blood spotting on the underwear. Clinically, it is easily recognized as a beefy red doughnut-shaped mass with the urethral meatus at the center. The magnification may improve the visualization of the urethral orifice. The diagnosis can be confirmed by passing a urethral catheter. Further radiographic evaluation is not needed if the diagnosis is confirmed by passing a urethral catheter.

Patients with large prolapse may progress to urinary retention and pain with voiding. Estrogen cream for 4–6 weeks and sitz baths are the first line of treatment. Manual reduction should not be attempted. Surgical treatment is the definitive modality to correct the condition in children who experience failure of conservative treatment, recurrence, and those with large necrotic prolapses or for those who are postpubertal. Surgical techniques include cauterization, ligation around a Foley catheter, and complete circumferential excision.

Take-Home Message

The urethral prolapse is an important cause of genitourinary bleeding in prepubertal girls and should be differentiated with sexual abuse.

ABP Content Specification

- Know how to evaluate and manage urethral prolapse.

Question 12

A healthy 13-year-old girl is brought to the emergency department with right lower quadrant and suprapubic abdominal pain and urinary urgency for the past few days. She has been having intermittent abdominal pain almost every month for the past year. She denies nausea, vomiting fever, or diarrhea yet complains of urinary urgency. Her urinary and bowel habits are otherwise within normal. The child has not yet reached menarche, denies having had sex, and has no underlying medical conditions. Physical examination reveals stable vital signs with tenderness in the right lower quadrant and suprapubic area. All of the following are appropriate next steps in the evaluation of this teen *EXCEPT*:

A. Pregnancy test
B. Vaginal examination
C. Pelvic ultrasound
D. Pelvic examination
E. Urinalysis

Correct A.nswer: D

Lower abdominal pain is a diagnostic challenge faced by many pediatric emergency physicians. The history of cyclical abdominal pain in a teenage girl who has not reached menarche should raise the suspicion of undetected lower genital tract abnormalities, such as imperforate hymen and vaginal atresia. Other conditions to suspect include acute appendicitis, pregnancy, urinary tract infection, and pelvic inflammatory disease.

An imperforate hymen presents with pain and a thin, translucent membrane distended by blood or mucus. It is the most common cause of congenital vaginal outlet obstruction.

It may be missed on the newborn examination because of the redundancy of hymenal fold. If imperforate hymen is not recognized, the patient usually develops hematocolpos in late puberty. This presents as a red or purplish bulge at the vaginal introitus. A palpable abdominal mass or perineal bulging with a translucent bluish-tinged hymen is suggestive of the diagnosis. A pelvic ultrasound shows a fluid- and blood-filled uterus and vagina which confirm the diagnosis of hydrometrocolpos. Treatment includes incision of the membrane to allow drainage, followed by excision of redundant tissue.

Take-Home Message

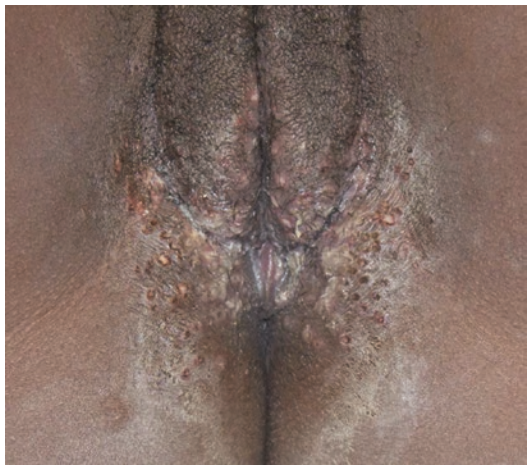
Cyclical abdominal pain in a teenager without menarche should raise the suspicion of imperforate hymen.

ABP Content Specification

- Know how to evaluate and manage complications of imperforate hymen.

Question 13

A 17-year-old teen presents to the emergency department with vaginal pain for the past 2 days. Five days prior, she had unprotected sexual intercourse with her new boyfriend. She denies fever, abdominal pain, irregular cycle, or similar symptoms in the past. Vital signs and physical examination are unremarkable except for the genital examination, which is displayed in the figure.



Which of the following is the correct management for this condition?

A. Topical acyclovir until lesions resolve
B. Intravenous acyclovir for 21 days
C. Oral 400 mg acyclovir three times daily for 5 days
D. Oral 400 mg acyclovir three times daily for 10 days
E. Observation and pain control

Correct Answer: D

The patient described is experiencing an initial episode of genital herpes. This condition is most commonly associated with herpes simplex virus 2 (HSV 2) but recently herpes simplex virus 1 also has been implicated. Classically, the virus produces grouped vesicles on an erythematous base. These vesicles and the skin around it erode leading to painful ulcers as displayed in the figure. Infection with genital herpes is a lifelong condition, and patients may experience reactivation or complications (urinary retention, psychological morbidity, and aseptic meningitis). Diagnosis can be made clinically on the basis of the classical presentation of these painful ulcers. Many tests are available to support the clinical diagnosis or to identify asymptomatic infections. Viral culture from a sample obtained from an unroofed vesicle is the gold standard for diagnosis. It requires a sample taken vigorously from an unroofed vesicle. The sensitivity of viral culture decreases as lesions heal. PCR assays for HSV DNA are more sensitive and are a widely accepted alternative to culture. Serologic assays are commercially available to detect specific antibodies against HSV 1 and 2. These tests are used in individuals with healing lesions, recurrent lesions, or those who are asymptomatic. Treatment with three doses of 400 mg of acyclovir daily for 7–10 days is indicated for the initial presentation of genital herpes. A shorter course (5 days) is indicated for patients with recurrent episodes. A 21-day intravenous acyclovir course is used to treat herpes meningitis or encephalitis, but not genitalis.

Take-Home Message

HSV is a common genital infection and best diagnosed with PCR assay.

Oral acyclovir is the treatment of choice for HSV genital infections.

ABP Content Specification

- Recognize the signs and symptoms of herpes genitalis.
- Plan the management studies of herpes genitalis.

Question 14

A pregnant 16-year-old teenager presents to the emergency department with a concern for a small painless growth near her vaginal area. She denies any vaginal discharge or bleeding. Physical examination is unremarkable except for this small pedunculated growth at the vaginal

introitus. Which of the following is correct in the management of this patient with genital warts?

A. Imiquimod 5% cream
B. Sinecatechins 15% ointment
C. HPV vaccine
D. Podofilox 0.5% solution
E. Trichloroacetic acid 80–90%

Correct Answer: E

More than five million new cases of genital warts are diagnosed each year in the United States. Human papilloma virus (HPV) 6 or 11 causes 90% of these warts. The condition is usually asymptomatic, but depending on size or location, some lesions can be pruritic or painful. Managing pregnant patients with genital warts can be challenging, since many over-the-counter medications are contraindicated in pregnancy (imiquimod, sinecatechins, podofilox). HPV vaccine is also not recommended during pregnancy. Patients found to be pregnant after initiating the vaccination series should not receive the remainder of the series until completion of pregnancy. While genital warts can resolve spontaneously without treatment, these lesions can proliferate and become friable during pregnancy. Trichloroacetic acid can be used safely in pregnant women and repeated weekly if necessary.

Take-Home Message

HPV 6 and 11 accounts for majority of genital warts in the United States.

Trichloroacetic acid is safe to use for warts during pregnancy.

ABP Content Specification

- Plan the management of genital warts.

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Infectious Diseases

12

Anna McFarlin and Tricia Swan

Question 1

A 7-year-old boy is brought by paramedics for headache, fever, stiff neck, and difficulty speaking due to inability to open his mouth. He lives on a farm with his parents and siblings. He is unimmunized due to parental preference. His initial vital signs on arrival are as follows: temperature 99.5 F, heart rate 120 beats/minute, respiratory rate 24 breaths/minute, BP 139/89 mm Hg, and oxygen saturations 100% on room air. He is ill appearing. He is unable to touch his chin to his chest or open his mouth more than 2 cm. There is no tenderness, facial swelling, or erythema of the cheeks or jaw. His extremities are hypertonic, and he exhibits clonus of the ankles bilaterally. There is a small puncture wound on his right hand with 0.5 cm of surrounding erythema and mild swelling without drainage. The mother reports that he sustained the injury 5 days ago from a barbed wire fence used for their cattle pens. After oral acetaminophen administration for his fever, the patient had painful contractions of his facial muscles lasting approximately 3 minutes. The most important next step in treatment in this child would be:

A. Oral diphenhydramine.
B. Administer tetanus immunoglobulin and tetanus toxoid.
C. Intramuscular midazolam.
D. Perform rapid sequence intubation.
E. Intravenous dantrolene.

Correct Answer: B

The child in this vignette is unimmunized and is displaying signs and symptoms consistent with tetanus. The most important next step in the care of this child is to administer tetanus immunoglobulin and tetanus toxoid. Benzodiazepines are effective symptomatic treatment for painful muscle spasms but would not be the most important next step in the treatment of this child. Since he is not currently demonstrating signs or symptoms of impending respiratory failure or airway compromise, intubation would not be necessary now; however, many patients with severe tetanus require mechanical ventilation. All patients with suspected tetanus should undergo wound care and debridement to eradicate spores as well as antibiotic therapy with metronidazole or penicillin G. Diphenhydramine may be used in children with extrapyramidal symptoms or dystonic reactions to

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_12

medications. Intravenous dantrolene is the treatment for muscle rigidity secondary to malignant hyperthermia.

Tetanus is caused by *Clostridium tetani*, an obligate, gram-positive, anaerobic bacillus that produces spores which persist in the environment, particularly soil, for years. The spores germinate in anaerobic conditions such as skin wounds (especially puncture wounds and burns) producing tetanus toxin. Non-immunization and under-immunization are important risk factors in the development of tetanus. It is commonly referred to as "lockjaw" because it causes trismus due to spams of the masseter muscle. The diagnosis of tetanus is based on medical history (including immunization status) and the signs and symptoms of painful muscle spasms and rigidity, usually in response to very minor stimuli such as noise, touch, or administration of oral medication. Difficulty swallowing, restlessness, irritability, tachycardia, and cranial nerve palsies can also be present. Laboratory tests and imaging generally are not helpful for diagnosis. Complications of tetanus include fractures, tendon rupture, laryngospasm, respiratory failure, cardiac dysrhythmias, autonomic instability, hypertensive crisis, and seizures.

Take-Home Message

- Tetanus treatment consists of local wound care, tetanus immunoglobulin, active immunization with a full series of tetanus vaccine, antibiotics, and supportive treatment for muscle spasms and airway management.

ABP Content Specifications

- Know the etiology of tetanus.
- Understand the pathophysiology of tetanus.
- Recognize signs and symptoms of tetanus.
- Recognize life-threatening complications of tetanus.

Question 2

A 2-year-old boy is brought to the emergency department for runny nose, nasal congestion, and dry cough for 3 days. His mother reports that he had a temperature at home of 100.8 °F. On examination, the child has clear rhinorrhea, erythema of the nasal mucosa and posterior oropharynx, and shoddy anterior cervical lymphadenopathy. He is otherwise well appearing and interactive during his examination. The most appropriate therapy would be:

A. Supportive care with antipyretics as needed.
B. Oral diphenhydramine.
C. Amoxicillin for 10 days.
D. Oral dextromethorphan.
E. Prescribe a nasal steroid spray.

Correct Answer: A

Children with the common cold usually present with runny nose, cough, congestion, and sneezing that may or may not be associated with fever. Diagnosis of the common cold is a clinical diagnosis, and supportive care remains the only recommended treatment. There is lack of proven benefit and risk of significant adverse effects for over-the-counter remedies including antihistamines, decongestants, antitussives, and expectorants. Since the common cold is caused by viruses, antibiotics are not recommended unless the child develops a secondary bacterial infection such as pneumonia, otitis media, or sinusitis. Over-the-counter cold or cough medications are not recommended for children under 4 years of age.

Take-Home Message

- The common cold is caused by viruses, and supportive care remains the only recommended therapy.

ABP Content Specifications

- Plan the management of acute nasopharyngitis.

Question 3

An 18-month-old girl is brought in for evaluation for decreased oral intake and fever for one day. Her mother reports she had a temperature at home of 102.7 °F. On examination, the child is drooling and has multiple shallow ulcerations

of her tongue, buccal mucosa, and hard palate as well as erythema of the posterior oropharynx. You note anterior cervical lymphadenopathy. She is making tears during the exam. The most appropriate treatment for this patient is:

A. Intravenous fluid hydration
B. Topical viscous lidocaine
C. Oral nystatin four times daily
D. Oral acyclovir
E. Supportive care with analgesics and encourage cool liquid intake

Correct Answer: E

Acute stomatitis is a general term for an infection of the mouth characterized by vesicular or ulcerative lesions on the tongue, lips, gums, and other oral mucosa. Specific processes are outlined in the table below (Table 12.1). Stomatitis in children is caused by viruses, particularly herpes simplex virus (HSV) and coxsackieviruses. Aphthous ulcers are thought to be secondary to trauma to the oral mucosa rather than a viral etiology. Mucositis is typically due to medication, particularly as a side effect of chemotherapy. Oral acyclovir has been shown to only minimally shorten the disease course in immunocompetent patients with herpetic stomatitis and is not routinely recommended. Due to high risk of overdose and lidocaine toxicity, topical viscous lidocaine is contraindicated in patients who cannot "swish and spit" the drug but can be considered as an appropriate method of analgesia in older children. The mainstay of treatment for acute stomatitis remains supportive care with oral analgesics, encouragement of cool liquid intake or frozen liquids, and a soft diet to maintain hydration until the lesions resolve, typically in 5–7 days. Nystatin is used to treat oral candidiasis which presents with white plaques rather than ulcerations.

Table 12.1 Causes of oral ulcerations

Type	Location	Fever and other symptoms
Herpetic gingivostomatitis	Throughout (buccal, labial, gingiva, hard palate)	Yes HA, pain, malaise, adenopathy
Herpes labialis	Labial	+/−
Hand, foot, mouth disease	Anterior oropharynx (hard palate, tongue, buccal); distal extremities, buttock	Low grade Malaise and cough
Herpangina	Posterior oropharynx (soft palate, tongue, tonsillar pillars, uvula)	Yes Malaise, sore throat, HA
Aphthous ulcers	Mucosal lips	+/−
Mucositis	Extensive	Yes

Take-Home Message

- Supportive care and oral analgesia is the recommended treatment for acute stomatitis in young children.
- Lidocaine is not recommended in young children due to toxicity and adverse effects when swallowed.

ABP Content Specifications

- Plan the management of acute stomatitis.

Question 4

A 16-year-old previously healthy boy presents to the emergency department complaining of severe pain in his mouth and bleeding gums for 3 days. He also complains of "very bad breath." His examination reveals swollen and hyperemic gingivae with a punched-out appearance between the teeth and a gray pseudomembranous substance over portions of the gingivae. There is no active bleeding of his gums. The most appropriate next step for treatment would be:

A. Recommend better oral hygiene care only.
B. Intravenous ampicillin and admission to the hospital.
C. Debridement of necrotic gum tissue, oral rinses with dilute hydrogen peroxide or chlorhexidine, and oral penicillin.
D. Oral acyclovir.
E. Supportive care and referral to a dentist.

Correct Answer: C

The patient has acute necrotizing ulcerative gingivostomatitis (ANUG), also known as trench mouth, primarily involving the interdental and marginal gingiva. It is rare in young children and characteristically seen in adolescents and young adults. ANUG is caused by fusiform bacteria or *Borrelia vincentii*, a spirochete. It is a rapidly progressing disease that requires debridement of the gingiva, oral rinses with dilute hydrogen peroxide or chlorhexidine, and oral antibiotics such as penicillin or metronidazole. Predisposing factors include malnutrition, tobacco exposure, viral infections, stress, sleep deprivation, and an impaired immune response. Future episodes can be avoided with improved oral hygiene and elimination of predisposing factors. Oral acyclovir is used to treat mouth ulcerations caused by herpes simplex viruses and is not appropriate treatment for this child.

Take-Home Message

- ANUG is a rapidly progressive disease with tissue destruction that requires a combination of improved oral hygiene, debridement of necrotic tissue, oral rinses, and oral antibiotic therapy.

ABP Content Specifications

- Plan the management of acute necrotizing ulcerative gingivostomatitis.

Question 5

A 14-year-old boy presents to the emergency department with fever, sore throat, and odynophagia for 2 days. The temperature in the emergency department is 102.6 °F. Parents report that the patient has been more fatigued and has had decreased oral intake today. The patient denies any cough or congestion. On examination, the posterior oropharynx is erythematous with bilateral tonsillar hypertrophy and tonsillar exudates. The uvula is midline. There is tender, shoddy anterior cervical lymphadenopathy bilaterally. The patient does not have any drug allergies. His rapid strep test is positive. His weight is 48 kg. The most appropriate treatment is:

A. A single dose of 600,000 units of intramuscular benzathine penicillin G
B. A single dose of 1.2 million units of intramuscular benzathine penicillin G
C. 80 mg/kg of amoxicillin twice a day for 10 days
D. 2 mg/kg of prednisolone once daily for 5 days
E. 12 mg/kg of azithromycin once daily for 10 days

Correct Answer: B

Due to its efficacy, safety, and narrow spectrum of action, the treatment of choice in patients with group A streptococcal (GAS) pharyngitis is penicillin. In patients greater than 27 kg, 1.2 million units of penicillin G is the recommended dose. Oral amoxicillin is an acceptable therapy for treatment of strep pharyngitis, but the recommended dosing is 50 mg/kg given in a single dose daily, maximum of 1 gram per day; therefore, choice C is not correct. Steroids can be adjunctive in patients with severe symptoms but should not be used without antibiotic therapy. Cephalosporins, macrolides, and clindamycin are acceptable treatment regimens for patients with a penicillin allergy. If azithromycin is used, the recommended duration of treatment is 5 days. Macrolide resistance patterns are as high as 20% in some areas. See Table 12.2 for specific dosing.

Infection is the most common cause of sore throat in children (see Table 12.3). While viruses are the most common infectious agent, pharyngitis can also commonly be caused by bacteria, particularly *Streptococcus pyogenes* or group A streptococcus. The GAS rapid detection tests are highly specific, though they are not as sensitive as throat culture. Therefore, all children and adolescents who have a negative rapid antigen detection test result should undergo throat culture. Empiric antibiotic therapy without testing is not recommended in children. More severe causes of sore throat include epiglottitis, retropharyngeal abscess, peri-

Table 12.2 Treatment of group A streptococcal pharyngitis

Antibiotic	Duration	Dosage
Benzathine penicillin G	Single dose	600,000 units if <27 kg 1.2 million units if >27 kg
Penicillin VK	10 days	250 mg BID or TID if <27 kg 500 mg BID or TID if >27 kg
Amoxicillin	10 days	50 mg/kg once daily, max 1 g/day
For penicillin-allergic patients:		
Cephalexin	10 days	25–50 mg/kg per day divided BID, max 1 g/day
Cefpodoxime	5 days	5 mg/kg BID max 100 mg/day
Cefdinir	5 days	7 mg/kg BID, max 600 mg/day
Clindamycin	10 days	10 mg/kg TID, max 1.8 g/day
Azithromycin	5 days	12 mg/kg once daily, max 500 mg
Clarithromycin	10 days	15 mg/kg per day divided BID, max 250 mg/dose

Table 12.3 Causes of acute pharyngitis

Bacterial	Viral
Group A streptococcus *Corynebacterium diphtheriae* *Neisseria gonorrhoeae*	Adenoviruses Epstein-Barr virus Influenza viruses Enteroviruses Coxsackieviruses Parainfluenza viruses

tonsillar abscess, infectious mononucleosis, diphtheria, Lemierre syndrome, or foreign body.

Take-Home Message

- Group A streptococcus (GAS) is a common cause of pharyngitis in children over 3 years of age.
- Due to its efficacy, safety, and narrow spectrum, penicillin remains the drug of choice to treat GAS infections.

ABP Content Specifications

- Plan the management of acute pharyngitis.
- Know the etiology of acute pharyngitis.

Question 6

A 4-year-old girl is brought to the emergency department for runny nose, nasal congestion, and right ear pain for 2 days. Her mother reports she had a temperature at home of 100.8 °F. On examination, the child has clear rhinorrhea and nasal congestion. Her right tympanic membrane is erythematous and bulging with a dull light reflex and a purulent effusion. The tympanic membrane does not move with insufflation. She is fussy but consolable by the mother. Of the following, which is the most likely etiology of infection in this child?

A. Gram-negative enteric bacilli
B. *Pseudomonas aeruginosa*
C. *Bartonella henselae*
D. *Streptococcus pneumoniae*
E. *Staphylococcus aureus*

Correct Answer: D

This child has acute otitis media (AOM), defined as the acute onset of signs and symptoms of inflammation of the middle ear caused by either bacteria or viruses. The most common bacterial etiologies in all ages of children include *Moraxella catarrhalis*, *Streptococcus pneumoniae*, and non-typeable *Haemophilus influenzae*. While pneumococcal and Hib vaccinations have changed the relative frequency of these pathogens in the last 20 years, non-typeable *H. influenzae* and non-PCV13 serotypes of *S. pneumoniae* remain common. Bacterial flora of the middle ear varies somewhat with age. Gram-negative enteric bacilli and *S. aureus* can cause AOM in 15–20% of children in the first month of life but would be unlikely pathogens in a 4-year-old child. *S. aureus* and *S. pyogenes* can be seen in older children and adolescents.

Pseudomonas aeruginosa and *Bartonella henselae* are not common causes of AOM in children. *Bartonella henselae* causes cat scratch disease, a regional lymphadenopathy developing after a cat bite or scratch. *Pasteurella multocida* is responsible for most infections due to cat bites.

The pathophysiology of AOM is felt to result from obstruction or inadequate drainage of fluid from the middle ear, often caused by hypertrophied lymphoid tissue or swelling from acute viral respiratory infections. Bacterial colonization, increased secretions and edema, mucous accumulation, and reflux of nasopharyngeal microbes into the middle ear may contribute to the development of AOM in children. The incidence of AOM peaks between 6 and 18 months of age. Risk factors for the development of AOM include day care attendance, lack of breastfeeding, family history, tobacco exposure, pacifier use, and low socioeconomic conditions.

Take-Home Message

- The most common bacterial etiologies of AOM in all age groups are *Streptococcus pneumoniae*, *Moraxella catarrhalis*, and nontypeable *Haemophilus influenzae*.

ABP Content Specifications

- Differentiate by age the etiology and understand the pathophysiology of otitis media.

Question 7

A 13-month-old boy presents with fever, congestion, and increased crying for three days. His parents report he has had runny nose and congestion with low-grade fever, but today, fever spiked to 103.8 °F. He has been pulling his right ear. On examination, the child has clear rhinorrhea, erythema of the nasal mucosa, and a bulging, erythematous tympanic membrane with a purulent effusion. He is otherwise well appearing and interactive during his examination and appears well hydrated. He has no drug allergies, nor has he taken any antibiotics in the last month. The most appropriate next step in the management of this patient would be:

A. Supportive care with antipyretics and analgesics as needed.
B. Oral amoxicillin for 10 days.
C. Refer to an ear, nose, and throat specialist for tympanocentesis.
D. Obtain CBC and blood culture.
E. Oral cefdinir for 10 days.

Correct Answer: B

The child in the vignette is demonstrating signs and symptoms of severe acute otitis media (AOM), requiring initiation of antibiotic therapy. Severe AOM is defined by moderate to severe otalgia, otalgia for at least 48 hours, or temperature greater than 39 °C (102.2 °F). In children greater than 6 months of age with non-severe AOM, supportive care with antipyretics and analgesics and observation for 48–72 hours with close follow-up is an option, based upon shared decision-making with the parent.

The drug of choice in non-penicillin-allergic children is high-dose amoxicillin. Children less than 2 years or any child with severe symptoms should be treated for 10 days; older children can be treated for 5–7 days. Referral to an ENT service is not indicated given a first episode of AOM without history of treatment failure. Laboratory evaluation, cultures, and imaging are not routinely required in the diagnosis or management of AOM. Oral cefdinir would be an appropriate drug of choice in patients with penicillin allergy or recent usage of amoxicillin-clavulanate (Tables 12.4, 12.5, and 12.6).

Take-Home Message

- First-line therapy for severe AOM (temperature > 39 °C, moderate or severe otalgia, or otalgia >48 hours) is high-dose amoxicillin.

ABP Content Specifications

- Plan management of acute otitis media.
- Recognize and interpret relevant laboratory and imaging studies in otitis media.

Question 8

A 2-year-old girl presents to the emergency department with fever and ear pain. She was diagnosed with acute otitis media (AOM) four days ago and is currently taking amoxicillin. Today, she had a temperature of 103.8 °F with

Table 12.4 Initial management of uncomplicated AOM

Age	AOM with otorrhea	Severe unilateral or bilateral AOM	Bilateral AOM without otorrhea	Non-severe unilateral AOM without otorrhea
6 months–2 years	Treatment with antibiotic	Treatment with antibiotic	Treatment with antibiotic	Treatment with antibiotic *or* close observation
≥2 years	Treatment with antibiotic	Treatment with antibiotic	Treatment with antibiotic *or* close observation	Treatment with antibiotic *or* close observation

Table 12.5 Initial antibiotic treatment for AOM at diagnosis or after close observation

First-line antibiotics	Alternative antibiotics
Amoxicillin (80–90 mg/kg/day divided BID)	Cefdinir (14 mg/kg/day daily or divided BID)
Amoxicillin-clavulanate (90 mg/kg/day of amoxicillin divided BID)[a]	Cefuroxime (30 mg/kg/day divided BID)
	Cefpodoxime (10 mg/kg/day divided BID)
	Ceftriaxone (50 mg/kg/day) IM or IV for 1 to 3 days

[a]In patients who have taken amoxicillin in the previous 30 days or have otitis-conjunctivitis syndrome

Table 12.6 Antibiotic treatment for AOM after 48–72 hours of initial antibiotic treatment failure

First-line antibiotics	Alternative antibiotics
Amoxicillin-clavulanate (90 mg/kg/day of amoxicillin divided BID)	Clindamycin (30–40 mg/kg/day divided TID) with or without a second- or third-generation cephalosporin
Ceftriaxone 50 mg/kg/day IM or IV for 3 days	Failure of second antibiotic: clindamycin (30–40 mg/kg/day divided TID) plus a second- or third-generation cephalosporin
	Tympanocentesis[a]
	Consult a specialist[a]

[a]Only perform tympanocentesis if skilled in the procedure; others consult specialist for procedure and culture of fluid

worsening severe right ear pain. On exam, you see a tired but non-toxic-appearing child. Her right ear appears displaced anteriorly, and she has swelling, erythema, and tenderness in the postauricular area. Otoscopic examination reveals a tympanic membrane that is erythematous and bulging with a purulent effusion; movement of the tympanic membrane is significantly reduced on pneumatic otoscopy. She has a normal neurologic examination. The most important next step in management of this child is:

A. Change antibiotic therapy to amoxicillin-clavulanate.
B. Admit to hospital for intravenous ceftriaxone therapy.
C. Consult an otolaryngologist for surgical intervention.
D. Obtain a computed tomography scan of the temporal bone.
E. Continue current antibiotic therapy and recommend follow-up in 48 hours for repeat examination.

Correct Answer: D

This child is demonstrating signs and symptoms suggestive of mastoiditis, a known complication of AOM. Physical exam findings concerning for mastoiditis include swelling, erythema and pain overlying the mastoid, displacement of the pinna inferiorly and anteriorly, and obliteration of the postauricular crease. The most important next step would be a computed tomography (CT) scan of the temporal bone. While mastoiditis is a clinical diagnosis, clinical suspicion should prompt CT scan to confirm the diagnosis, delineate the extent of disease, and identify complications. The most common finding of mastoiditis on CT scan is a cloudy mastoid; it may progress and develop into osteitis, with destruction of the mastoid bone.

Management of acute mastoiditis involves early consultation with an otolaryngologist, hospitalization with intravenous antibiotics, and, in the case of severe disease or significant complication, aggressive surgical management. The most common bacterial cause is *Streptococcus pneumoniae*. Other causes include *Streptococcus pyogenes*,

Staphylococcus aureus, and *Pseudomonas aeruginosa*. The recommended initial treatment is ceftriaxone plus clindamycin, pending culture results. If the child has a history of recurrent or chronic otitis media, consider broadening antibiotic coverage for pseudomonas with ceftazidime, cefepime, or piperacillin-tazobactam. It would not be appropriate to continue the current antibiotic therapy or change her current therapy to amoxicillin-clavulanate as this is not a simple AOM

Complications of mastoiditis are due to extension of infection from the middle ear to the mastoid and contiguous structures. Extracranial complications include subperiosteal abscess, facial nerve paralysis, hearing loss, labyrinthitis, osteomyelitis, and deep-space abscesses in the neck. Intracranial complications include meningitis, brain abscess, epidural or subdural abscess, and venous sinus thrombosis. Mastoiditis is due to local extension of infection and therefore rarely involves bacteremia. While mastoiditis is a rare complication of AOM, other more common sequelae include hearing loss, balance and motor problems, tympanic membrane perforation, cholesteatoma, and chronic suppurative otitis media.

Take-Home Message

- Mastoiditis is a known suppurative complication of AOM resulting from the extension of infection from the middle ear to the mastoid air cells.
- Mastoiditis is a clinical diagnosis characterized by displacement of the pinna, postauricular swelling, erythema, and tenderness.
- CT scan can confirm the diagnosis, delineate the extent of disease, and identify intracranial complications.

ABP Content Specifications

- Differentiate by age the etiology and understand the pathophysiology of mastoiditis.
- Plan the management of mastoiditis.
- Recognize and interpret relevant laboratory and imaging studies in mastoiditis.
- Recognize signs and symptoms and complications of acute otitis media.
- Recognize the signs and symptoms and complications of mastoiditis.

Question 9

A father brought his 6-year-old daughter to the emergency department for 1 day of ear drainage. The child has no significant past medical history. The father reports that she has been complaining of difficulty hearing from the left ear. She has been afebrile. Her examination reveals foul-smelling purulent drainage from the left ear with swelling of the external canal with epithelial debris. You are unable to visualize the tympanic membrane due to secretions. The child cries from pain when her pinna is manipulated during the ear examination. The most likely diagnosis in this patient is:

A. Acute otitis media with tympanic membrane perforation
B. Necrotizing (malignant) otitis externa
C. Herpes zoster oticus
D. Chronic suppurative otitis media
E. Acute otitis externa

Correct Answer: E

This child's symptoms and examination are indicative of acute otitis externa (AOE). The external ear canal is erythematous and edematous and may be filled with pus and flakes of skin debris. The ear itches and becomes increasingly painful particularly with manipulation of the tragus or pinna. Other features include a sense of ear fullness, hearing loss, and pain with palpation or manipulation of the tragus or pinna. Fever is uncommon, and the tympanic membrane appears normal. The most common organisms responsible for AOE are *P. aeruginosa* and *S. aureus*. Many infections are polymicrobial.

The removal of cerumen, desquamated skin, and purulent material from the ear canal facilitates healing and enhances penetration of the antibiotic ear drops. Gentle debridement with a cotton swab or ear loop and, if the tympanic membrane is intact, irrigation with a mixture of 1:1 hydrogen peroxide and warm water can be helpful. Some authors recommend drying with alcohol, but this may irritate an already inflamed external auditory canal. For mild disease, simple acetic acid solution +/− aluminum acetate (Burow's solution) may alone be

effective. For moderate disease, topic antibiotics such as fluoroquinolone otic solution (ofloxacin or ciprofloxacin) or polymyxin-neomycin should be added. The inclusion of hydrocortisone to the antibiotic (Cipro HC otic or Cortisporin) is effective but more costly. Oral antibiotics are not indicated unless the patient has severe otitis externa with surrounding cellulitis or lymphadenitis.

Pain with manipulation of the pinna or tragus is not typically associated with AOM with tympanic membrane perforation. Necrotizing (invasive or malignant) otitis externa can be seen in patients who are elderly, immunosuppressed, or diabetic. This child is healthy and has no risk factors making necrotizing OE unlikely. *P. aeruginosa* is almost always the causative agent of necrotizing otitis externa. Herpes zoster oticus is caused by a latent varicella zoster infection of the 7th and 8th cranial nerves and is characterized by vesicles on the auricle, external auditory canal, and/or tympanic membrane. Chronic suppurative otitis media is a chronic infection of the middle ear and does not present with external canal swelling, redness, or otorrhea unless perforation of the tympanic membrane has occurred.

Take-Home Message

- Acute otitis externa presents with a swollen, erythematous external canal associated with otorrhea, epithelialization of the canal, and pain with movement of the pinna or tragus.
- AOE is treated with cleansing of the external canal, topical otic acidifying agents, and topical otic antimicrobials.

ABP Content Specifications

- Plan the evaluation and management of otitis externa.
- Recognize the signs and symptoms of otitis externa.

Question 10

A 6-year-old boy presents to the emergency department for fever, cough, nasal congestion, and drainage for 12 days. His symptoms began with clear nasal drainage that the mother reports is now yellow-green in color with a thickened consistency. The mother reports over the past 3 days his fever at home has been 101.8 °F, which she has been treating with acetaminophen and ibuprofen. His symptoms are not improving despite supportive therapy at home. On your exam, the patient is ill appearing but nontoxic. He is febrile with heart rate of 134 beats/min. Lungs are clear without tachypnea or hypoxia. The most appropriate next step is:

A. Supportive care with continued antipyretics and reassurance.
B. Amoxicillin-clavulanate 90 mg/kg/day.
C. Obtain imaging of the face to evaluate for sinus disease or foreign body.
D. Cefdinir 14 mg/kg/day.
E. Clindamycin 30–40 mg/kg/day.

Correct Answer: B

The diagnosis of acute bacterial sinusitis (ABS) is based on history and met with any one of the following criteria:

- Persistent symptoms of nasal discharge, congestion, and/or cough for more than 10 days without improvement
- Severe symptoms (ill appearance, temperature greater than 102 °F, and purulent rhinorrhea) for at least 3 days
- Worsening symptoms of nasal congestion or drainage, cough, and fever after an initial period of improvement

Given the clinical picture above, the child meets criteria for ABS.

Although the ethmoidal and maxillary sinuses are present at birth, only the ethmoidal sinuses are pneumatized. The maxillary sinuses are pneumatized by 4 years of age. The sphenoidal sinuses are present by 5 years of age. The frontal sinuses usually begin to develop at 7–8 years of age but are not completely developed until adolescence.

Sinusitis is defined as inflammation of the paranasal sinuses. If ABS is suspected, antibiotics should be initiated. High-dose amoxicillin-clavulanate is the first-line therapy for the treatment

of acute bacterial sinusitis in children aged 1 to 18 years of age. Because of the proportion of cases of sinusitis caused by β-lactamase-producing *H. influenzae*, the use of amoxicillin alone without the addition of clavulanate is not adequate for treatment of ABS. Cefdinir may be used in patients that are penicillin allergic but has less activity against *S. pneumoniae* than amoxicillin-clavulanate. Clindamycin may be used in addition to cefixime in patients who have worsening of symptoms or lack of improvement in the following 72 hours after initiation of treatment. Macrolides such as clarithromycin or azithromycin are not recommended for empiric therapy because of high rates of resistance among *Streptococcus pneumoniae*.

Infection of the sinuses arises in a similar way to acute otitis media; bacterial organisms ascend from the nasopharynx and cause infection when the mucosal barrier of the sinuses or drainage of the sinuses is disrupted. The typical pathogens in sinusitis are *S. pneumoniae*, *H. influenzae*, and *M. catarrhalis*. Acute viral upper respiratory infections typically last 5–10 days with peak intensity around days 3–5 followed by gradual improvement of symptoms. This child has had symptoms for 12 days, and his symptoms are worsening which should be concerning for secondary bacterial infection such as ABS. Infected nasal foreign body classically presents with foul-smelling, discolored, possibly bloody nasal discharge from a single nare. Children with chronic sinusitis complain of cough and rhinorrhea for greater than 30 days. Fever, headache, and facial pain are uncommon in chronic sinusitis.

Take-Home Message

- The diagnosis of bacterial sinusitis requires one of the following conditions:
  - Persistent symptoms of nasal discharge, congestion, and/or cough for more than 10 days without improvement
  - Severe symptoms with temperature greater than 38.5 °C with purulent rhinorrhea for at least 3 days
  - Worsening symptoms of nasal congestion or drainage, cough, and fever after an initial period of improvement
- High-dose amoxicillin-clavulanate is the first-line therapy for the treatment of acute bacterial sinusitis.

ABP Content Specifications

- Differentiate by age the etiology and understand the pathophysiology of sinusitis.
- Recognize the signs and symptoms of sinusitis.
- Plan the management of acute sinusitis.

Question 11

The most common complication of bacterial sinusitis is:

A. Subdural empyema
B. Orbital cellulitis
C. Meningitis
D. Venous sinus thrombosis
E. Brain abscess

Correct Answer: B

The most frequent complications of acute bacterial sinusitis (ABS) involve the orbit. Orbital cellulitis most commonly arises from the paranasal (ethmoid) sinuses. Other complications include subperiosteal abscess, orbital abscess, periorbital cellulitis, and optic neuritis. Intracranial complications are much less common and include meningitis, epidural or subdural empyema, brain abscess, and venous sinus thrombosis. Pott puffy tumor, a subperiosteal abscess of the frontal bone, is an uncommon bony complication of frontal sinusitis.

Intracranial complications should be considered in any child presenting with severe headache, seizures, focal neurologic deficits, or meningeal signs. It is not necessary to perform any imaging studies such as plain films, computed tomography (CT), magnetic resonance imaging (MRI), or ultrasonography to diagnose sinusitis. Similarly, laboratory studies are not warranted in the diagnosis of ABS. CT scan and/or MRI studies of the sinuses with contrast should only be performed when a child is suspected of having an orbital,

bony, or CNS complication. These complications must be recognized promptly and treated aggressively.

Take-Home Message

- The most common complications of ABS involve the orbit, which include subperiosteal abscess, orbital cellulitis, orbital abscess, periorbital cellulitis, and optic neuritis.

ABP Content Specifications

- Recognize and interpret relevant laboratory and imaging studies for sinusitis.
- Recognize life-threatening complications of sinusitis.

Question 12

A 17-year-old boy presents to the emergency department with fever, sore throat, and difficulty swallowing for 4 days. Over the past 2 days, the patient reports decreased oral intake and difficulty swallowing his saliva. On arrival to the emergency department, the vital signs are temperature 102.7 °F, heart rate 135 beats/minute, respiratory rate 14 breaths/minute, blood pressure 122/74 mm Hg, and pulse oximetry 98% on room air. On examination, he is moderately distressed and drooling. There is diffuse erythema of the posterior pharynx with exudates bilaterally. The uvula is deviated to the left. He has difficulty fully opening his mouth, and his voice sounds muffled when he speaks. Lung examination reveals clear breath sounds bilaterally. The most likely diagnosis in this patient would be:

A. Lemierre syndrome
B. Retropharyngeal abscess
C. Infectious mononucleosis
D. Streptococcal pharyngitis
E. Peritonsillar abscess

Correct Answer: E

This adolescent's examination is most consistent with a peritonsillar abscess (PTA). Approximately 1% of patients with acute bacterial pharyngitis develop serious suppurative complications. PTAs are more often seen in older children and adolescents. They typically present with fever, sore throat, neck pain, and dysphagia. Sore throat may be severe and unilateral. Ipsilateral otalgia may be present. Physical findings include trismus, difficulty speaking, a muffled voice, drooling, a deviated uvula, and a soft, fluctuant mass in the tonsillar fossa. The examination of the pharynx may be limited by trismus.

The abscess is most commonly initiated from the upper pole of the tonsil. PTAs are typically polymicrobial. Predominant organisms include *Streptococcus pyogenes* (group A streptococcus), *Staphylococcus aureus* (including methicillin-resistant *S. aureus*), and various anaerobes. The treatment of a PTA includes source control with needle aspiration or incision and drainage, analgesics, and antibiotics (oral or intravenous based on the child's ability to swallow). Empiric therapy should be initiated with intravenous (IV) ampicillin-sulbactam, oral (PO) amoxicillin-clavulanate, or clindamycin (IV/PO). Up to 10% to 20% of patients may have recurrent PTAs.

Infectious mononucleosis and streptococcal pharyngitis may present with fever, exudative pharyngitis, and cervical lymphadenopathy, but a deviated uvula or fluctuant peritonsillar mass should not be present. The patient with infectious mononucleosis may also have splenomegaly. Laboratory features of infectious mononucleosis include reactive lymphocytosis, the presence of significant atypical lymphocytes, and reactive heterophile antibodies.

An uncommon but potentially life-threatening complication of severe pharyngitis is septic thrombophlebitis of the internal jugular vein, also known as Lemierre syndrome. The typical presentation includes antecedent pharyngitis, persistent fever despite antibiotics, and neck and throat pain with associated respiratory symptoms secondary to septic pulmonary emboli. A contrast-enhanced computed tomography scan of the neck and chest or ultrasound of the neck is required to establish the diagnosis. Lemierre syndrome is caused by *Fusobacterium necrophorum* or mixed anaerobic flora. Bacteremia, empyema, and metastatic infections such as septic arthritis, osteomyelitis, or other deep-space infections may occur.

A retropharyngeal abscess (RPA) is characterized by suppurative adenitis in the space between the anterior border of the cervical vertebrae and the posterior wall of the esophagus. Because these lymph nodes atrophy after four years of age, RPA is seen primarily in younger children. The typical history includes an acute, febrile upper respiratory tract infection or pharyngitis for several days followed by sudden worsening with development of a high fever, toxicity, anorexia, drooling, and dyspnea. Since neck movement (particularly extension) exacerbates pain, the child tends to lie with the head in a neutral position with limited neck movement. Tender cervical lymphadenopathy is usually present, and a neck mass or swelling may be appreciated on pharyngeal exam or palpation of the neck. A lateral neck radiograph may show marked widening of the prevertebral soft tissue, typically greater than half the width of the corresponding vertebral body. A computed tomography (CT) scan is necessary to confirm the diagnosis of RPA.

Take-Home Message

- Patients with a PTA present with severe sore throat, drooling, a muffled voice, and peritosillar swelling with shift of the uvula to the contralateral side.
- Treatment involves antibiotics and source control with needle aspiration or incision and drainage.

ABP Content Specifications

- Know the etiology and understand the pathophysiology of peritonsillar abscesses.
- Recognize the signs and symptoms of peritonsillar abscess.
- Recognize and interpret relevant laboratory and imaging studies for peritonsillar abscess.
- Plan management of acute peritonsillar abscesses.

Question 13

A 48-day-old infant is brought to the emergency department with difficulty breathing and cough. His parents report that he has not had any fever. They report that the infant began having increased work of breathing that morning and is not feeding well.

On arrival to the emergency department, the vital signs are a temperature of 99.3 °F, heart rate of 165 beats/minute, respiratory rate of 72 breaths/minute, blood pressure of 89/64, and pulse oximetry of 93% on room air. On examination, he has clear rhinorrhea. His heart examination reveals normal heart sounds, without murmurs, gallops, or rubs. His lung examination reveals moderate intercostal retractions, diffuse rales, and scattered rhonchi bilaterally.

Of the following, the most important treatment for this patient would be:

A. Give an oral corticosteroid.
B. Nasal suctioning.
C. Ribavirin.
D. Begin antibiotic therapy.
E. Administer nebulized bronchodilator.

Correct Answer: B

This patient is showing signs and symptoms of acute bronchiolitis, an acute inflammatory disorder of the small airways characterized by obstruction with "air trapping," hyperinflation of the lungs, and atelectasis. Bronchiolitis typically occurs in children younger than 2 years; most commonly in the first year of life, peaking between 3 and 6 months. Typical signs and symptoms include cough, tachypnea, accessory muscle use, rales, rhonchi, and/or wheezing on examination. Respiratory syncytial virus is the most common cause of acute bronchiolitis, but other causes include adenovirus, influenza A and B virus, parainfluenza, human metapneumovirus, and rhinoviruses.

In 2014, the American Academy of Pediatrics published clinical practice guidelines for the diagnosis and treatment of bronchiolitis that did not find strong evidence to recommend corticosteroids, ribavirin, antibiotics, or bronchodilators for the treatment of bronchiolitis. Antibiotic therapy should only be used if a specific bacterial coinfection is present. Radiographic and laboratory studies should not be routinely obtained in

children with bronchiolitis. Beware that radiographic changes may mimic pneumonia and should not be used to determine the need for antibiotics. Life-threatening complications of bronchiolitis include hypoxemia, upper or lower airway obstruction, and apnea. The treatment for bronchiolitis is supportive. Supplemental oxygen is provided to keep oxygen saturations greater than 90%. Adequate hydration should be maintained via intravenous or nasogastric fluids if the infant is not tolerating feeds.

Take-Home Message

- Bronchiolitis is a viral lower respiratory infection characterized by cough, tachypnea, accessory muscle use, rales, rhonchi, and/or wheezing.
- The treatment is supportive care; diagnosis is clinical without radiographic or laboratory studies.

ABP Content Specifications

- Know the etiology and understand the pathophysiology of bronchiolitis.
- Recognize signs and symptoms of bronchiolitis.
- Recognize and interpret relevant laboratory and imaging studies for bronchiolitis.
- Recognize life-threatening complications of bronchiolitis.
- Plan management of acute bronchiolitis.

Question 14

A 15-year-old girl is brought to the emergency department for evaluation by the police. She ran away from home and is vague when questioned where she has been living for the past six weeks. She states that she is sexually active with "her boyfriend" but does not want to give specifics about him. You are concerned that she may be a victim of trafficking. As part of your review of systems, she endorses a "rash down there" but denies pain or discharge.

On examination, you note a somewhat disheveled but otherwise well-appearing girl with stable vital signs. You note a normal oropharyngeal examination. Lungs are clear, and heart is regular without murmurs. She is neurologically intact and denies vision changes. On genitourinary examination, you note a 1.7 cm ulcer with a non-exudative base and raised borders on her labia. Scant physiologic discharge is noted without cervical lesions or motion tenderness. No lymphadenopathy is present and there are no other rashes.

The best treatment for this patient is:

A. Benzathine penicillin G 2.4 million units intramuscularly once
B. Benzathine penicillin G 2.4 million units intramuscularly weekly × 3 weeks
C. Acyclovir 400 mg three times daily for 10 days
D. Doxycycline 100 mg twice daily for 21 days
E. Azithromycin 1 gram orally single dose

Correct Answer: A

This patient has primary syphilis. Syphilis is caused by the spirochete *Treponema pallidum* which can be transmitted via direct sexual contact or transplacentally from infected mother to fetus. Transmission via oral, vaginal, or anal sex is possible.

Clinical manifestations of syphilis vary depending on the stage of illness. Primary syphilis begins with the eruption of a painless papule at the site of inoculation on average three weeks after infection. This lesion eventually ulcerates to develop a chancre, a painless 1- to 2-cm ulcer with a firm non-exudative base and raised borders. The chancre lasts three to six weeks and heals regardless of treatment. Secondary syphilis follows weeks to months later. Patients develop systemic symptoms including a generalized non-pruritic rash causing rough red/brown spots typically involving palms and soles; condyloma lata which are large gray/white hypertrophic lesions distributed in warm moist areas such as mouth, underarms, or groin; lymphadenopathy; fever; malaise; and myalgias. Symptoms again resolve spontaneously without treatment in approximately 3 to 12 weeks. Tertiary syphilis develops after years of latency, often decades, making this extremely rare in the pediatric population.

Clinical manifestations include dementia, tabes dorsalis (degeneration of posterior spinal cord), aortic aneurysms and regurgitation, blindness, and gummas (soft, noncancerous growths which occur on the skin, bones, or internal organs).

The diagnosis of syphilis is complicated. Nontreponemal serologic tests including the rapid plasma reagin (RPR) test and Venereal Disease Research Laboratory (VDRL) slide test are used as first-line screens due to their ease and low cost. The VDRL and RPR tests become positive 4–6 weeks after infection, so these can be falsely negative for this period after the chancre appears. There is a potential for false-positive results with conditions such as pregnancy, autoimmune disease, or other infections; therefore, all positives must be confirmed with a specific treponemal test such as the fluorescent treponemal antibody absorption (FTA-ABS), the treponemal enzyme immunoassay (TP-EIA), or the T pallidum particle agglutination (TP-PA) test.

Treatment of all stages of syphilis remains benzathine penicillin G. Primary and secondary syphilis can be treated with a single intramuscular dose (2.4 million units), whereas latent or tertiary syphilis requires three doses. Combinations of penicillin preparations (e.g., Bicillin CR, a combination of benzathine and procaine penicillin) are not appropriate treatment as they provide inadequate doses of penicillin. Treatment should not be delayed while awaiting the results of the treponemal test if the patient is symptomatic. Therefore, it is appropriate to treat empirically any patient with suspicion of acquired syphilis.

This patient should also be broadly screened for other sexually transmitted infections. Social work consult would be prudent given runaway behavior with concern for trafficking. Patient should be counseled on safe sex practices and offered partner treatment. Any new case of syphilis should be reported to local public health authorities.

In addition to primary syphilis, differential diagnosis of infectious genital ulcers would include herpes simplex virus types I and II, *Haemophilus ducreyi* (the causative agent of cancroid), *Chlamydia trachomatis* serovars L 1–3 (the causative agents of lymphogranuloma venereum or LGV), and *Klebsiella granulomatis* (the causative agent of granuloma inguinale). Noninfectious etiologies would include drug eruptions, Behcet's syndrome, neoplasms, and trauma. HSV causes multiple painful shallow ulcers and is treated with acyclovir, famciclovir, or valacyclovir. Chancroid causes painful ulcer and is caused by the organism *Haemophilus ducreyi*. It is treated with single-dose azithromycin or ceftriaxone. LGV typically causes significant inguinal lymphadenopathy and a single painless lesion. Treatment for LGV is doxycycline 100 mg twice daily for 21 days. Granuloma inguinale presents as one or more nodular lesions that cause painless ulcerations. It is treated with 3 weeks of azithromycin.

Take-Home Message

- Primary syphilis is characterized by a painless chancre.
- The treatment of acquired syphilis remains benzathine penicillin G.
- The VDRL and RPR are screening tests, which may not become positive until approximately four weeks after the initial lesion appears.

ABP Content Specifications

- Differentiate by age the etiology and understand the pathophysiology of syphilis.
- Recognize signs and symptoms of syphilis.
- Plan management of acute and chronic syphilis.
- Recognize and interpret relevant laboratory and imaging studies in acute and chronic syphilis.

Question 15

A 7-week-old Hispanic male infant is brought to the emergency department for evaluation of rash, fussiness, and decreased movement of his upper extremities. His family just moved to the United States from Central America. Physical examination reveals a fussy but consolable infant with copious rhinorrhea. He is afebrile with normal vitals per age. The infant is found to have

a brown maculopapular rash involving the palms and soles with exfoliation. He demonstrates decreased spontaneous movement of bilateral upper extremities and fusses with palpation of his arms. His liver edge is noted 3 cm below the right costal margin.

The most likely diagnosis is:

A. Congenital syphilis
B. Non-accidental trauma
C. Disseminated herpes
D. Staphylococcal scalded skin syndrome
E. Dengue fever

Correct Answer: A

This child has congenital syphilis. It results from the transplacental, hematogenous spread of syphilis from the mother to the fetus. Placental transmission can occur at any clinical stage of syphilis, although mothers are more likely to transmit the infection while in the early stages of the disease. There is an inverse relationship with severity of disease and gestational age at time of infection. Intrauterine syphilis infection can result in stillbirth, hydrops fetalis, or preterm birth. Most infants are asymptomatic at birth.

The clinical manifestations of congenital syphilis can be divided into early and late congenital syphilis dependent on whether symptoms are clinically apparent before or after age 2 years. Symptoms of early congenital syphilis include diffuse rash, classically involving the palms, copious nasal secretions (also known as snuffles), thrombocytopenia, hepatosplenomegaly, osteochondritis and pseudoparalysis of Parrot (lack of limb motion because of pain), and chorioretinitis. Late congenital syphilis presents with developmental delay, Hutchinson teeth (widely spaced, peg-shaped, and centrally notched incisors), mulberry molars, rhagades (perioral fissures), bone abnormalities and arthritis, and saddle-nose deformity. Neurologic manifestations are common and may include eighth cranial nerve deafness and interstitial keratitis. Clinicians must also consider the possibility of sexual abuse in any young child diagnosed with syphilis.

Congenital syphilis should be suspected in any infants born to mothers with positive serologic tests, as well as any child with pertinent signs and symptoms. These children should undergo nontreponemal serologic screening with a rapid plasma regain (RPR) test or a Venereal Disease Research Laboratory (VDRL) slide test. Children with high suspicion of disease should undergo lumbar puncture as approximately 40% of newborns with syphilis have asymptomatic involvement of the cerebrospinal fluid (CSF). In a child with neurosyphilis, CSF would have elevated white blood cell count, elevated protein, and a positive VDRL. Infants should also undergo long-bone and chest radiography, ophthalmologic examination, liver function tests, and a complete blood count.

Congenital syphilis should be treated with 10 days of parenteral penicillin G. The CDC recommends universal syphilis screening for all pregnant women in the first trimester and again during the third trimester and at delivery for women at high risk. Physicians in the emergency department should especially consider a diagnosis of syphilis in children born to mothers without prenatal care or born in an area where they may not have undergone screening.

Non-accidental trauma should be considered in infants with fussiness not explained by another etiology and in children with orthopedic injuries inconsistent with history. Disseminated neonatal HSV causes irritability, seizures, vesicular exanthema, and liver involvement. Staphylococcal scalded skin syndrome is characterized by red blistering skin that causes desquamation of the skin as the disease process evolves. Dengue fever is a tropical disease that can cause fever, rashes, and myalgias.

Take-Home Message

- Congenital syphilis, often asymptomatic at birth, can cause maculopapular rash often involving palms and soles, snuffles, hepatosplenomegaly, and osteochondritis.
- Treatment of congenital syphilis is parenteral penicillin for 10 days.

ABP Content Specifications

- Differentiate by age the etiology and pathophysiology of syphilis.
- Recognize signs and symptoms of syphilis.
- Plan management of acute and chronic syphilis.
- Recognize and interpret relevant laboratory and imaging studies in acute and chronic syphilis.

Question 16

A 17-year-old boy presents to the emergency department very distressed by bumps noted in the perianal area. He is concerned that "they might be hemorrhoids or something." He notes that the lesions have been present for a few months and occasionally cause itching. He denies other rashes, lesions, or pain. Bowel movements have been normal. On further history, the patient states that he is sexually active with males and has had receptive anal sex. On examination, you note a nervous but otherwise well-appearing patient. No other rashes are noted. Abdominal examination is unremarkable. The patient is circumcised with no penile lesions noted. Bilateral testicles are descended and nontender with a normal-appearing scrotum. Multiple skin-colored perianal lesions are noted, some of which are pedunculated.

The most likely diagnosis is:

A. Condylomata acuminata
B. Condyloma lata
C. Molluscum contagiosum
D. External hemorrhoids
E. Skin tags

Correct Answer: A

Anogenital warts, also called condylomata acuminata, are skin-colored warts caused by various strains of the human papillomavirus (HPV). Lesions can be papular, flat, pedunculated, or cauliflower-like they are often seen in groups, ranging in size from a few millimeters to several centimeters. These warts are usually painless, although they may cause itching, burning, or bleeding.

Anogenital HPV is transmitted by skin-to-skin contact, usually through sexual intercourse. HPV infection is one of the most frequent sexually transmitted infections occurring in up to 80% of adults. Condom use may reduce the risk of infection but only when infected areas are covered by the condom. HPV vaccines have reduced the risk of HPV infection, but they do not provide protection against all HPV types. Infection may be transmitted by perinatal exposure, heteroinoculation, autoinoculation, and indirect fomite transmission. When anogenital warts are identified in a child who is prepubertal, the clinician must consider sexual abuse as a possible etiology.

Diagnosis is clinical. Serologic testing is not indicated. Biopsy can be done when the diagnosis is unclear. There is no definitive treatment for HPV infection. Management is directed toward symptomatic relief of the resultant lesions. Spontaneous regression occurs in approximately 30–75% of cases within 6 months, and therefore, many clinicians recommend watchful waiting. Interventions include ablative/excisional treatments such as cryotherapy, laser therapy, or surgical excision; antiproliferative methods such as 5-fluorouracil, podofilox/podophyllin, or trichloroacetic acid; and immune-modulating therapy such as imiquimod.

HPV is the cause of most cervical, vulvar, vaginal, penile, and anal cancers as well as a significant percentage of oropharyngeal cancers. Adolescent females diagnosed with anogenital warts should be referred to gynecology for further treatment and evaluation. Young children can be followed by dermatology. Adolescents of either sex with perianal warts should be referred to gastroenterology for anoscopy because many have concurrent internal lesions which can cause obstruction when severe. Adolescents should be screened for concurrent sexually transmitted infections.

Condyloma lata is a lesion associated with secondary syphilis. This patient has no other signs or symptoms of syphilis which would include rash, hepatosplenomegaly, malaise, myalgias, and fever. Molluscum contagiosum presents as small 1–2 mm shiny smooth papules with central umbilication.

Take-Home Message

- Anogenital warts are diagnosed clinically.
- If lesions are not symptomatic, observation can be suggested given high rate of spontaneous resolution. Recommendations should be made for appropriate follow-up with gynecology, dermatology, or gastroenterology.

ABP Content Specifications

- Plan the management of genital warts.
- Know the etiology of genital warts.
- Recognize the signs and symptoms of other genital warts.

Question 17

A 15-year-old girl presents to the emergency department with lower abdominal pain for two days, right greater than left. Today, she developed nausea, but no vomiting. She denies dysuria and hematuria, and her stools have been normal. Her last menstrual period was three weeks ago. She endorses some light vaginal discharge which began one week ago. She states that she became sexually active six months ago, has had one partner, and uses condoms "sometimes."

On examination, the patient appears uncomfortable. Her temperature is 100.1 °F, and the remainder of her vital signs are normal for age. The abdomen is soft with tenderness noted to the right lower quadrant with rebound and guarding. Psoas, obturator, and Rovsing signs are negative. Pelvic examination reveals no external lesions. You note discharge in the vault and covering the cervix. She has cervical motion and right adnexal tenderness. Urine pregnancy testing is negative.

What is the next appropriate step?

A. Obtain a pelvic ultrasound.
B. Consult surgery for evaluation of possible appendicitis.
C. Start IV antibiotics and admit to the hospital.
D. Order a CT of the abdomen and pelvis with IV contrast.
E. Consult gynecology for laparoscopy.

Correct Answer: A

Pelvic inflammatory disease (PID) is an inflammatory disorder of the female upper genital tract involving any combination of endometritis, salpingitis, oophoritis, tubo-ovarian abscess (TOA), and pelvic peritonitis. Symptoms may include unilateral or bilateral lower abdominal or pelvic pain, fever, vomiting, vaginal discharge, and irregular vaginal bleeding.

Sexually transmitted organisms, especially *N. gonorrhoeae* and *C. trachomatis*, are the most commonly implicated organisms. However, <50% of women diagnosed with PID test positive for either of these organisms. Other culprits would include microorganisms of the vaginal flora (anaerobes, *G. vaginalis*, *H. influenza*, enteric gram-negative rods, and *Streptococcus agalactiae*), cytomegalovirus, *M. hominis*, *U. urealyticum*, and *M. genitalium*.

Diagnosis of PID is primarily clinical, is notoriously imprecise, and is often missed, occasionally because the patient is asymptomatic, but more commonly because it was unrecognized due to mild or nonspecific symptoms. Presumptive diagnosis should be made in a sexually active adolescent if they are experiencing lower abdominal or pelvic pain, if no other cause can be identified, and if one or more of the followed criteria are present on examination: cervical motion, uterine, or adnexal tenderness. Other findings that can increase the specificity of the diagnosis include temperature > 101 F, abnormal cervical mucopurulent discharge or friability, presence of abundant numbers of WBC on saline microscopy of vaginal fluid (wet prep), elevated erythrocyte sedimentation rate (ESR) or C-reactive protein (CRP), and laboratory documentation of cervical infection with *N. gonorrhoeae* or *C. trachomatis*. Wet prep and genital or urine NAAT for *C. trachomatis* and *N. gonorrhoeae* should be sent.

The differential diagnosis of lower abdominal pain includes ectopic pregnancy, acute appendicitis, ovarian cyst, ovarian torsion, and functional pain. Pregnancy testing is important in the evaluation of postpubertal girls with lower abdominal pain. Urine should be evaluated with analysis and culture to identify any concomitant urinary tract infection. Short-term complications

of PID include perihepatitis (Fitz-Hugh-Curtis syndrome) and periappendicitis. Pelvic ultrasound is recommended in patients with unilateral adnexal tenderness to evaluate for possible TOA. If considering both appendicitis and TOA, pelvic ultrasound should be obtained prior to computed tomography (CT). CT is notoriously poor for diagnosing gynecologic problems. Ultrasound has a higher likelihood of detecting TOA and other ovarian causes, has potential to diagnosis appendicitis, and has added benefit of no radiation exposure.

Treatment should be initiated as soon as the presumptive diagnosis has been made. Adolescents with mild to moderate disease and good follow-up can be treated as outpatients with oral antibiotics. They should be instructed to follow-up in 72 hours and to return if symptoms worsen. Those with TOA, pregnancy, severe illness, and outpatient oral antibiotic failure or who are not able to tolerate an outpatient oral antibiotic regimen should be hospitalized for parenteral antibiotics (Table 12.7).

Possible complications of untreated PID include future infertility, ectopic pregnancy, and chronic abdominal pain. Adolescents should be counseled to practice safe sex and refrain from sexual activity until therapy is complete and symptoms have resolved. They should be screened for other sexually transmitted infections such as HIV and syphilis. Sex partners should be referred for treatment or provided with expedited partner therapy.

Take-Home Message

- PID must be considered in any adolescent female with lower abdominal/pelvic pain plus cervical, uterine, or adnexal tenderness on examination.
- The CDC recommends a low threshold for empiric treatment based on minimal criteria that can based on the history and physical examination.

ABP Content Specifications

- Know the etiology of pelvic inflammatory disease.
- Recognize the signs and symptoms of pelvic inflammatory disease.
- Plan the management of pelvic inflammatory disease.
- Recognize the complications of pelvic inflammatory disease.

Question 18

A 5-day-old female infant is brought to the emergency department by her parents for concerns about bilateral "pink eye" for one day. She was born full term via vaginal delivery at home in the care of a midwife. The mother denies complications or infections. She reports that she refused all vaccinations for the baby. The mother states that the baby has been afebrile and is breastfeeding well.

On your examination, the baby is sleeping but is easily arousable. You note obvious thick

Table 12.7 Recommended antibiotic regimens for PID

Inpatient		
Cefotetan 2 g IV q12h PLUS	Doxycycline 100 mg PO/IV q12h	
Cefoxitin 2 g IV q6h PLUS	Doxycycline 100 mg PO/IV q12h	
Clindamycin 900 mg IV q8h PLUS	Gentamicin 2 mg/kg IV/IM loading followed by 1.5 mg/kg q8 OR	Gentamicin 3–5 mg/kg q24h
Ampicillin/sulbactam 3 g IV q6h PLUS	Doxycycline 100 mg PO/IV q12h	
Outpatient		
Ceftriaxone 250 mg IM × 1 PLUS	Doxycycline 100 mg PO q12h × 14d WITH or WITHOUT	Metronidazole 500 mg q12h × 14d
Cefoxitin 2 g IM and probenecid 1 g PO x 1 PLUS	Doxycycline 100 mg PO q12 x 14d WITH or WITHOUT	Metronidazole 500 mg q12h x 14d

copious green discharge from both eyes with mild swelling to the eyelids and erythematous, chemotic conjunctiva. Discharge reaccumulates quickly after gently wiping the eyes. Anterior fontanelle is soft, open, and flat. The neck is supple. The infant has good tone, no rashes, or swelling to extremities.

The best plan for this baby would be:

A. Full septic evaluation including lumbar puncture, culture of eye, and admission for broad-spectrum antibiotics.
B. CBC, blood and eye cultures, and admission for broad-spectrum antibiotics.
C. Culture of eye and discharge after single-dose ceftriaxone in the emergency department.
D. Discharge home with erythromycin ophthalmic ointment.
E. Discharge home with instructions for nasolacrimal massage and warm compresses.

Correct Answer: A

Neonatal conjunctivitis is an acute mucopurulent infection that affects up to 12% of all infants in the first four weeks of life. Different disease processes are implicated in the pathogenesis of this condition including chemical exposure and bacterial and viral infections.

Gonococcal infection in the newborn infant usually involves the eyes (ophthalmia neonatorum). Other possible manifestations of neonatal gonococcal infection include scalp abscess (secondary to fetal scalp monitoring), vaginitis, and disseminated disease with bacteremia, arthritis, and/or meningitis. Neonatal gonococcal infection is caused by exposure to infected cervical exudate at birth and typically manifests 2–5 days after birth. Newborns who did not receive ophthalmia prophylaxis (erythromycin ophthalmic ointment) or whose mothers had history of sexually transmitted infections or no prenatal care are at increased risk of gonococcal ophthalmia neonatorum.

Diagnosis of gonococcal ophthalmia should be considered in infants with copious green purulent drainage, conjunctival erythema, chemosis, and swelling of the eyelids. Definitive diagnosis is made with conjunctival exudates cultured for *N. gonorrhoeae* and tested for antibiotic susceptibility. This is of little utility in guiding management in the emergency department given that cultures do not result for days. Gonococcal ophthalmia should be suspected in any infant with intracellular gram-negative diplococci on gram stain. Simultaneous cultures for chlamydia should be obtained as well as serologic tests for syphilis and HIV. Infants suspected of having gonococcal ophthalmia should be hospitalized and evaluated for disseminated infection (e.g., sepsis and meningitis).

Topical antibiotic therapy is inadequate for gonococcal conjunctivitis. A single dose of ceftriaxone 25–50 mg/kg IV or IM is curative. However, these patients should be started on broad-spectrum antibiotics pending results of full septic workup. If disseminated gonococcal disease is detected, ceftriaxone or cefotaxime for 7–14 days is required. If left untreated, gonococcal ophthalmia can cause corneal ulceration, globe rupture, and blindness. Infants with gonococcal ophthalmia should receive frequent eye irrigations with saline until discharge is eliminated. All cases of gonorrhea must be reported to public health officials. The mother and her partner should be tested and treated.

Infants with chemical conjunctivitis usually present with scant purulent conjunctivitis in the first 24 hours of life in reaction to topical application of prophylaxis. No testing or treatment is required. Non-sexually transmitted bacteria (*Staphylococcus*, *Streptococcus*, and *Haemophilus* species, *Moraxella catarrhalis*, *Escherichia coli*, and *Pseudomonas aeruginosa*) represent a frequent cause of neonatal conjunctivitis. Most cases are treated effectively with topical antibiotics except for infections with *Pseudomonas aeruginosa* which requires treatment with systemic and topical antibiotics along with ophthalmologic consultation.

Infants with chlamydial conjunctivitis usually present 5–14 days after birth with unilateral or bilateral watery discharge that progresses to

become mucopurulent. Neonatal ophthalmia due to *C. trachomatis* is not as clinically severe as gonococcal conjunctivitis. It is characterized by mucopurulent discharge, eyelid swelling, and pseudomembrane formation. While topical erythromycin prevents gonococcal ophthalmia, it does not prevent neonatal chlamydial conjunctivitis. Treatment is a 14-day course of oral erythromycin.

Take-Home Message

- Neonates suspected of gonococcal ophthalmia should have full septic evaluation for disseminated disease and should be started on empiric therapy.
- Neonatal gonococcal ophthalmia can be cured with single-dose ceftriaxone.

ABP Content Specifications

- Differentiate by age the etiology and understand the pathophysiology of gonorrhea.
- Recognize signs and symptoms of gonorrhea.
- Recognize the complications of gonorrhea.
- Plan management of acute gonorrhea.
- Recognize and interpret relevant laboratory and imaging studies in acute gonorrhea.
- Differentiate by age the etiology and understand the pathophysiology of chlamydia infections.
- Plan the management of acute chlamydia infections.

Question 19

A 17-year-old girl presents to the emergency department with ten days of generalized malaise and poor appetite followed by two days of diffuse arthralgias, particularly in her ankles and wrists. She denies sick contacts, insect or animal bites, recent travel, fever, rash, vomiting, or diarrhea. On examination, she is febrile to 103.2 °F and has a heart rate of 132 beats/minute. She has swelling, erythema, and warmth to left wrist. There is a 7-mm fluid-filled lesion on the dorsum of the left hand with a dark center. Laboratory findings are significant for white blood cell count of 8.2 x 10^9/L, hemoglobin of 9.5 g/dL, and C-reactive protein of 6.1 mg/L.

The best treatment of this condition is:

A. Ceftriaxone
B. Azithromycin
C. Doxycycline
D. Vancomycin
E. Solumedrol

Correct Answer: A

This patient's arthritis is secondary to disseminated gonococcus infection. In this patient, arthrocentesis of the wrist revealed gram-negative diplococci. *N. gonorrhea* was isolated from cultures of both synovial fluid and peripheral blood.

N. gonorrhea incidence remains high. Many patients remain asymptomatic. Infection in males may cause urethritis, proctitis, or pharyngitis. Females may develop cervicitis, urethritis, proctitis, menometrorrhagia, or pharyngitis. Urethritis is characterized by urethral discharge, dysuria, and meatal pruritus. Cervicitis may be asymptomatic or may be characterized by purulent vaginal discharge or erythema and friability of the cervix. Since it is rare for patients with cervicitis to present with severe abdominal pain and fever, one should suspect pelvic inflammatory disease (PID) in the setting of these symptoms. Complications of gonococcal infection can include PID, epididymitis, prostatitis, or disseminated gonococcal infection.

Diagnosis of gonococcal infection can be made with culture of suspected tissue plated on selective (Thayer-Martin) or nonselective (chocolate agar) media or, alternatively, nucleic acid amplification tests (NAATs). NAATs demonstrate higher specificity and sensitivity and may be considered less invasive than culture. However, NAATs are currently only FDA-cleared for use on endocervical, vaginal, and urethral (men) swabs and urine (from both men and women). Cultures should be sent from other tissues suspected of infection. Synovial fluid analysis usually reveals a leukocyte count around 50,000 cells/mm^3, low glucose level, and elevated lactate dehydrogenase level in patients with purulent arthritis. Synovial, skin, urethral or cervical, rectal, and pharyngeal specimens should be obtained in all patients with

suspected disseminated gonorrhea. Patients suspected to have gonorrhea should also be screened for other sexually transmitted infections including chlamydia, syphilis, HIV, and trichomoniasis. A vaginal wet prep can be performed to evaluate for bacterial vaginosis.

Disseminated disease, occurring in 1–3% of patients infected with *N. Gonorrhea*, presents classically with either a purulent arthritis or the triad of tenosynovitis, dermatitis, and migratory polyarthralgias. These patients usually experience an acute stage of fever, chills, and malaise that resolves spontaneously. Localized infection involving the urethra, cervix, rectum, or pharynx typically precedes the onset of systemic symptoms and is commonly asymptomatic. Rarely, patients can develop meningitis or endocarditis. Skin manifestations of disseminated disease present as hemorrhagic or vesiculopapular lesions, often painful and located on hands or feet. Only about 20–30% of these skin lesions will give a positive culture. Risk factors for developing disseminated disease include current or recent pregnancy, recent menstruation, systemic lupus erythematosus, and complement deficiencies.

Currently, combination therapy of ceftriaxone (250 mg IM × 1) with either azithromycin (1 g PO × 1) or doxycycline (100 mg PO BID × 7d) is the recommended treatment for uncomplicated genital, rectal, and pharyngeal infections. This provides empiric treatment for possible coinfection or alternative diagnosis with *C. trachomatis*. Disseminated disease is best treated as an inpatient with ceftriaxone 1 g IV every 24 hours for 24–48 hours or until patient experiences some clinical improvement, after which patients can be transitioned to oral cefixime (400 mg PO BID) to complete a minimum of 7 days of antibiotic therapy. These patients should also be presumptively treated for concurrent *C. trachomatis* infection. Efforts should be made to ensure that partner is referred for therapy or to provide expedited partner therapy and counseling regarding safe sex.

In prepubertal children, vaginitis is the most common gonococcal infection and is almost always due to sexual abuse. Anorectal and pharyngeal infection can also occur and are frequently asymptomatic. When evaluating a child for whom you have suspicion of child abuse, consider sending cultures rather than NAATs as they are preferred in most legal cases.

Differential diagnosis for patients with disseminated gonococcal infection includes meningococcemia, reactive arthritis, acute rheumatic fever, and typical bacterial septic arthritis. Vancomycin would be an appropriate choice if this patient's symptoms represented *S. aureus* infection, either soft tissue infection such as an abscess or septic arthritis. Doxycycline would be the appropriate treatment if this was Lyme disease resulting in arthritis and a rash. Azithromycin could be used to treat cat-scratch disease. Steroids can be used to treat inflammatory arthritis. The monoarticular or pauciarticular involvement of small joints helps to distinguish disseminated gonococcal infection from typical immune-mediated reactive arthritis which is more symmetric and extensive.

Take-Home Message

- Gonococcal infections are commonly asymptomatic.
- If symptomatic, the most common symptoms include urethritis or cervicitis.
- Disseminated gonococcal infections classically present with either a purulent arthritis or a triad of tenosynovitis, dermatitis, and migratory polyarthralgias.

ABP Content Specifications

- Differentiate by age the etiology and understand the pathophysiology of gonorrhea.
- Recognize signs and symptoms of gonorrhea.
- Recognize the complications of gonorrhea.
- Plan management of acute gonorrhea.
- Recognize and interpret relevant laboratory and imaging studies in acute gonorrhea.
- Know the etiology of urethritis/cervicitis.
- Recognize the signs and symptoms of urethritis/cervicitis.
- Plan the management of urethritis/cervicitis.

Question 20

A 14-year-old girl returns to the emergency department with dysuria 3 days after being seen at an urgent care center for the same complaint. She states that they diagnosed her with possible urinary tract infection and started nitrofurantoin. Despite compliance with medication, she states that symptoms are worsening. She denies fevers, hematuria, discharge, abdominal or flank pain, nausea, or vomiting. On examination, she appears uncomfortable. Vital signs are as follows: temperature 99.8 °F, heart rate 108 beats/minute, respiratory rate 14 breaths/minute, and blood pressure 110/74 mm Hg. Abdominal examination is unremarkable. No CVA tenderness. You note scattered bilateral inguinal lymphadenopathy. Urinalysis reveals leukocyte esterase 1+, nitrite negative, WBC 10–15, RBC 10, and squamous epithelial cells 25–50.

You next best step is:

A. Pelvic examination.
B. CT renal stone protocol.
C. Renal ultrasound.
D. Admit to hospitalist for IV antibiotics, failed outpatient management.
E. Change antibiotic to cephalexin and discharge home.

Correct Answer: A

On external pelvic examination, this patient was found to have skin lesions consistent with herpes simplex virus (HSV). These lesions can be painful and can burn when contacted by urine. HSV exists as two types: HSV-1 (classically associated with oral/labial HSV) and HSV-2 (classically associated with genital HSV). Despite these historical associations, either type can infect any anatomic site. HSV is transmitted through contact with infected skin lesions and mucous membranes. It can also be spread perinatally. Transmission is more likely during outbreaks but can occur via asymptomatic virus shedding.

Herpes genitalis is characterized by grouped vesicular or ulcerative lesions on an erythematous base of the genitalia or perineum. Transmission can be reduced substantially with the use of condoms. Other mucocutaneous manifestations of HSV would include herpes labialis (cold sores), gingivostomatitis, eczema herpeticum, herpetic whitlow, and herpes gladiatorum.

HSV infection is characterized by symptomatic episodes ("outbreaks") followed by asymptomatic periods when the virus is described as latent. Factors such as stress, immunodeficiency, trauma, menstruation, and exposure to sunlight can trigger recurrences. While most patients with HSV remain either asymptomatic or experience occasional mild-to-moderate outbreaks, HSV has the potential to cause life-threatening illness such as encephalitis or frequent severe recurrences associated with significant morbidity. Primary infection (the first HSV infection in any individual who has not had prior HSV infections) is typically associated with more severe symptoms including more extensive skin lesions, lymphadenopathy, and concomitant systemic symptoms including fever, headache, and malaise.

Diagnosis of genital herpes is usually clinically apparent, and further diagnostic testing is unnecessary. In the event of diagnostic uncertainty or history of immunocompromise, HSV testing may be helpful. Diagnostic options include viral culture, direct fluorescent antibody (DFA), or PCR of samples taken from the base of an unroofed vesicle. Type-specific antibodies detected in serum indicate history of HSV exposure a few weeks after initial infection and persist indefinitely.

Acyclovir (400 mg TID; 7–10 days for primary infection, 5 days for recurrent symptoms) is the treatment of choice for most cases of HSV infection. It can partially control the symptoms, limiting duration of an outbreak when administered at onset of symptoms. However, antiviral drugs neither eradicate latent virus nor affect future recurrences. Immunocompromised patients and patients with disseminated infection should be admitted for parenteral acyclovir. Topical acyclovir is generally not recommended. Patients with severe, frequent recurrences (>6 per year) may benefit from daily suppressive therapy.

Other causes of dysuria would include kidney stone, urinary tract infection, cervicitis, and

vulvovaginitis. CT abdomen/pelvis and renal ultrasound would both be used for assessment of the patient with suspected renal stone or abscess. Changing antibiotics to either oral or parenteral forms would be indicated if she, in fact, had a urinary tract infection which did not respond to current management. Her urinalysis is not definitive of a UTI, and alternative diagnosis is found in this patient with an appropriate physical exam.

Take-Home Message

- Mucocutaneous HSV is characterized by painful grouped vesicles and ulcerations found most commonly in the orolabial and anogenital regions.
- Recognition of the presentation of HSV can lead to rapid diagnosis and timely treatment with acyclovir.

ABP Content Specifications

- Understand the pathophysiology of herpes genitalis.
- Recognize the signs and symptoms of herpes genitalis.
- Plan the management studies of herpes genitalis.
- Recognize and interpret relevant laboratory and imaging studies in herpes genitalis.

Question 21

A 14-year-old boy presents to the emergency department with scrotal pain and swelling. He reports that symptoms began gradually three days ago and have progressively worsened. His mother noted that he had a fever today, so she brought him in for evaluation. The patient endorses mild dysuria for the last few weeks but denies discharge. The patient reports no trauma or prior similar episodes. He states that he has been sexually active for a year. On examination, the patient has an enlarged, tender mass superior to testis with erythema and swelling to the hemiscrotum. He is circumcised with scant clear fluid expressed from the meatus. Cremasteric reflex is present and testicular lie is vertical.

What is the most likely cause for this patient's condition?

A. *Chlamydia trachomatis* infection
B. Decreased circulation to the testicle
C. Persistent tunica vaginalis
D. Non-seminomatous germ cell tumor
E. *Staphylococcus aureus* infection

Correct Answer: A

This patient has epididymitis secondary to *Chlamydia trachomatis* infection. Most chlamydial genital tract infections are asymptomatic and, therefore, are likely to be undiagnosed and untreated. When symptomatic, *C. trachomatis* most commonly causes urethritis and epididymitis in males and mucopurulent cervicitis and pelvic inflammatory disease in females.

The gold standard for diagnosis of any *C. trachomatis* infection is culture on a Dacron polyester-tipped swab that has either a wire or plastic shaft; cotton-tipped swabs and wooden shafts are inhibitory to the organism. Nucleic acid amplification tests (NAATs) are an attractive alternative with a high specificity and a sensitivity higher than culture. NAATs are approved for cervical swabs from females, urethral swabs from males, and urine from men and women. Noninvasive methods of specimen collection such as urine or self-collected vaginal swab are particularly attractive in the adolescent patient. Because of possible false-positive results with NAATs, culture should be used to diagnose chlamydial infection in situations that have legal implications.

C. trachomatis and *N. gonorrhoeae* are the most frequent causes of epididymitis in men younger than age 35. Other causes of epididymitis, especially common in younger boys, include viral and coliform bacterial infections or tuberculosis. Clinically, epididymitis can present with unilateral scrotal pain, swelling, erythema, tenderness, and fever. Scrotal ultrasound is recommended to rule out other possibilities of scrotal swelling such as testicular torsion, inguinal hernia, cutaneous abscess, or mass. Scrotal ultrasound detects increased perfusion seen with the inflammatory changes of epididymitis.

Other complications of *C. trachomatis* could include proctitis or proctocolitis, prostatitis, Reiter syndrome (conjunctivitis, urethritis, and arthritis), inclusion conjunctivitis, and bartholinitis. If a pregnant woman has active infection during delivery, the infant may acquire the infection, developing either conjunctivitis or pneumonia. Isolation of *C. trachomatis* from a rectal or genital site in prepubertal children may be a marker of sexual abuse. LGV (lymphogranuloma venereum) and trachoma infections are caused by different serovars of *C. trachomatis* and are both rare in the Unites States. LGV is an invasive lymphatic infection with an initial genital ulcer accompanied by extensive, tender suppurative inguinal lymphadenopathy. Trachoma is a chronic keratoconjunctivitis which is a common cause of blindness worldwide.

The recommended treatment of uncomplicated urethral or endocervical chlamydia infections is azithromycin 1 gram administered once in healthcare setting, ensuring 100% compliance, or doxycycline 100 mg orally twice daily for 7 days. Patients with epididymitis should be treated for both *C. trachomatis* and *N. gonorrhea* with doxycycline 100 mg twice daily for 7 days and ceftriaxone 250 mg once intramuscularly. Empiric therapy is recommended in high-risk patients and those with unreliable follow-up. This would include most patients seen in the emergency department with signs or symptoms concerning for chlamydia. Such empiric therapy should also cover alternative diagnosis or concomitant *N. gonorrhoeae*. Treatment should be provided to any sexual partners. Concurrent testing for syphilis, HIV, and other sexually transmitted infections should be considered. Patients should be counseled to avoid sexual contact for at least one week after the antibiotic administration.

Take-Home Message

- Chlamydial genital tract infections are often asymptomatic.
- Empiric therapy should be started for presumed *C. trachomatis* infection in adolescent males with urethritis or epididymitis, adolescent females with cervicitis or PID, or any patient with diagnosis of gonococcal infection.

ABP Content Specifications

- Differentiate by age the etiology and understand the pathophysiology of chlamydia infections.
- Recognize signs and symptoms of genital chlamydia infections.
- Plan the management of acute and chronic chlamydia infections.
- Recognize the complications of chlamydia infections.
- Recognize and interpret relevant laboratory and imaging studies in acute chronic chlamydia infections.

Question 22

A 7-month-old female infant is brought to the emergency department for evaluation of fever. She has had a subjective fever for 24 hours, has been lethargic and irritable, and has had six episodes of non-bloody, non-bilious emesis. On examination, her temperature is 103.6 °F, heart rate 173 beats/minute, respiratory rate 24 breaths/minute, and blood pressure 96/55 mmHg. She is listless and ill appearing in mom's arms and poorly responsive to stimulation and IV attempts, though cries and resists with attempts at passive neck movement. Her examination is otherwise non-focal, and she has no focal neurologic findings. An IV is placed and workup is initiated. Her CSF is cloudy and reveals 1800 WBC/hpf with 89% neutrophils, 2% bands, and 9% lymphocytes; 3 RBC/hpf; glucose 30 mg/dL; and protein 110 mg/dL. Gram stain is pending. What medication(s) should be given next?

A. Piperacillin-tazobactam
B. Ampicillin and gentamicin
C. Vancomycin and ceftriaxone
D. Dexamethasone
E. Acyclovir

Correct Answer: C

The patient in this vignette has bacterial meningitis and should be treated with intravenous vancomycin and high-dose intravenous ceftriaxone.

Table 12.8 Common causative organisms of bacterial meningitis by age

<1 month	Group B streptococcus (GBS) *Escherichia coli* *Listeria monocytogenes* Gram-negative bacilli
Between 1 and 3 months	Group B streptococcus Gram-negative bacilli *Streptococcus pneumoniae* *Neisseria meningitidis*
Between 3 months and 3 years	*Streptococcus pneumoniae* *Neisseria meningitidis* Group B streptococcus Gram-negative bacilli
Between 3 years and 10 years	*Streptococcus pneumoniae* *Neisseria meningitidis*
Between 10 years and 19 years	*Neisseria meningitidis*

While the incidence of bacterial meningitis has declined due to widespread vaccination against Hib and pneumococcus, it remains a significant cause of morbidity and mortality. The etiology of bacterial meningitis depends on age (Table 12.8). *Streptococcus pneumoniae* is the most common causative organism across all age groups. *Staphylococcus aureus* may affect patients with indwelling catheters, recent head trauma or neurosurgical procedures, or prolonged hospitalization.

Children with bacterial meningitis often present with rapid onset of severe symptoms such as headache, nuchal rigidity, vomiting, lethargy, focal neurologic symptoms, or seizures; however, the presentation can be more protracted with subtle symptoms as well. While many patients will have classic symptoms, up to 20–40% of cases of bacterial meningitis will present without nuchal rigidity or a positive Kernig or Brudzinski sign on examination.

A lumbar puncture (LP) should be performed in most cases, though should not be obtained in clinically unstable patients. When patients are too clinically unstable to undergo LP, empiric antibiotic therapy administration should not be delayed. In patients with suspected increased intracranial pressure or focal neurologic findings, cranial imaging should be obtained prior to lumbar puncture to evaluate for intracranial lesion and risk for herniation.

Once cerebrospinal fluid (CSF) is obtained, it should be sent to the laboratory for cell count, glucose, protein, culture, and gram stain. Typical findings include a CSF white blood cell count >1000/hpf, glucose <40 mg/dL, protein <100 mg/dL, and a positive gram stain. However, early or atypical bacterial meningitis may have few or none of these findings.

The choice of antibiotic regimen depends on the age of the patient and should cover the most common pathogens for the specific age range. Children younger than 1 month should receive ampicillin and either gentamicin or cefotaxime depending on local susceptibilities and expert opinion. Children older than 1 month should receive vancomycin and a high-dose third-generation cephalosporin, either cefotaxime (300 mg/kg/day divided in 3 to 4 daily doses) or ceftriaxone (100 mg/kg/day once daily or divided twice daily). Piperacillin-tazobactam is not a commonly used antibiotic for meningitis. While it has reasonable CNS penetration, the rate of penicillin-resistant pneumococcus and meningococcus makes this an inappropriate single agent to treat meningitis.

Dexamethasone given prior to or within one hour of first dose of antibiotics has been shown to decrease hearing loss secondary to *Haemophilus influenzae* (Hib) meningitis which was a devastating pathogen prior to widespread vaccination. In the postvaccine era, this pathogen is extremely rare, and the use of dexamethasone has not been proven to decrease mortality or other neurologic sequelae secondary to other organisms. While some infectious disease specialists will still advocate for dexamethasone, this is not universal and should be considered on a case-by-case basis.

Finally, this child does not have any apparent risk factors or symptoms of herpes simplex virus (HSV) meningoencephalitis, making acyclovir an inappropriate choice. In neonates with fever undergoing an evaluation for meningitis, many experts recommend evaluation for HSV with a CSF HSV PCR test and empiric administration of acyclovir, though this practice varies and is not recommended for older children.

Take-Home Message

- Children with bacterial meningitis typically (though not always) present with fever, headache, and signs of meningeal irritation such as nuchal rigidity.
- *S. pneumoniae* and *N. meningitidis* are the most common causative pathogens in infants and children older than 1 month of age.
- Empiric antibiotics (typically vancomycin and ceftriaxone) should be administered as soon as possible and should not be delayed for lumbar puncture in a child who is critically ill in whom meningitis is suspected.

ABP Content Specifications

- Differentiate by age the etiology and understand the pathophysiology of bacterial meningitis.
- Recognize signs and symptoms of bacterial meningitis.
- Recognize and interpret relevant laboratory and imaging studies for bacterial meningitis.
- Recognize life-threatening complications of bacterial meningitis.
- Plan management of acute bacterial meningitis.

Question 23

A 9-year-old girl presents to the emergency department in August with 2 days of subjective fever, worsening headache, and vomiting. She is previously healthy and fully vaccinated. On examination, she is febrile with a temperature of 101.4 °F but is otherwise well appearing. Her physical examination is unremarkable. She has a non-focal neurologic examination, without frank nuchal rigidity, though she states that neck movement worsens her headache. Blood work and a lumbar puncture are performed, and results are as follows:

- Serum:
  - WBC: 13,000 cell/mm^3
  - Neutrophils: 20%
  - Bands: 0
- CSF:
  - WBC: 375/hpf
  - Neutrophils: 15%
  - Lymphocytes: 73%
  - Monocytes: 12%
  - RBC: 8/hpf
  - Glucose: 75 mg/dL
  - Protein: 50 mg/dL
  - Gram stain: No organisms

What is the appropriate next step in her management?

A. Admit for observation with plan for repeat lumbar puncture in 24 hours.
B. IV vancomycin and ceftriaxone while awaiting CSF culture results.
C. Send CSF herpes simplex PCR and treat with IV acyclovir until PCR results available.
D. Reassurance, pediatrician follow-up, and strict return precautions.
E. Admit her for observation and continuous EEG monitoring.

Correct Answer: D

This patient is displaying the signs and symptoms of aseptic meningitis, likely caused by an enterovirus such as coxsackievirus or echovirus. While aseptic meningitis syndrome is classified as any CSF inflammation in the absence of bacterial growth, the clear majority of these illnesses are caused by viruses. These viral illnesses occur commonly from July through October, though may occur year-round. Symptoms are variable, but patients often present with sudden onset of fever, headache, neck pain, nausea, vomiting, photophobia, and malaise. The severity varies widely, and patients may present with either mild headache or severe meningismus and vomiting.

Workup for patients with suspected viral meningitis depends on the clinical presentation. Patients with only mild symptoms may be reassured without further testing and treated with nonsteroidal anti-inflammatory drugs (NSAIDs) and oral hydration. In patients with more severe symptoms, workup is aimed at ruling out more

significant pathology, most notably bacterial meningitis. Treatment should include empiric antibiotic treatment until bacterial meningitis has been excluded and symptom control with antiemetics, intravenous fluids, and pain medications. The vast majority of patients with aseptic meningitis recover in 5–14 days without complication; however, prolonged symptoms persisting for weeks to months have been reported. In endemic regions, consideration should be given to evaluation for Lyme disease or rickettsial pathogens.

Much work has been done in determining which patients are likely to have viral rather than bacterial meningitis. The bacterial meningitis score (BMS) is a tool that can be used by the emergency department provider to identify patients at low risk for bacterial meningitis. If patients have any of the following, they cannot be deemed low risk and will likely need empiric antibiotic therapy until CSF culture is finalized:

- Positive CSF gram stain.
- CSF ANC ≥1000 cells/mm^3.
- CSF protein ≥80 mg/dL.
- Peripheral blood ANC ≥ 10,000 cells/mm3.
- Seizure at onset or prior to time of presentation.

The power of this score lies in its high negative predictive value (NPV). Meta-analysis showed that a BMS of zero gives a NPV for bacterial meningitis of 99.3%–99.9%. Therefore, otherwise healthy patients older than 2 months of age, who have not been pretreated with antibiotics, who are not ill appearing, without petechiae or purpura, and without a history of neurosurgery or ventriculoperitoneal shunt, can be safely discharged home with a likely diagnosis of aseptic meningitis if they have a BMS of zero. The patient in the vignette has a BMS of zero after evaluation and is well appearing, making her a good candidate for home management.

Observation and repeat lumbar puncture would be inappropriate given the low likelihood of bacterial meningitis. If our patient had other risk factors, pretreatment with antibiotics, or severe symptoms, it may be reasonable to admit her with empiric antibiotics to await culture, but given her well appearance in this vignette, it is likely unnecessary. An otherwise healthy 9-year-old without risk factors, seizures, or vesicular rash is unlikely to have herpes simplex virus (HSV) meningoencephalitis; therefore, empiric treatment and evaluation for this are unnecessary. Lastly, she has not exhibited any symptoms concerning for seizure activity, and aseptic meningitis is unlikely to predispose her to seizures; therefore, electroencephalogram (EEG) monitoring is unwarranted.

Take-Home Message

- Aseptic meningitis is a common illness during summer months characterized by fever, headache, neck stiffness, nausea, and vomiting which resolves without sequelae in most patients.
- In well-appearing low-risk patients with symptoms concerning for meningitis, the bacterial meningitis score is a valuable tool to rule out bacterial meningitis given its very high negative predictive value.

ABP Content Specifications

- Differentiate by age the etiology of aseptic meningitis.
- Recognize signs and symptoms of aseptic meningitis.
- Recognize and interpret relevant laboratory and imaging studies for aseptic meningitis.
- Recognize life-threatening complications of aseptic meningitis.
- Plan management of acute aseptic meningitis.

Question 24

A 7-year-old female presents to the emergency department via EMS following seizure-like activity. For the past 3 days, she has had fever, headache, rhinorrhea, cough, and occasional non-bloody, non-bilious vomiting. The mother denies rashes, oral lesions, neck pain, or diarrhea. The patient has been tolerating fluids and

has not received any medication for this illness. Today, she began to act strangely with nonsensical speech, lethargy, and difficulty walking. Prior to arrival, she had 30 seconds of generalized seizure activity that spontaneously resolved before EMS arrival.

In the ED, the patient is febrile with a temperature of 102 °F. She has a pulse of 130 beats/minute, respiratory rate of 18 breaths/min, and blood pressure of 104/62. She is awake and alert, though babbling nonsensically and pointing to the corner of the room. She is uncooperative with exam though has no focal neurologic findings, and the remainder of her physical examination is normal. Serum studies are unremarkable, a head CT is normal, and a lumbar puncture is performed. Her cerebrospinal fluid (CSF) is significant for 410 WBC/hpf with 15% neutrophils, 75% lymphocytes, 10% monocytes, 10 RBC/hpf, glucose 70 mg/dL, and protein 90 mg/dL. The patient's mental status remains unchanged. Which of the following statements is true?

A. Electroencephalogram (EEG) will likely be normal as she does not have clinical seizure activity.
B. She is safe for discharge home with close primary care follow-up.
C. She is at low risk for persistent neurologic sequelae following this illness.
D. Bacterial meningitis is unlikely; therefore, she does not need empiric antibiotics.
E. Glucocorticoids have not been shown to be beneficial for treatment.

Correct Answer: E

The patient in this vignette is suffering from acute encephalopathy in the setting of a febrile illness, making viral encephalitis highly likely. Encephalitis is characterized by inflammation of brain parenchyma that presents with neurologic disturbances. Symptoms vary and may include altered mental status, behavior or personality changes, motor or sensory deficits, speech or movement disorders, seizures, and coma. Symptoms can have a rapid onset or follow a more indolent and gradual course. Encephalitis is often accompanied by symptoms of meningeal inflammation (meningoencephalitis) which include headache, neck pain, nausea, vomiting, and meningismus. While most cases of encephalitis are caused by viral illnesses, other etiologies include bacterial infection, fungal infection, and paraneoplastic and autoimmune processes (i.e., anti-NMDA receptor encephalitis). Furthermore, up to 50% of cases are idiopathic, and no specific etiology is ever found. Newborns with encephalitis are at high risk for herpes simplex virus (HSV) infection, though HSV meningoencephalitis can occur in older children and adults as well.

Initial evaluation of children with suspected encephalitis includes assessment of hemodynamic and respiratory stability along with the ability of the patient to protect his or her airway followed by resuscitation as needed. A thorough neurologic exam should be done with emphasis on identifying focal neurologic findings. If the clinical picture is unclear or if there are focal neurologic findings, cranial imaging should be obtained prior to lumbar puncture to rule out evidence of significantly increased intracranial pressure or a space-occupying lesion. In the emergency department, this will generally be done with a noncontrasted computed tomography (CT) study, though most patients will eventually require magnetic resonance imaging (MRI) as well.

Laboratory evaluation is often nonspecific. CSF evaluation reveals pleocytosis with CSF WBC typically less than 500 cells/hpf with a lymphocytic predominance. CSF glucose is usually normal, and protein may be mildly elevated. A culture of the CSF should be sent as bacterial meningitis will remain on the differential diagnosis early in the course of the illness. HSV and varicella zoster (VZV) PCR of the CSF and serum should be ordered. EEG should be considered on all patients to evaluate for nonconvulsive status epilepticus. EEG findings are abnormal in up to 90% of patients with encephalitis, though findings are often nonspecific. MRI will help detect subtle mass lesions not previously seen on CT, identify signs of HSV encephalitis, and differentiate viral encephalitis from acute demyelinating encephalomyelitis (ADEM) which may present similarly.

Treatment for encephalitis depends on the etiology of the illness and often involves only supportive care. Until CSF cultures have been negative for 48 hours, empiric antibiotics should be given to cover for possible bacterial meningitis. Most patients should also be given empiric acyclovir until HSV and VZV PCR are negative. If no treatable causes of symptoms are identified, treatment involves supportive care until symptoms improve. Physical or occupational therapy may help rehabilitation of any identified neurologic deficits. While glucocorticoids are the mainstay of treatment in ADEM, they have not been shown to improve symptoms or outcomes in viral encephalitis. Similarly, other immunomodulatory treatments such as intravenous immunoglobulin (IVIG) and plasma exchange have not been beneficial.

Prognosis depends on the etiology of the illness, as well as patient factors and presenting symptoms. HSV and eastern equine encephalitis carry a high mortality rate, as well as a high rate of long-term neurologic sequelae. Other types of viral encephalitis have much lower mortality rates. The rate of persistent neurologic sequelae including personality changes, behavior disorders (i.e., ADHD), movement disorders, intellectual disability, learning disorders, ataxia, and motor or sensory disturbances may be as high as 50%. The rate of neurologic sequelae is higher in younger children and those presenting with seizures or encephalopathy, such as the patient in this vignette.

Take-Home Message

- Acute encephalitis is characterized by inflammation of the brain parenchyma usually due to a virus leading to a variety of neurologic symptoms, altered level of consciousness, seizures, and/or behavioral changes.
- CSF studies and neuroimaging are necessary in most cases in order to evaluate for potentially treatable etiologies.
- Treatment and prognosis depend on the underlying etiology of the illness with many children experiencing prolonged neurologic sequelae.

ABP Content Specifications

- Differentiate by age the etiology of encephalitis.
- Recognize signs and symptoms of encephalitis.
- Recognize and interpret relevant laboratory and imaging studies for encephalitis.
- Recognize life-threatening complication.

Question 25

A recently immigrated Creole speaking mother living in a shelter brings her 4-year-old son to the emergency department to have his PPD test read. She states it was placed roughly 60 hours ago. You note that there is 20 mm of induration. The child has not had any fevers, coughing, or night sweats. He is growing appropriately and is otherwise well according to the mother. Your exam is unremarkable. What is your next step for this patient?

A. Discharge home with primary pediatrician follow-up.
B. Obtain a chest X-ray while the patient is in the ED.
C. Prescribe the patient a 9-month course of isoniazid.
D. Order a Quantiferon test to confirm PPD testing.
E. Obtain a sputum sample from the patient for AFB testing.

Answer: B

Tuberculosis (TB) is caused by a bacterium called *Mycobacterium tuberculosis*. The bacteria usually target the lungs but can involve any organ system. Pulmonary tuberculosis in children is characterized by chronic cough, prolonged fever, and weight loss. The most common forms of extrapulmonary tuberculosis in children involve the central nervous system and superficial lymph nodes, but it can involve nearly any organ system. Patients who have been exposed to tuberculosis but are not currently symptomatic are described as having latent tuberculosis.

PPD (purified protein derivative) testing is currently the most common method of screening patients for TB (Table 12.9). The tuberculin skin test (PPD in North America) consists of an intradermal injection of tuberculin material stimulating a delayed-type hypersensitivity reaction resulting in induration at the site of injection. When interpreting the test, the area of induration (not erythema) should be measured in millimeters, 48 to 72 hours after injection. Analyses of results are dependent on risk of the patient (Table 12.10). The diagnosis of latent TB is made when there is immunological evidence of TB infection (positive PPD or Quantiferon testing), no symptoms of TB, a normal physical exam, and an X-ray negative for active TB.

This patient has no signs or symptoms of active TB (cough, fevers, night sweats, weight loss) but will need to have a chest X-ray as the next step to ensure there is no active pulmonary involvement. Ultimately, if X-ray demonstrates no signs of active TB, he will need to be started on medications and followed out patient for treatment of latent TB. There are many equally efficacious treatment options for latent TB; choice of regimen is determined based upon likelihood of adherence, potential for adverse effects, and shared decision-making between provider and family. Options include:

- Daily rifampin (RIF) for 4 months
- Weekly isoniazid (INH) and rifapentine for 3 months (direct observation)
- Daily INH for 9 months
- Daily INH and RIF for 3 months

Take-Home Message

- Latent tuberculosis is a clinical diagnosis made in asymptomatic patients with immunologic evidence of prior exposure (positive PPD or Quantiferon test).

ABP Content Specifications

- Know the etiology and understand the pathophysiology of tuberculosis.
- Recognize signs and symptoms of tuberculosis.
- Recognize and interpret relevant laboratory and imaging studies for tuberculosis.
- Recognize life-threatening complications of tuberculosis.
- Plan management of tuberculosis.

Table 12.9 High-risk groups for tuberculosis

Medically underserved/homeless persons
Illicit drug use
Resident or employee in institutional setting
Occupation in healthcare field
Extended travel in high-incidence countries
Immigration within the past five years from high-incidence countries

Table 12.10 Interpretation of PPD results

Positive read if > 5 mm and:	*Positive read if > 10 mm and:*	*Positive read if > 15 mm and:*
HIV infected	Recent immigration (<5 years) from high-prevalence country	Persons with no known risk factors
A recent contact with person with active TB	Injecting drug user	
Transplant patients	Children <4 years	
Fibrotic changes on CXR consistent with prior TB	Mycobacteriology laboratory personnel	

Question 26

The parents of 3-week-old male bring the neonate to the emergency department for concerns regarding erythema and a foul smell "from the belly button." The child was born at 34 weeks gestational age and had "a tube placed in the belly button" in the NICU. The patient is awake and alert, in no acute distress. He is afebrile with a heart rate of 166 beats/min. The abdomen is non-distended. You note foul-smelling scant purulent drainage from the umbilicus with 3 cm of surrounding erythema and induration. Which of the following is the next best step?

A. Use silver nitrate topically to debride granulation tissue and cauterize any bleeding.
B. Provide reassurance and education regarding umbilical care.
C. Order a fistulogram.
D. Obtain a renal ultrasound and VCUG (voiding cystourethrogram).
E. Obtain cultures of serum, urine, and cerebrospinal fluid, start patient on empiric antibiotics, and admit to the hospital.

Correct Answer: E

Umbilical care is a frequent concern for parents. Most visits to the emergency department regarding umbilical concerns can be addressed by simple reassurance and education regarding umbilical care, specifically regarding normal cleansing of the stump and cord separation. However, more serious infections, hernias, granulomas, and congenital abnormalities can occur. This patient has omphalitis, a potentially life-threatening infection of the umbilical stump. Presentation involves foul-smelling drainage from the stump with surrounding erythema, induration, and tenderness. These infections are polymicrobial. Risk factors for development of omphalitis include prematurity, improper cord care, umbilical catheterization, home birth, prolonged rupture of membranes, or maternal infection. Patients suspected of having omphalitis are at risk for concurrent bacteremia, sepsis, meningitis, and necrotizing fasciitis. Therefore, they should undergo a full septic workup and be hospitalized for empiric broad-spectrum antibiotics.

Differential for discharge from the umbilicus includes normal cord separation, umbilical granuloma or polyp, persistent urachal, or omphalomesenteric anomalies. Umbilical granulomas form in the remnant of the umbilicus. The size is variable, and they can be up to 1 cm. They are moist and respond well to application of silver nitrate. There is no involvement of the skin surrounding the umbilicus (as seen in omphalitis). Umbilical polyps are masses found in the umbilicus. They consist of intestinal or uroepithelium. They do not respond to application of silver nitrate; treatment is excision. A draining sinus in the umbilicus may represent incomplete closure of the omphalomesenteric duct or the urachus. These patients need a more extensive evaluation that includes a fistulogram for concern regarding omphalomesenteric duct or renal ultrasound and VCUG for concern regarding a patent urachus.

Take-Home Message

- Omphalitis is a serious polymicrobial infection of umbilicus and surrounding tissues. Possible complications include sepsis and necrotizing fasciitis.
- Workup of omphalitis includes full septic evaluation and admission with broad-spectrum parenteral antibiotics.

Endocrine and Metabolic Diseases

13

Pediatric Endocrinology

Mushtaq Godil

Question 1

A previously healthy 2-year-old African-American girl presented with vomiting and abdominal pain for 2 days. She had no fever, cough, or diarrhea but for the past 3 months has frequent urination and increased thirst associated with weight loss despite good appetite. Past medical history was unremarkable, and family history was negative for diabetes. On arrival in the emergency department, she is severely dehydrated and has rapid shallow breathing. What is the most likely diagnosis?

A. Diabetic ketoacidosis (DKA)
B. Acute gastroenteritis
C. Syndrome of inappropriate secretion of ADH (SIADH)
D. Munchausen by proxy
E. Diabetes insipidus (DI)

Correct Answer: A

This patient has a history of polyuria, polydipsia, and weight loss; at her age, it makes the diagnosis type 1 diabetes likely. Diabetic ketoacidosis (DKA) is an acute life-threatening complication of diabetes mellitus. Up to 30% of patients with newly diagnosed diabetes present with DKA. DKA is defined by the triad of hyperglycemia (blood glucose >13.9 mmol/L: 250 mg/dl), ketonemia/ketonuria, and acidemia (pH ≤7.3; serum bicarbonate ≤15 mmol/L). Younger children are especially prone to present with DKA as the disease progresses rapidly, and symptoms of diabetes are often nonspecific and may be attributed to other common conditions such as urinary tract infection or behavioral issues. Prompt diagnosis and treatment is critical for the outcome as delay in treatment can be associated with significant morbidity and mortality. None of the other conditions can explain the constellation of polyuria, polydipsia, weight loss, and acute decompensation with severe dehydration and hyperventilation with Kussmaul breathing.

Diabetes insipidus (DI) presents with polyuria, polydipsia, hypernatremia, and dehydration. In DI, urinary output is greater than 4 ml/kg per hour, but the urine specific gravity is less than 1.005. It is a disorder of a large volume of urine that is hypotonic and dilute as opposed to the hypertonic urine of diabetes mellitus.

The syndrome of inappropriate secretion of ADH (SIADH) exists when the secretion of ADH occurs in the absence of an appropriate physiologic stimulus. The characteristic findings are inappropriately concentrated urine, despite the presence of a low serum osmolality and a normal blood volume. The laboratory findings include low serum osmolarity, high urine osmolarity, and high urine sodium.

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_13

Take-Home Message
Consider diabetes mellitus in the differential diagnosis of acute weight loss in children even if there is no clear history of polyuria and polyuria. In preverbal children, it may be difficult to diagnose early in the disease process.

ABP Content Specification
- Recognize signs and symptoms of diabetic ketoacidosis.

Question 2

Identify the appropriate sequence of management options to treat DKA.

A. Hyperglycemia, dehydration, acidosis
B. Acidosis, dehydration, hyperglycemia
C. Electrolyte abnormalities, hyperglycemia, dehydration
D. Dehydration, hyperglycemia, acidosis
E. Dehydration, electrolyte abnormalities, acidosis

Correct Answer: E

The initial goal in treatment of DKA is to restore perfusion with intravenous fluids to improve hemodynamic instability. After initial volume stabilization, the second most urgent problem is to correct electrolyte abnormalities, such as hyponatremia, hypokalemia, and hyperkalemia. Termination of ketogenesis by giving low-dose insulin infusion will eventually reverse acidosis and stimulate glucose uptake and metabolism. Correction of hyperglycemia is not of higher priority in the management of DKA.

Take-Home Message
Hemodynamic instability in DKA is associated with increased morbidity and mortality and should be addressed promptly.

ABP Content Specification
- Plan the management of acute diabetic ketoacidosis.

Question 3

An 11-year-old boy with poorly controlled type 1 diabetes presents to the ED with a 2-day history of abdominal pain, vomiting, and diarrhea. At home, he had received multiple doses of rapid-acting insulin for high blood sugars with ketones. He was noted to have anion gap metabolic acidosis (CO_2 8 mmol/L), hyperglycemia (blood glucose 339 mg/dl), glucosuria (urine glucose 500 mg/dl), and ketonuria (urine ketones >80 mg/dl). A diagnosis of DKA was made, and he was given a 10 ml/kg saline bolus and 0.1 u/kg bolus of regular insulin. He was then started intravenous fluid (maintenance × 2) and insulin infusion at 0.1 u/kg/h. Two hours later, his glucose was 121 mg/dl, but CO_2 was remained low at 7 mmol/L. The best management option would be to:

A. Add glucose in the IVF and continue with insulin infusion at 0.1 u/kg/hour.
B. Decrease insulin infusion to 0.05 u/kg/hour.
C. Add glucose in the IVF and decrease insulin infusion to 0.05 u/kg/hour.
D. Make no change in the current management.
E. Start sodium bicarbonate at 1 mEq/kg/hour.

Correct Answer: A

Insulin insufficiency is the core problem in triggering DKA followed by subsequent increase in counter-regulatory hormones causing hyperglycemia and accumulation of ketoacids. Insulin stimulates the uptake of glucose from the blood into tissues (muscle, adipose tissue) where it is utilized for energy production and storage. Insulin also inhibits hepatic gluconeogenesis, lipolysis, and ketogenesis. When insulin is missing, hepatic gluconeogenesis continues, further exaggerating hyperglycemia. Increased lipolysis and ketogenesis cause an elevated anion gap metabolic acidosis.

Treatment of DKA involves the correction of hypovolemia and electrolyte abnormalities and reducing ketoacid production and hyperglycemia, besides treatment of any underlying cause.

Fluid replacement therapy should be initiated immediately after diagnosis followed by insulin. Subcutaneous insulin administration has unpredictable or inadequate absorption in acutely sick patients, who are likely volume depleted and have poor peripheral perfusion. It may have a prolonged half-life and a delayed onset of action causing an unpredictable fall in blood glucose as in this patient, who received multiple doses of rapid-acting insulin at home before presenting to the ED.

The best course of action in this patient would be to add glucose in the IVF to prevent further decrease in blood glucose, while keeping the insulin infusion at 0.1 u/kg/h as DKA cannot be reversed without insulin because of increased production of ketoacids (β-hydroxybutyrate and acetoacetate).

Take-Home Message
Do not decrease insulin dose for hypoglycemia if the patient is still acidotic.

ABP Content Specification
- Understand the pathophysiology of diabetic ketoacidosis.

Question 4

A 7-year-old boy with a past medical history of type 1 diabetes started vomiting with abdominal pain while camping with family. According to his sister, he was taking his insulin as usual, and his blood sugar before breakfast this morning was in the 450 s. No report of excessive urination, cough, nasal congestion, sore throat, ear pain, headaches, fevers, or chills.

In the ED, his glucose is 432 mg/dl, pH 6.99, pCO_2 14.8 mmHg, Na 130 mEq/L, bicarbonate 2 mmol/L, and anion gap 35. He was immediately started on IV fluids and continuous insulin infusion. A few hours later, he had an episode of staring into space with inability to respond to questions. Physical exam showed dilated pupils.

The steps in the management of this patient include all of the following except:

A. Reducing the intravenous fluid rate administration
B. Elevation of the head of the bed
C. Mannitol 2 g/kg IV
D. 3% hypertonic saline 5–10 ml/kg over 30 minutes
E. Intubation and mechanical ventilation

Correct Answer: C

Cerebral edema is a well-known complication of diabetic ketoacidosis (DKA) in pediatric patients with an incidence of 1%. The mortality rate once cerebral edema sets in is between 20% and 40% and is the most common cause of mortality among type 1 DM children. Most cases of cerebral edema occur in patients less than 20 years of age.

Risk factors include severe acidosis (pH less than 7.0), PCO_2 less than 20 mm Hg, excessive fluid administration, severe dehydration, treatment with bicarbonate, and failure of serum sodium to rise with corresponding decrease in glucose levels. It usually presents with headache and vomiting and progresses to decreased arousal and altered mental status. Other features may include high BP, bradycardia, and irregular respirations (Cushing triad) indicating increased intracranial pressure and impending herniation. If not recognized and treated promptly, it may progress to decorticate or decerebrate posturing and, finally, herniation and death.

Treatment involves measures to decrease intracranial pressure and includes head elevation, mannitol 0.5 to 1 g/kg over 20 minutes (not 2 g/kg) (repeat if necessary), and reducing IV fluids. 3% hypertonic saline 5 to 10 ml/kg over 30 minutes may also be used. Intubation and mechanical ventilation are also a consideration if clinical condition deteriorates.

Take-Home Message
Suspect cerebral edema in patient with DKA and altered mental status.

ABP Content Specification
- Recognize the life-threatening complications of diabetic ketoacidosis.

Question 5

A 17-year-old diabetic male, who recently started using an insulin pump, presents to the emergency department for high sugar levels. His blood sugar at breakfast was 104 mg/dl and at lunch time was 141 mg/dl. He had a soccer game earlier which lasted a couple of hours. After the game, his glucose level was 353 mg/dl. He gave himself a correction bolus of 7.4 units. He repeated his blood glucose level at home around dinner time, and it was 402 mg/dl. He gave himself another correction bolus of 8 units plus 10 units for 80 grams of carbohydrates. His urine was negative for ketones. His blood sugar before bed was high on the meter for which parents brought him to the emergency department. He has no complaint of abdominal pain, nausea, or vomiting.

The best next step in the management of this patient should be.

A. Give another bolus via pump based on the pump's bolus wizard setting.
B. Give another bolus via subcutaneous injection based on the pump's bolus wizard setting.
C. Change the pump site and check blood glucose level in 2 hours.
D. Change the pump site, but give bolus via subcutaneous injection based on the pump's bolus wizard setting.
E. Admit the patient for management of DKA.

Correct Answer: D

The use of continuous subcutaneous insulin infusion (CSII) via external pumps is increasing in pediatric population even in very young patients. An insulin pump is an alternative to treatment with multiple daily injections (MDI), and it has shown to be effective in improving HbA1c and reducing the incidence of hypoglycemia as well as improving the quality of life. The insulin pump provides both basal and bolus coverage with rapid-acting insulin, and there is no background long-acting insulin on board in case of interruption of insulin infusion (dislodgement of the site, obstruction in the tubing, or pump malfunction). Most of the cases of unexplained hyperglycemia in a patient on insulin pump are pump-related malfunctions (e.g., a bad site). A common mistake is using the pump for the correction bolus which is unlikely to control the hyperglycemia, as interruption in the insulin infusion due to a bad site is the cause of hyperglycemia to begin with.

This patient had a soccer game, and he was very active during the day, and most likely, his pump site was dislodged causing interruption in insulin infusion and hyperglycemia. However, instead of changing the site, he continued to use the same site for correction bolus which led to a progressive worsening of hyperglycemia. Providing another bolus via pump is not going to help him. Simply changing the pump site will not address current hyperglycemia. Giving a bolus via subcutaneous injection may temporarily help hyperglycemia but will not address the core problem of interruption in insulin infusion and ultimately lead to recurrent hyperglycemia. As he has no ketones, no abdominal pain, nausea, or vomiting or other features suggestive of DKA, there is no need for admission at this time.

Take-Home Message

For patients on insulin pump with unexplained hyperglycemia, always consider changing the pump site.

ABP Content Specification

- Plan the management of nonketotic hyperglycemia.

Question 6

An 11-year-old boy, with known type 1 diabetes, presents in the emergency department in diabetic ketoacidosis (DKA). He is noncompliant, and his last hemoglobin A1c was 11.1% a few months ago. He woke up in the morning feeling dizzy. He tried to eat but then vomited twice at home. He checked his blood sugar which was high. He then checked his urine, and it was showing large ketones. At that time, he told his mother, who brought him to the ED.

In the ED, his vital signs are as follows: temperature 97.4 °F, heart rate 106 beats/minute, respiratory rate 32 breaths/minute, and BP 108/60 mmHg. Laboratory evaluation is obtained and shows:

- Serum glucose 670 mg/dl
- Serum sodium 128 mEq/L
- Serum potassium 5.1 mEq/L
- Serum chloride 92 mEq/L
- Serum bicarbonate 5 mmol/L
- Blood urea nitrogen 26 mg/dl
- Serum creatinine 1.09 mg/dl
- Serum calcium 10 mg/dl

Complete blood profile shows the following:

- White blood cells 18 K
- Hemoglobin 14.7 g/dl
- Hematocrit 43.2%
- Platelet count 331 K
- Neutrophils 81.7%, lymphocytes 11.1%
- A venous blood gas was obtained and shows
- pH 7.12
- PCO_2 29 mmHg
- PO_2 110 mmHg
- HCO_3 6.99 mmol/L
- Serum amylase 49 U/L
- Serum lipase 11 U/L
- PT 12.3 seconds
- INR 1.05
- PTT 31 seconds

He receives two 10 ml/kg boluses of normal saline, and repeat laboratory evaluation shows:

- Serum sodium 130 mEq/L
- Serum potassium 5.5 mEq/L
- Serum chloride 97 mEq/L
- Serum bicarbonate 4 mmol/L
- Serum glucose 429 mg/dl
- Blood urea nitrogen 25 mg/dl, Serum creatinine 1.06 mg/dl
- Serum calcium 9.6 mg/dl

Repeat venous blood gas shows:

- pH 7.10
- PCO_2 27 mmHg
- PO_2 66 mmHg
- Oxygen saturation 85%

The next choice of fluid for replacement in this patient should be:

A. 0.9% NaCl at 1.5–2 maintenance
B. 0.45% NaCl at 1.5–2 maintenance
C. D5 0.9% NaCl at 1.5–2 maintenance
D. D5 0.45% NaCl at 1.5–2 maintenance
E. 3% NaCl at 5 cc/kg over 30 minutes

Correct Answer: A

Diabetic ketoacidosis (DKA) continues to be a serious life-threatening condition despite significant advancement in the fluid and electrolyte management over years. The prevalent cause of mortality associated with DKA is cerebral edema. The etiology of cerebral edema is still poorly understood. Possible contributing factors may include excessive rate of rehydration, rapid fall in serum glucose and plasma osmolality, failure of an appropriate rise in serum Na level, dose of insulin, bicarbonate administration, and cerebral hypoxia. Because of the risk of cerebral edema, fluid management in DKA is of critical importance. Initial fluid therapy is directed to restore intravascular volume and improve tissue perfusion. The initial fluid of choice is normal saline with 10–20 ml/kg administered in the first hour. In a severely dehydrated patient, this may need to be repeated. After the initial fluid bolus, the corrected serum sodium should be calculated and used to determine further fluid replacement. Corrected serum sodium is calculated by adding 1.6 mEq for each 100 mg/dl glucose >100 mg/dl.

In this patient, initial calculated serum osmolality was about 303 mOsm/kg which had decreased to 293 mOsm/kg in 2 hours. Most of the fall in serum osmolality was due to decrease in serum glucose, as his initial corrected Na was 137 and subsequent corrected sodium was 135 mEq/L. However, his Na did not rise appropriately and in fact had decreased slightly. Appropriate fluid replacement in this situation would be 0.9% NaCl at 1.5–2 maintenance. As his glucose is still over 400 mg/dl, there is no

need to add dextrose in the IVF which would be indicated once serum glucose drops below 250 mg/dl. Treatment with 3% NaCl is only indicated for the treatment of symptomatic cerebral edema, which is not the case here.

Take-Home Message
Normal saline is the best choice for fluid replacement in most patients with DKA.

ABP Content Specification
- Plan the fluid management of diabetic ketoacidosis.

Question 7

A 12-year-old obese Hispanic girl is brought to the emergency department with altered mental status. Her weight is 136 kg. Her vital signs are as follows: temperature 96.7 °F, heart rate 158 beats/minute, RR rate 26 breaths/minute, BP 106/78 mmHg, and oxygen saturation 97%. Bedside glucose is >500 mg/dl. Pupils are equal and reactive. Her respiration is labored, and there is an odor of acetone. She has a thick layer of acanthosis nigricans on her neck.

Initial laboratory studies are as follows: venous blood gas pH 7.02, PCO_2 29.4 mmHg, PO_2 35.5 mmHg, bicarbonate 9.4 mmol/L. Serum electrolytes, sodium 149 mEql/L, potassium 3.6 mEq/L, chloride 108 mEq/L, glucose 870 mg/dl, blood urea nitrogen (BUN) 51 mg/dl, creatinine 3.5 mg/dl, and calcium 10.6 mg/dl. She receives normal saline 2 L in 2 hours and a bolus of regular insulin 0.1 u/kg body weight followed by continuous infusion of regular insulin at 0.1 u/kg/h. Repeat vital signs were as follows: temperature 98.0 °F, heart rate 108 beats/minute, respiratory rate 20 breaths/minute, and blood pressure 110/80 mmHg. Her repeat glucose after these interventions is 866 mg/dl. The next step in the management should be:

A. Give her another bolus of 2 L of normal saline.
B. Start intravenous fluid 0.45% NaCl at 1 maintenance.
C. Increase infusion of regular insulin at 0.2 u/kg/hour.
D. Decrease infusion of regular insulin at 0.05 u/kg/hour.
E. Continue the same management.

Correct Answer: C

The prevalence of obesity in children has significantly increased in the United States. Until recently, the majority of cases of diabetes mellitus (DM) in pediatric age group were immune-mediated type 1 DM. Obesity has resulted in a dramatic increase in the incidence of type 2 DM, and it has been described as a new epidemic, affecting the children and adolescents. Obesity is strongly associated with insulin resistance which, when coupled with relative insulin deficiency, leads to the development of type 2 DM. It is estimated that type 2 DM represents 8–45% of patients with DM, and this is believed to be an underestimation of the problem. Although diabetic ketoacidosis (DKA) occurs most often in patients who have type 1 DM, it also can occur in type 2 DM, especially in patients with ethnic minority background. Acanthosis nigricans is a sign of insulin resistance. Because of significant insulin resistance, higher dose of insulin may be required for the resolution of acidosis and hyperglycemia. A standard insulin regimen consists of regular insulin intravenous drip at 0.1 u/kg per hour. The optimal rate of glucose drop with continuous insulin infusion should be between 50 and 75 mg/dl per hour. If this is not achieved in the first couple of hours, the insulin dose may be doubled as needed to achieve steady drop in glucose level. This patient is overweight and likely has type 2 DM which is complicated by DKA. She has received two boluses of normal saline, and her vitals have improved suggesting improvement in hydration status. However, her glucose remains elevated even after receiving insulin for 2 hours, likely due to significant insulin resistance. At this point, increase in the dose of insulin is indicated.

Take-Home Message
The obese patient with signs of insulin resistance (acanthosis) may require higher than the usual dose of insulin.

ABP Content Specification
- Plan the pharmacologic management of diabetic ketoacidosis.

Question 8

A 3-week-old boy presents to the emergency department for poor feeding. He was born at 39 weeks of gestation, and his birth weight was 6 lb. The mother was on insulin during pregnancy for diabetes. Infant's blood sugars at birth were normal. He was discharged home next day. After discharge from the hospital, he was seen in the pediatrician clinic a couple of times and was noted to have poor weight gain. As per the mother, he was taking 2–3 oz. of formula every 2–3 hours. He was constipated, but his diapers were always soaked.

The mother states that, for the past several days, he has been fussier than usual. On the day of admission, the parents aroused the child as they wanted to feed him, but he was not acting himself. They noticed some "strange breathing," and based on that, parents decided to bring him to the ED.

In the ED, he was noted to be dehydrated. He was limp and cyanotic and subsequently went into cardiopulmonary arrest. His evaluation showed:

Capillary blood gas: PH 6.648, PCO_2 79.1 mmHg, PO_2 34.1 mmHg, O_2 Saturation 20%, Base Deficit 29. Sodium161 mEq/L, Potassium 9.0 mEq/L, CO_2: 8.7 mmol/L, Glucose >700 mg/dl, Ionized Calcium: 1.22 mmol/L, Hemoglobin: 8.8 g/dl, Hematocrit: 26% and urine was positive for large ketones.

CPR was performed that included administration of multiple normal saline boluses, intravenous epinephrine, and sodium bicarbonate at 1 mEq/kg. A diagnosis of diabetic ketoacidosis was made and he was admitted to the pediatric intensive care unit. Of the following, the most likely primary etiology of his diabetes is:

A. Type 1 diabetes
B. Type 2 diabetes
C. Congenital diabetes
D. Maturity onset diabetes
E. Stress-induced hyperglycemia

Correct Answer: C

This patient presented with lethargy, hyperglycemia, and severe metabolic acidosis, subsequently went into cardiopulmonary arrest, and required resuscitation. Hyperglycemia with ketonuria, severe metabolic acidosis, poor weight gain, and soaked diaper (polyuria) are consistent with the diagnosis of diabetic ketoacidosis, which was complicated by lactic acidosis from severe dehydration and cardiopulmonary arrest.

Diabetes before the age of 6 months is considered neonatal diabetes unless proven otherwise. Neonatal diabetes can be transient or permanent. Although true autoimmune type 1 diabetes has been described in the newborn period, it is extremely unusual for type 1 diabetes to present at birth. The mother's history of diabetes raises the possibility of autosomal dominant congenital neonatal diabetes. The five genes currently known to be associated with permanent neonatal diabetes (in the absence of other dysmorphic features) are *KCNJ11*, *ABCC8*, *INS*, *GCK*, and *PDX1* (<1%).

Take-Home Message
Neonatal diabetes is in the differential if diabetes develops within the first 6 months of life.

ABP Content Specification
- Recognize and interpret relevant laboratory studies in diabetic ketoacidosis.

Question 9

A 14-year-old girl with past medical history of hypothyroidism and asthma presents to the emergency department for evaluation of generalized weakness and abdominal pain. She has been feeling generally weak and nauseated for the past

few months. She sleeps more than usual and has poor energy level. She has not noticed wheezing or shortness of breath or chest tightness. She has no fevers or chills. She uses a nebulizer and metered dose inhaler (MDI) at home. For the past month, she has had increased abdominal pain and a decreased appetite. The pain is located in her lower abdomen, begins in the morning, can last for hours, and tends to occur on a daily basis. It is associated with nausea most of the times. She has poor appetite but no vomiting. Pain is sometimes improved with bowel movements. She also has had a 10 lbs. unintentional weight loss in the past 8 months. She states her Synthroid dose was decreased 2 weeks ago.

Vital signs: Temperature 99.7 °F, HR 104 beats/minute, RR 16 breaths/minute, BP 95/55 mmHg. Abdominal examination is significant for diffuse mild tenderness to palpation in all quadrants, and bowel sounds are present.

Labs: Sodium 124 mEq/L, chloride 86 mEq/L, glucose 46 mg/dl, and BUN 30 mg/dl. Serum potassium was considered hemolyzed and was not reported. Other evaluations showed WBC 12.6 k/ul, hemoglobin 18.4 g/dl, platelets 276 k/ul, and TSH 1.48 uIU/ml. She received ondansetron (Zofran) and intravenous fluids.

Further evaluation which will likely yield the etiology of her symptoms includes:

A. FT4, TSH, and thyroid antibodies
B. Erythrocyte sedimentation rate (ESR) and fecal occult blood
C. Tissue transglutaminase antibody, IGA
D. Hepatic function panel, serum lipase, and serum amylase
E. Serum ACTH and serum cortisol level

Correct Answer: E

This patient's clinical presentation is consistent with slowly progressive primary adrenal insufficiency. She is complaining of nonspecific abdominal pain which is associated with poor appetite and significant weight loss over the past 8 months. Her blood pressure is low for her age, pulse rate is increased, and she has hyponatremia and hypoglycemia, all of which points toward primary adrenal insufficiency. The presentations of primary and secondary adrenal insufficiency may overlap and include fatigue, weakness, anorexia, and weight loss. Serum potassium was likely elevated, but it was not reported considering that hemolysis may have been a contributing factor toward hyperkalemia.

Her TSH is normal, and she is on thyroid replacement which makes hypothyroidism highly unlikely to be the cause of her symptoms. Although inflammatory bowel disease and celiac disease are in the list of differentials, tissue transglutaminase antibody, ESR, and fecal occult blood may be informative, but may not be helpful in establishing a specific diagnosis. Besides that, they also do not explain hyponatremia, hypoglycemia, and probably hyperkalemia which are classical findings for primary adrenal insufficiency resulting from both glucocorticoid and mineralocorticoid deficiency. Her AM cortisol was low which along with elevated ACTH was diagnostic of primary adrenal insufficiency (Addison disease). A likely etiology at her age is autoimmune adrenal destruction, and her adrenal antibodies were positive. Hyponatremia is the most consistent finding reported with primary adrenal insufficiency. It can be also found in secondary or central adrenal insufficiency as cortisol is required for free water clearance. Hyperkalemia is also expected to be present in primary adrenal insufficiency but is a more variable finding. Since the hypothalamic-pituitary-adrenal axis (HPA axis) is intact in primary disease, decreased cortisol release results in loss of negative feedback leading to increased ACTH release resulting in hyperpigmentation.

Take-Home Message

Suspect adrenal insufficiency in any patient with nonspecific constitutional symptoms and weight loss.

ABP Content Specification

- Differentiate the etiology by age and understand the pathophysiology of hypoglycemia.

Question 10

A 14-month-old girl presented in the emergency department with history of cough, cold, and poor appetite for 1 day. The mother had difficulty waking her up this morning, and she appeared pale. She had unsteady gait and sat down on the floor while the mother was getting something for her to eat. Couple of minutes later, the mother heard a loud noise and found her on the floor with jerking movement of her extremities with some eye rolling. The mother reports having frequent episodes of weakness and sweating that responded to eating during her pregnancy. She brought her to the emergency department (ED) where her bedside glucose level was 37 mg/dl. Critical samples were drawn after which she received an IV glucose D10% bolus at 2 ml/kg followed by continuous infusion of D5 0.45 NS. Her glucose in the laboratory evaluation was 31 mg/dl. Other labs from that time showed the following results:

- Serum sodium 137 mEq/L.
- Serum potassium 4.0 mEq/L.
- Serum chloride 101 mEq/L.
- Serum bicarbonate 18 mmol/L.
- BUN 7 mg/dl.
- Serum creatinine 0.3 mg/dl.
- Serum cortisol 35.2 ug/dl.
- Serum insulin 2.3 uIU/ml.
- C-peptide 0.6 ng/ml.
- Lactic acid 0.8 mmol/L.
- Serum ammonia 14 umol/L.
- LFTs were normal.
- Urinalysis: specific gravity 1.002, pH 7.0, and ketones 5 mg/dl.

The most likely diagnosis is:

A. Hyperinsulinism
B. Organic acidemia
C. Ketotic hypoglycemia
D. Fatty acid oxidation disorder
E. Hypopituitarism

Correct Answer: A

At the time of hypoglycemia, this patient was positive for trace ketones which are consistent with hypoketotic hypoglycemia. Serum cortisol level was appropriately elevated making adrenal insufficiency or hypopituitarism unlikely. Differential diagnosis at this point includes hyperinsulinemia or free fatty acid oxidation defect. Her insulin and C-peptide were both inappropriately detectable suggesting hyperinsulinemic hypoglycemia.

Hyperinsulinemic hypoglycemia at her age can be familial (autosomal dominant), and severity is usually mild to moderate. Family history of hypoglycemia is often present in other family members, especially history of episodes of weakness and sweating that respond to eating. Etiology of familial hyperinsulinism includes autosomal dominant inheritance of glucokinase or KATP mutation which is usually responsive to diazoxide. Although free fatty acid oxidation defect can also present with hypoketotic hypoglycemia, insulin usually is undetectable at the time of hypoglycemia. Free fatty acid oxidation defects are autosomal recessive, and at the time of acute episode, the patient may have hepatomegaly or hepatic dysfunction. Her LFTs were normal.

Take-Home Message
Detectable insulin at the time of hypoglycemia should raise the concern for hyperinsulinemia.

ABP Content Specification
- Recognize and interpret relevant laboratory studies for hypoglycemia.

Question 11

A 19-month-old previously healthy girl became ill 2 days prior to presentation with two episodes of vomiting. She was then fine until the following evening when she began having trouble walking, was not acting like herself, and became less responsive. Parents also noted her eyes crossing intermittently. She is currently drowsy and staggers if placed to walk. Parents report that she had

a similar episode 6 months ago, in which she seemed to have trouble walking and her eyes were crossed. This lasted only a short time (<1 hour), so no care was sought. Parents report that the only prescription medication in the house is methylphenidate (Ritalin). The most likely laboratory abnormality is:

A. Low sodium
B. Low insulin
C. Low lactate
D. Low glucose
E. Low hemoglobin

Correct Answer: D

Hypoglycemia is one of the most common endocrine emergencies which has varied clinical manifestations including nonspecific symptoms of fatigue, inability to concentrate, anxiety, dizziness, confusion, aberrant behavior, or coma. This patient had a similar episode few months ago suggesting that she probably has subtle metabolic dysfunction which presents with hypoglycemia at the time of illness or decrease food intake. While elevated insulin or lactate level can be associated with hypoglycemia in certain conditions, elevated insulin and lactate are nonspecific findings and can also be seen without hypoglycemia, and clinical presentation depends upon the underlying cause. Low hemoglobin presents with anemia, and its associated symptoms can be nonspecific; however, significant anemia is unlikely to present with symptoms described especially months apart. Although abnormality in the serum sodium can present with nonspecific symptoms, it is quite unlikely in an otherwise healthy child to present with recurrent, acute symptoms described in the patient.

Take-Home Message
Consider hypoglycemia in the differential diagnosis of acute mental status changes.

ABP Content Specification
- Recognize signs and symptoms of hypoglycemia.

Question 12

A 4-year-old boy was brought to the emergency department with a history of seizure described as clenched fists and clamped jaw without color change. He has been diagnosed with salt wasting CAH due to 21-hydroxylase deficiency and has been on glucocorticoid and mineralocorticoid supplementation since birth. He and his family are recovering from a "cold" with runny nose, congestion, and cough. This morning, his mother noted that, although he took his normal medications this morning, he seemed to gag on them. Later, when the family went out to breakfast, he vomited three times. Upon returning home, he drank three large glasses of water and fell asleep for 2 hours, and after which, he was found to be seizing.

In the emergency department, his blood glucose was 29 mg/dl, and he was febrile to 100.9 °F. He was noted to be lethargic. The next best step in the management of this patient should be:

A. Normal saline bolus followed by IVF D5 ½ NS at maintenance.
B. Rectal Tylenol.
C. Get CBC and blood cultures.
D. Get CMP, cortisol, and ACTH.
E. Give D25 bolus and 50 mg hydrocortisone IV.

Correct Answer: E

The likely cause of hypoglycemia in this patient is acute adrenal insufficiency. This patient was sick for a few days but was on replacement dose of hydrocortisone as opposed to stress dose (approximately 3 times the replacement dose). He gagged after taking the medication in the morning and then vomited a few times later on. Increased glucocorticoid requirement due to intercurrent illness followed by vomiting of the morning dose were the likely reasons for acute adrenal crisis leading to hypoglycemia and seizure. While normal saline bolus, drawing labs, and giving Tylenol for fever are all important, none of those will address the issue of acute

hypoglycemia and adrenal insufficiency which should be the priority in this patient to prevent adverse outcome.

Take-Home Message
A patient on steroid replacement needs an increased dose during intercurrent illness.

ABP Content Specification
- Plan management of acute hypoglycemia.

Question 13

A 13-year-old girl presents to ED with vomiting, fatigue, and hot flashes for the past few days. Her past medical history is significant for the diagnosis of diffuse intrinsic pontine glioma 3 years ago. Her MRI then showed a large solid minimally enhancing mass involving the pons with extension into the bilateral cerebral peduncles and thalami along with effacement of the Sylvian aqueduct and upper fourth ventricle causing mild hydrocephalus. Surgical resection of the lesion was not feasible, so she underwent ventriculoperitoneal shunt and was started on radiation therapy which she completed 2 years ago.

She was well until few months ago, when she began to have frequent episodes of gagging and vomiting. She is taking esomeprazole (Nexium), polyethylene glycol (Miralax), and a fiber supplement. She has lost 20 lbs. in the last 7 months. She has been complaining of significant fatigue and has decreased level of activity. She also complains of a dozen hot flashes daily. These episodes include facial flushing, diaphoresis, and discomfort. They last approximately 10 minutes and occasionally wake her from sleep. She is premenarchal by history. Per mother, breast budding started approximately 1 year ago and has progressed, and she has also developed pubic hair. She further complains of approximately a half-dozen episodes of dizzy spells in the last 3 weeks. Her recent thyroid tests revealed low free thyroxine levels with normal TSH.

Her physical examination showed minimal tenderness in the right upper quadrant, Tanner stage III breasts, and Tanner stage IV pubic hair. The rest of her physical exam was unremarkable.

What is the likely etiology of her symptoms?

A. Radiation-induced enteritis
B. Intestinal obstruction
C. Major depression
D. Hypopituitarism
E. Shunt malfunction

Correct Answer: D

This patient has history of diffuse pontine glioma s/p radiation therapy now presenting with fatigue, vomiting, hot flashes, dizzy spells, and vague abdominal symptoms. Her symptoms are nonspecific, relate to multiple organ systems, and can be explained by radiation-induced hypopituitarism leading to central adrenal insufficiency (fatigue, dizziness, abdominal pain, and weight loss), central hypothyroidism (fatigue, decreased activity), and hypogonadotropic hypogonadism (hot flashes). With history of diffuse pontine glioma and its treatment, she is at risk of hypothalamic and pituitary dysfunction. Her thyroid function recently showed low Free T4 with normal TSH which in her clinical situation is consistent with hypothalamic/pituitary hypothyroidism.

The prevalence of endocrinopathy is greater than 70% among patients with CNS tumors. These may include growth hormone deficiency, hypogonadotropic hypogonadism, central hypothyroidism, central adrenal insufficiency, hyperprolactinemia, and precocious puberty. CNS radiation may result in hypothalamic/pituitary dysfunction. Development of hormonal deficiencies and their onset depend on the dose of radiation, duration of treatment, age of the patient, and the interval since the completion of treatment, as it may develop gradually over years after treatment. Although this patient has breast development which has progressed, it does not rule out gonadotropin deficiency as radiation effects are slowly progressive and manifest over time.

Radiation-induced enteritis is quite uncommon and will not explain fatigue, hot flashes, and

low FT4. Major depression is quite possible in her case and will cause many of these symptoms. Low total T4 is expected with depression due to conversion of T4 to reverse T3; however, FT4 is usually normal. Shunt malfunction will cause increased intracranial pressure which will present with persistent vomiting, usually in the middle of the night or early in the morning, and may have abnormalities on eye exam. Her physical exam is essentially unremarkable. Intestinal obstruction will not explain many of her symptoms except for abdominal pain and vomiting.

Take-Home Message
Pituitary hormonal deficiencies may develop years after cranial radiation.

ABP Content Specification
- Recognize signs and symptoms of hypopituitarism.

Question 14

A 2-month-old girl with a past medical history significant for intestinal atresia s/p repair, microcolon s/p repair, direct hyperbilirubinemia, atrial septal defect (ASD), agenesis of the corpus callosum, possible schizencephaly, and failure to thrive presented in the emergency department with a 1-day history of multiple episodes of emesis. The emesis was non-bloody and non-bilious and mainly consists of the formula she drank. She was lethargic, and her temperature was 95.5 °F.

Her evaluation showed Na 142 mEq/L, K 3.5 mEq/L, glucose 57 mg/dl, and lactic acid 2.8 mmol/L. Her newborn screen was reported as abnormal for which she had a thyroid function test in the past that had shown FT4 0.76 ng/dl and TSH 4.22 uIU/ml. Which of the following laboratory evaluations is most likely to help your management plan?

A. Insulin level
B. Free T4 level
C. Serum TSH
D. Random cortisol level
E. C-peptide

Correct Answer: D

This is a 2-month-old child with failure to thrive and history of multiple gastrointestinal and cerebral malformations presented with lethargy, hypothermia, and emesis. Her FT4 was low for age, while TSH was normal, raising the possibility of hypothalamic or pituitary hypothyroidism. Low body temperature with central nervous system (CNS) malformation raises the possibility of hypothalamic dysfunction. Her glucose was low normal, and she also has agenesis of corpus callosum which raises the possibility of hypopituitarism. Although random low cortisol does not confirm pituitary dysfunction, low cortisol at the time of acute illness will be suspicious for central adrenal insufficiency, especially with history of failure to thrive and CNS malformation, and stress dose of hydrocortisone (50 mg/m^2 IV) should be the next step to prevent adrenal crisis.

Formal diagnosis of hypopituitarism is necessary for the ongoing management; however, it can be accomplished later after her condition is stabilized.

Take-Home Message
Cortisol level of <3 ug/dl at the time of acute illness is suggestive of adrenal insufficiency unless proven otherwise.

In most cases of hypopituitarism, TSH is not necessarily below the reference range and is usually in the normal range with low FT4.

ABP Content Specification
- Plan the management of acute hypopituitarism.

Question 15

A 13-year-old girl, with past medical history significant for panhypopituitarism, astrocytoma resection, and cranial radiation, presented in the emergency department (ED) with slurred speech.

She is on hydrocortisone, thyroxine, and DDAVP replacement at home. The mother states good compliance with her medicines. Her evaluation showed serum sodium 175 mEq/L, serum potassium 3.4 mEq/L, serum chloride 124 mEq/L, serum bicarbonate 25.9 mmol/L, serum glucose 94 mg/dl, BUN 27 mg/dl, serum creatinine 0.7 mg/dl, serum alkaline phosphatase 210 IU/L, aspartate aminotransferase 47 IU/L, and alanine aminotransferase 83 IU/L. Urine specific gravity was 1.030. What is the likely etiology of hypernatremia?

A. Noncompliance with DDAVP
B. Resistance to DDAVP
C. Free water deficit
D. Hyperaldosteronism
E. Cerebral salt wasting

Correct Answer: C

One of the complications of extensive pituitary surgery can be hypothalamic dysfunction which can lead to temperature instability, hypodipsia or adipsia (lack of thirst), anorexia, or polyphagia depending upon the extent of damage. This patient is on replacement of pituitary hormones including DDAVP. Her urine is appropriately concentrated at the time of hypernatremia ruling out DDAVP deficiency (noncompliance) or resistance. The likely etiology of hypernatremia in her case is free water deficit as reflected by serum Na of 175 mEq/L, and it is secondary to poor oral intake due to damage to the thirst center. Although her mother is giving her DDAVP appropriately, she does not feel thirsty and does not drink enough water to regulate Na balance even with DDAVP. Hyperaldosteronism usually presents with hypertension rather than hypernatremia. Cerebral salt wasting presents with hyponatremia rather than hypernatremia.

Take-Home Message
Adipsia or hypodipsia is also an important cause of hypernatremia in patient with global CNS dysfunction.

ABP Content Specification
- Recognize the complications of acute and chronic hypopituitarism.

Question 16

A 2.5-month-old girl presented with a tonic-clonic seizure. On history, she has had 2 days of cough and congestion with poor appetite. She was born full term by normal spontaneous vaginal delivery. Her birth weight was 5 lb. 11 oz. (2.608 kg). There were no complications during pregnancy. Her neonatal course was remarkable for poor feeding and hyperbilirubinemia for which she required phototherapy. On review of her electronic medical record from her NICU stay, her first newborn screen demonstrated a low T4 with normal TSH. Repeat newborn screening (NBS) also revealed a low T4 with normal TSH. Her thyroid function tests in the local labs showed Free T4 0.78 ng/dl, T4 5.0 mcg/dl, and TSH 7.46 IU/ml. She was diagnosed with congenital hypothyroidism and started on L-thyroxine. She was discharged from the neonatal intensive care unit at the age of 3 weeks.

Her evaluation in the emergency department showed glucose 26 mg/dl, serum sodium 130 mEq/L, serum potassium 5.0 mEq/L, serum chloride 98 mEq/L, BUN 18 mg/dl, serum creatinine 0.3 mg/dl, and serum bicarbonate 17 mmol/L. Complete blood count was unremarkable with 60% lymphocytes. Which additional test will confirm the diagnosis?

A. Serum T3
B. Serum TSH
C. Growth hormone
D. IGF-1
E. Serum cortisol

Correct Answer: E

This patient's NBS twice showed low T4 with normal TSH suggesting the possibility of central (hypothalamic/pituitary) hypothyroidism. Similarly, her thyroid function test in local

laboratory showed low free T4 with inappropriately normal TSH for age arguing against primary hypothyroidism. As central hypothyroidism can be associated with other pituitary abnormalities, she should have been evaluated for hypopituitarism, especially with poor feeding and prolonged hyperbilirubinemia before starting thyroxine. However, she was discharged on thyroxine replacement for hypothyroidism. Depending upon the severity of pituitary dysfunction, patient with hypopituitarism may present acutely in the immediate newborn period with severe hypoglycemia, or if pituitary deficiency is not complete, it can present insidiously with poor feeding and slow growth until some intercurrent illness precipitates acute crisis due to the inability to mount a stress cortisol response, resulting in acute hypoglycemia with or without seizures. In the face of hypoglycemia, serum cortisol should be at least 18 ug/dl with an intact hypothalamic-pituitary-adrenal axis. Low serum cortisol in this scenario would be suggestive of central adrenal insufficiency and hypopituitarism. Although growth hormone deficiency also can present with hypoglycemia, central adrenal insufficiency is the more common cause of hypoglycemia in this situation. IGF-1 is not very reliable in the first 6 months of life. T3 will not add any further information in already diagnosed hypothyroidism at this point.

Take-Home Message

In a patient without elevated TSH in response to a low T4, suspect other hypothalamic/pituitary deficiencies.

ABP Content Specification

- Understand the pathophysiology of hypopituitarism.

Question 17

A 15-year-old obese girl presented with vomiting and abdominal pain for 3 days. Review of systems was significant for excessive thirst and nocturia over the past few nights. She was morbidly obese and severely dehydrated. Her weight was 80 kg. On arrival, her vital signs were temperature 98.7 °F, heart rate 142 beats/minute, respiratory rate 24 breaths/minute, blood pressure 138/80 mm Hg, and oxygen saturation 96% on room air. Her capillary refill was greater than 3 seconds. On physical examination, she had decreased activity and was feeling weak with nausea, vomiting, and diarrhea but responding to verbal stimuli. Her mucous membranes were dry. Pupils were equally reactive to light, and the neck was supple. She had bilateral good air entry. Her abdomen was soft, and there was no tenderness. Bowel sounds were present. The remainder of her examination was noncontributory.

Initial laboratory studies showed the following: blood gas pH 7.25, PCO_2 43 mmHg, PO_2 74 mmHg, and HCO_3 18.8 mmol/L. Serum electrolytes were as follows: sodium 123 mmol/L, potasium 5.6 mmol/L, chloride 82 mmol/L, glucose 2184 mg/dl, blood urea nitrogen 44 mg/dl, creatinine 1.9 mg/dl, and calcium 10 mg/dl. Calculated serum osmolality was 383 mOsm/kg. Liver enzymes were normal. The urinalysis showed specific gravity 1.035, 3+ glucose, + ketones, and + blood. A diagnosis of hyperosmolar hyperglycemic state (HHS) was suspected. All of the following statements about HHS are true except:

A. HHS can present in patient with type 1 diabetes.
B. HHS in pediatric population is associated with obesity, insulin resistance, and type 2 diabetes.
C. HHS can be associated with high mortality even in pediatric patients.
D. Presence of ketones does not rule out HHS.
E. The diagnosis of HHS cannot be made in the presence of acidosis.

Correct Answer: E

The prevalence of obesity in children has significantly increased in the United States. Until recently, the majority of cases of diabetes mellitus in pediatric age group were immune-mediated type 1 diabetes. Obesity has resulted in a dramatic increase in the incidence of type 2 diabetes in children and adolescents. Type 2 diabetes mellitus (DM) has been described as a new epidemic,

affecting the children and adolescents. Obesity is strongly associated with insulin resistance which, when coupled with relative insulin deficiency, leads to the development of type 2 diabetes. It is estimated that type 2 DM represents 8–45% of patients with DM, and this is believed to be an underestimation of the problem.

HHS is generally considered a complication in elderly patients with type 2 DM and has been rare in children. Recently, there have been many reports of pediatric patients presenting with HHS at the onset of type 2 diabetes. The rising incidence of HHS in pediatric population is believed to be due to recent epidemic of obesity and its associated insulin resistance and type 2 diabetes, although it can present with type 1 diabetes and secondary to causes other than diabetes. The prevalence of HHS in pediatric population is unknown but is associated with high mortality; therefore, prompt recognition and aggressive management are critical. Children with HHS are predominately male, morbidly obese, and members of a minority population.

The standard diagnostic criteria are blood glucose >600 mg/dL, serum osmolality greater than >320 mOsm/L, pH ≥7.3, HCO_3 ≥15 mmol/L with minimal or no serum, or urinary ketones. However, the presence of ketones and significant acidosis does not exclude HHS and usually represents lactic acidosis from poor perfusion and starvation ketoacidosis. Patients are lethargic and often present with neurologic dysfunction ranging from confusion to coma.

Take-Home Message
HHS can present even in pediatric patients.

ABP Content Specification
Plan the management of non ketotic hyperglycemia.

Question 18

A 13-year-old girl is brought to the emergency department for evaluation of fatigue, weakness, and recurrent episodes of body aches, abdominal pain, vomiting, and diarrhea. She has been losing weight. Her family is Middle Eastern, and she was treated for infection in her country 6 months ago, but the symptoms did not subside. On her examination, you noticed that there is hyperpigmentation of her skin and also of her nails, elbows, and knees. Notably, she is darker than her mother. She is weak and has dry mucous membranes, but the remainder of her examination is normal. When asked what she is eating, her mother states that she does not eat much and has the habit of putting salt on everything. Her findings are consistent with:

A. Hyperaldosteronism
B. Primary adrenal insufficiency
C. McCune-Albright syndrome
D. Classic congenital adrenal hyperplasia
E. Secondary adrenal insufficiency

Correct Answer: B

This child has findings consistent with Addison's disease (primary adrenal insufficiency). The clinical presentation includes weakness, anorexia, weight loss, hypotension, decreased serum sodium and chloride, increased serum potassium, hypoglycemia, and hyperpigmentation of the skin and mucous membranes (from chronic elevation of ACTH). Increased pigmentation may be noted in existing nevi. As the pigmentation may in some cases be subtle, comparison of the patient to other family members is useful in highlighting the skin findings. Hyperaldosteronism usually presents with hypertension which is difficult to treat and is not associated with clinical findings present in this patient.

McCune-Albright syndrome (MAS) consists of the triad of fibrous dysplasia of bones (polyostotic fibrous dysplasia), patchy cutaneous pigmentation, and precocious puberty. Other associated endocrine disorders include pituitary adenomas (secreting growth hormone), hyperthyroidism, and hypercortisolism. In MAS, the café-au-lait lesions have irregularly ragged or serrated borders and are usually present early in life, and recent development of hyperpigmentation is not consistent with that of MAS.

Females with classic congenital adrenal hyperplasia (CAH) due to a 21-hydroxylase deficiency present with ambiguous genitalia at birth and are prone to salt wasting with hyponatremia, hyperkalemia, hypovolemia, dehydration, and shock. Late-onset 21-hydroxylase deficiency may present with precocious puberty, clitoromegaly, or excessive growth; however, salt wasting, dehydration, and electrolyte abnormalities are not expected findings in late-onset CAH.

Take-Home Message
Suspect adrenal insufficiency in any patient with nonspecific constitutional symptoms and weight loss.

ABP Content Specification
- Differentiate the etiology by age and understand the pathophysiology of adrenal insufficiency.

Question 19

A 2-year-old girl with past medical history significant for medium-chain acyl-CoA dehydrogenase (MCAD) deficiency diagnosed at birth presents in the emergency department (ED) with altered mental status. She was in her usual state of health until this morning when she felt tired and went to take a nap. An hour later when the mother went to wake her, she was not responding. The mother checked her finger-stick glucose, and it was 53. She also had about a 60 second episode where she was "stiff and rigid" with her upper extremities shaking/hypertonic. The mother called emergency medical services (EMS). EMS was unable to obtain an intravenous access so an intraosseous access was obtained in her left tibia.

On arrival at the ED, she had a low-grade fever (100.4 °F), her heart rate was 143/min, blood pressure was 119/64 mmHg, respiratory rate was 36/min, and her oxygen saturation was 55%. Her blood gas showed pH of 6.9 with PCO_2 of 85 mm Hg, so she was intubated. Her blood sugar was 21 mg/dl in the ED, and she received IV glucose and was admitted to the pediatric intensive care unit. What is the most likely underlying etiology of hypoglycemia?

A. Hyperinsulinemia
B. Adrenal insufficiency
C. Decreased gluconeogenesis
D. Decreased ketogenesis
E. Decreased gluconeogenesis and ketogenesis

Correct Answer: E

This child has a history of medium-chain acyl-CoA dehydrogenase (MCAD) deficiency. MCAD deficiency is the most common defect of fatty acid oxidation. MCAD involves the beta oxidation of medium-chain (C6-C12) fatty acids. During prolonged fasting (>10 hours) or stress associated with illness, a patient with MCAD deficiency depends on glucose oxidation as a source of energy, which can quickly lead to hypoglycemia which is hypoketotic. Underlying etiology for hypoglycemia is decreased hepatic ketogenesis and gluconeogenesis because of decreased acetyl-CoA production from the underlying MCAD deficiency. During metabolic crisis, such as in this patient, accumulating medium-chain fatty acids may have toxic effect on the liver, and without intervention, children may rapidly progress from lethargy to coma and death.

Take-Home Message
Simple illness can precipitate a metabolic crisis in MCAD deficiency which can rapidly progress to coma and death, if not treated promptly.

ABP Content Specification
- Recognize metabolic causes of hypoglycemia.

Question 20

A 2-year-old girl with a past medical history significant for medium-chain acyl-CoA dehydrogenase (MCAD) deficiency presents in the emergency department with altered mental status and hypoglycemia (lowest value 12 mg/dl) requiring intubation. For her MCAD, her grandmother reports that she sees a metabolic geneti-

cist at a specialty center. She used to visit every 3 months, but at her last appointment, it was decided that she now follows up every 6 months. She is on a regular diet except that she was instructed to avoid coconut/coconut oil and have a tablespoon of cornstarch every night before bedtime. Her glucose is tested only if she is sick or not acting right, and the goal is between 50 and 110 mg/dl. She ate Italian sausage for dinner around 1730 yesterday evening and then later had a snack of popcorn and chips. She went to bed around 2300. You contacted the specialty center and spoke with the on-call fellow who does not think that her hypoglycemia was related to her underlying MCAD deficiency, insofar as she did not have prolong fasting or was she sick last night. If this patient in fact has metabolic crisis associated with underlying MCAD deficiency, all of the following labs can be expected to be abnormal except:

A. Lactic acid
B. Ammonia
C. β-Hydroxybutyrate
D. Creatine kinase (CK)
E. Alanine aminotransferase (ALT)

Correct Answer: C

MCAD deficiency is the most common defect of fatty acid oxidation. MCAD involves in the beta oxidation of medium-chain (C6-C12) fatty acids. During prolonged fasting (>10 hours) or stress associated with illness, patient with MCAD deficiency depends on glucose oxidation as a source of energy which can quickly lead to hypoglycemia which is hypoketotic, and β-hydroxybutyrate is not expected to be significantly elevated. During a metabolic crisis, the accumulating medium-chain fatty acids can cause acidosis and may have a toxic effect on other tissues, leading to elevated liver enzymes, CK, and hyperammonemia. In a patient with MCAD deficiency who is acutely ill, laboratory testing should include blood gas, liver function tests, electrolytes, serum CK, ammonia, and lactic acid as well as glucose and urine organic acids.

Question 21

A 7-day-old baby girl presents in the emergency department late in the evening as her mother had received a phone call from her primary care provider regarding her newborn screening, which was reported to be abnormal for galactosemia. She was instructed to take her to the ED as soon as possible. She was born after full 9 months of pregnancy without any complications, and her birth weight was 7 lbs. 12 oz. She is exclusively breast-fed, has no vomiting, and has regained her birth weight.

The next step in management should be to:

A. Admit to the hospital.
B. Obtain confirmatory testing for galactosemia.
C. Stop breast-feeding and start her on a lactose-free formula.
D. Obtain confirmatory testing, stop breast-feeding, and start her on a lactose-free formula.
E. Do nothing as she is feeding well; her newborn screen is likely to be a false positive.

Correct Answer: D

Galactosemia is the disorder of galactose metabolism. Milk is the major source of dietary galactose (including human milk). Classic galactosemia results from decreased galactose-1-phosphate uridyltransferase (GALT) activity that leads to increase both galactose-1-P and galactose concentrations. The clinical manifestations of galactosemia are believed to be due to elevated galactose-1-P concentration and include feeding problems, growth failure, cataracts, liver damage, bleeding, prolonged jaundice, hemolytic anemia, hyperammonemia, sepsis (if untreated), and shock. Early treatment with a galactose-free diet can help minimize long-term complications (e.g., developmental delay, speech problem, abnormal motor function, increased risk of ovarian failure) and should be instituted as soon as possible. Although this patient is clinically asymptomatic, it is possible that the newborn screening may have been a false positive. However, considering the devastating consequences

of delayed treatment, abnormal newborn screening should be considered positive until proven otherwise. Thus, the appropriate next steps should include confirmatory testing for galactosemia (GALT, galactose, and galactose-1-P concentration) and the institution of a lactose-free diet until the results of confirmatory testing become available.

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Question 1

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Hematology and Oncology

14

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Question 1

A 6-year-old boy with HbSS disorder presents with back and arm pain for 2 days. His mother has been giving ibuprofen every 6–8 hours since the onset of pain with little relief. He has had similar episodes in the past, occurring 2–3 times a year. His parents report no fever, cough, runny nose, and chest or abdominal pain. His vital signs are as follows: temperature 100 °F, heart rate 146 beat/minute, respiratory rate 22 breaths/minute, blood pressure 84/52 mm Hg, and oxygen saturation 96% on room air. He is in distress with mild scleral icterus. The remainder of his examination is unremarkable. The most appropriate initial step in the management of this patient is:

A. Laboratory evaluation; normal saline fluid bolus; ibuprofen; reassess in 30 minutes; and if no response, administer parenteral opioids.
B. Normal saline fluid bolus; intravenous morphine; reassess in 2 hours; and if no response, administer another dose of morphine.
C. Normal saline fluid bolus; intravenous morphine; reassess in 30 minutes; and repeat morphine if pain is not controlled.
D. Intravenous fluids at maintenance; intravenous morphine; reassess in 1–2 hours; and if no response, administer intravenous meperidine.
E. Laboratory evaluation; normal saline fluid bolus; intravenous morphine; antibiotics; and admit to hospital.

Correct Answer: C

Sickle cell anemia (SCA) refers to only sickle cell disorders like HbSS or HbS β^0-thalassemia, whereas sickle cell disease (SCD) refers to all genotypes such as SCA and heterozygous disorders like HbSC, HbSD, and HbS β^+-thalassemia. SCD does not include sickle cell trait (HbAS), a carrier state.

The most frequent complication of SCD is severe acute episodic pain, referred to as vaso-occlusive crisis (VOC). VOC results from tissue ischemia caused by vaso-occlusion mostly in the bones and bone marrow. Almost all patients with SCD will experience a VOC during their lifetime with episodes beginning as early as 6 months of age, often as dactylitis. VOC and pain most commonly occur in the extremities, chest, and back. However, they can also occur in other sites and can be confused with other acute complications such as stroke, papillary necrosis, splenic sequestration, constipation (due to opioid use), or other hepatobi-

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_14

liary complications. It is important to determine if the pain is due to VOC or other potential causes such as acute chest syndrome (ACS), pneumonia, or other non-sickle cell-related disorders. The patient can often distinguish between VOC- and non-VOC-related pain. SCA (HbSS or HbS β^0-thalassemia) patients are more prone to experience frequent VOCs, whereas sickle cell trait (HbAS) patients do not experience VOCs.

The primary management of a VOC is pain control. Pain should be treated aggressively, within 30 minutes of triage or 60 minutes of arrival. Always evaluate for other causes particularly if pain is atypical. But for the patient in the vignette, this episode is similar to his typical VOC; therefore, laboratory evaluation and imaging studies are not required. In children with mild to moderate pain who report relief with NSAIDS, continue treatment with NSAIDS in the absence of contraindications. But for severe pain, rapidly initiate treatment with potent analgesics, such as morphine. If IV access is difficult, choose an alternate route (intranasal, sublingual, intramuscular) to deliver the analgesic medications. Alongside systemic analgesics such as morphine, oral or systemic NSAIDS can be administered as an adjuvant.

All patients should be reassessed frequently, and their analgesic dose adjusted appropriately, recognizing that opiate tolerant may need higher doses. Some patients may benefit from the initiation of a patient-controlled analgesia. In the absence of dehydration, overly aggressive fluid therapy should be avoided, especially among patients with known or suspected cardiac dysfunction.

The uses of adjunctive non-pharmacologic treatment modalities such as local heat application, distraction, hypnosis, and acupuncture have been described to relieve the pain. Oxygen should be administered if saturations fall below 95 percent in room air. Patients with persistent pain despite adequate therapy in the ED should be considered for admission to an in-patient or observation unit.

Take-Home Message

Rapid pain management is important to manage a VOC. If the pain is atypical, look for another trigger.

ABP Content Specification

- Know the etiology and understand the pathophysiology of sickle hemoglobin disorders.
- Recognize and differentiate by age signs and symptoms of sickle hemoglobin disorders.
- Recognize and interpret relevant laboratory and imaging studies for sickle hemoglobin disorders.
- Recognize and differentiate by age acute complications of sickle hemoglobin disorders.
- Recognize life-threatening complications of sickle hemoglobin disorders.
- Plan management of acute sickle cell disease.

Question 2

A 4-year-old boy with HbS β^0-thalassemia and asthma was brought by his mother for evaluation of fever. He was well until 2 days ago when he developed cough and runny nose and since the past 2 hours had a temperature of 102 °F. His mother denies wheezing, shortness of breath, or chest pain, but reported that he did complain of mild abdominal and thigh pain.

He has no history of previous blood transfusions, acute chest syndrome, or splenic sequestration. He is currently on penicillin V and folic acid. His vital signs are temperature 102.3 °F, heart rate 131 beats/minute, respiratory rate 32 breaths/minute, blood pressure 102/57 mm Hg, and oxygen saturation 97% on room air. His examination is unremarkable except for mild tachypnea with clear bilateral breath sounds and a normal abdominal examination.

The most appropriate management of this patient includes obtaining a complete blood count (CBC) with reticulocyte count and:

A. Obtain blood culture, administer ibuprofen and intravenous fluids, and reassess. Administer antibiotics only if laboratory results are abnormal.

B. Obtain UA, blood and urine cultures, and chest radiograph, administer IV antibiotics, and admit the patient until cultures are negative for 48–72 hours.
C. Obtain blood culture and chest radiograph, administer ibuprofen and IV antibiotics, and admit the patient until cultures are negative for 48–72 hours.
D. Obtain blood culture and chest radiograph, administer ibuprofen and IV antibiotics, and discharge with follow-up in 24 hours if fever and pain are controlled, physical examination and laboratory results are normal, and there is a reliable caregiver.
E. Obtain blood culture and chest radiograph, administer ibuprofen and oral antibiotics, and discharge with appropriate follow-up, if fever and pain are controlled, physical examination and laboratory results are normal, and there is a reliable caregiver.

Correct Answer: D

Children with sickle cell disease are at increased risk for serious bacterial infections, due to functional asplenia, decreased opsonic activity in the serum, and poor antibody response to the polysaccharide component of the bacterial capsule.

The greatest risk is among children between 6 months and 5 years. As the fetal hemoglobin declines by 2 or 3 months of age, children with SCA begin to develop splenic impairment and are especially prone to infections with encapsulated organisms such as *Streptococcus pneumoniae*. Fortunately, the incidence of these infections has declined over the last decade as a result of prophylactic penicillin and pneumococcal vaccination. However, febrile children with sickle cell disease are still considered to be at risk for overwhelming infection. This may be due to incomplete vaccination status and the possibility of penicillin-resistant organisms.

Any child with SCD presenting with fever requires a rapid evaluation including complete blood count (CBC) with differential, reticulocyte count, and blood culture followed by prompt administration of empiric parenteral antibiotics (such as ceftriaxone at 50–75 mg per kg per day) to ensure coverage against *Streptococcus pneumoniae* and gram-negative enteric organisms. Obtain urine culture when urinary tract infection is suspected and chest X-ray (CXR) in the presence of cough, shortness of breath, tachypnea, or abnormal lung findings to evaluate for the presence of acute chest syndrome. Consider osteomyelitis in children with erythema, swelling, and bony tenderness and obtain further evaluation.

An important step in the ED is prompt administration of IV antibiotics after obtaining appropriate cultures. Subsequent management depends on several factors and varies according to institution protocol. If available, pediatric hematology service should be consulted. Hospitalization should be considered for children age < 2 years (higher risk of bacterial sepsis and more difficult to assess for early signs of sepsis), those with a previous history of severe bacterial infection (SBI) or sepsis (risk factor for subsequent episodes), or those with temperature > 39 C to 40 °C (102.2–104 °F) at presentation (may suggest an increased likelihood of sepsis). Patients who are not ill appearing with normal physical examination, chest radiograph, and laboratory evaluation are at low risk for bacteremia and can be discharged with close follow-up (either a return visit or telephone follow-up in 24 hours).

For the patient in the vignette, obtaining laboratory evaluation and chest radiograph and prompt administration of IV antibiotics are critical steps. If the child defervesces and is not ill appearing, with normal vital signs, normal CBC result, and normal chest radiograph, discharging the patient with follow-up in 24 hours is the most appropriate strategy.

Take-Home Message

Patients with SCD are at an increased risk for SBI specifically with encapsulated bacteria [i.e., *Streptococcus pneumoniae*] and require rapid evaluation and prompt administration of intravenous antibiotics.

ABP Content Specification

- Know the etiology and understand the pathophysiology of sickle hemoglobin disorders.

- Recognize and differentiate by age signs and symptoms of sickle hemoglobin disorders.
- Recognize and interpret relevant laboratory and imaging studies for sickle hemoglobin disorders.
- Recognize and differentiate by age acute complications of sickle hemoglobin disorders.
- Recognize life-threatening complications of sickle hemoglobin disorders.
- Plan management of acute sickle cell disease.

Question 3

A 6-week-old girl is brought to the emergency department for vomiting and diarrhea. The mother reports that the child was well until 5 days ago, when she developed non-bloody non-bilious postprandial emesis consisting of digested milk. Several episodes of non-bloody watery diarrhea developed the following day. She denies any fever, cough, or runny nose but has been less active with decreased formula intake for the last 24 hours. The child was born at 36 weeks via emergent Cesarean section due to non-reassuring fetal heart rate and was on oxygen in the NICU for few days. The mother denies any medications. On physical examination, the child is limp and cyanotic with dry mucous membranes and has capillary refill of 3–4 seconds. Vital signs are as follows: temperature 99.8 °F, heart rate 184 beats/minute, respiratory rate 64 breaths/minute, blood pressure 74/46 mm Hg, and oxygen saturation 88% on room air. Her breath sounds are fair and symmetrical. She has normal heart sounds and no murmur. She has equal pulses in all four extremities, with no jugular venous distension (JVD). Her abdomen is soft, with no masses or organomegaly. The child is placed on 100% oxygen via non-rebreather mask without any improvement in color or oxygen saturation. The most likely cause of this patient's condition is:

A. AV canal defect
B. Chronic lung disease
C. Methemoglobinemia
D. Child abuse
E. Bronchiolitis

Correct Answer: C

The most likely cause of this baby's condition is methemoglobinemia secondary to diarrheal illness. Methemoglobinemia is an uncommon cause of cyanosis in young infants and children but can cause serious morbidity and mortality in susceptible patients. It is due to high levels of oxidized forms of iron molecules (ferric states) in the hemoglobin which leads to impaired oxygen-carrying capacity and delivery of hemoglobin to tissues. This therefore causes tissue hypoxia and death in some cases. A normal level of methemoglobin is about 1–1.5% of a child's total hemoglobin. Young and premature infants are more susceptible to methemoglobinemia for two reasons: First, because of the presence of fetal hemoglobin, which is more susceptible to oxidation. Second, the enzyme (cytochrome b5 reductase) responsible for converting methemoglobin (ferric state) back to hemoglobin (ferrous state) is immature. Hence, certain oxidant stressors can induce methemoglobinemia in these young infants, specifically, infections with *E. coli* species.

Diarrhea can lead to acidosis and precipitate methemoglobinemia by oxidation of iron from ferrous to ferric forms especially in very young, premature, or small for gestational age infants. Certain medications such as benzocaine, lidocaine, and prilocaine, foods such as fava beans, or well water with high concentrations of nitrites or nitrates can lead to methemoglobinemia by inducing oxidant stress. Methemoglobinemia should be considered in the absence of cardiac or pulmonary disease and when cyanosis does not respond to oxygen therapy. Tachypnea is a compensatory mechanism to correct the acidosis. The lungs are typically clear, and there is no increased work of breathing.

Clinical manifestations depend on methemoglobin levels. Cyanosis occurs only when the levels are between 10 and 30%. Tachycardia, dyspnea, headache, fatigue, and lethargy occur at higher levels of 30–50%. Coma and death can

occur at level of >50% and > 70%, respectively. A blood gas should be obtained in these patients; it will reveal a normal PO_2. The difference between the saturation measured by pulse oximetry and the saturation derived from the PaO_2 in arterial blood gas causes "saturation gap." A saturation gap greater than 5% is abnormal. The presence of chocolate brown blood is a clue to the diagnosis.

The first step in the management of methemoglobinemia is to stop the offending agent (such as food or medication). With the infant in the vignette, hydration and correcting the acidosis will improve the symptoms. But if symptoms are severe or methemoglobin level is >30%, 1% methylene blue is given at 1–2 mg/kg IV over 5 minutes and repeated if symptoms persist after 1 hour [max of 7 mg/kg]. Consider G6PD deficiency in patients who are unresponsive or with an inadequate response to the above treatment; ascorbic acid could be an option in such cases. Exchange transfusion and hyperbaric oxygen therapy are options for patients with severe symptoms.

Take-Home Message

Consider methemoglobinemia in a cyanotic infant, with a normal cardiac and pulmonary examination. Methemoglobin has a brownish to blue color which does not revert to red on exposure to oxygen. Patients with methemoglobinemia thus appear to be cyanotic. The arterial partial pressure of oxygen ($PaO_{2)}$ values is usually normal in methemoglobinemia.

ABP Content Specification

- Know the etiology and understand the pathophysiology of methemoglobinemia.
- Recognize and differentiate by age signs and symptoms of methemoglobinemia.
- Plan the management of acute methemoglobinemia.

Question 4

A 3-year-old boy, previously healthy, presents with rash and bleeding from his mouth for the past 2 days. Review of systems is negative. The mother denies prior bleeding episodes. He is circumcised. He is not on any medications. In the emergency department, the child is afebrile and relatively well appearing. Vital signs are as follows: temperature 99.8 °F, heart rate 142 beats/minute, respiratory rate 22 breaths/minute, blood pressure 82/54 mm Hg, and oxygen saturation 98% on room air. Physical examination is unremarkable except for a generalized petechial rash and gingival bleeding. A CBC demonstrates a WBC of 8000/mm^3 with neutrophil predominance, hemoglobin of 12 g/dL, and platelets of 6000/mm^3. His serum chemistry and prothrombin time (PT)/partial thromboplastin time (PTT) are within normal limits. Of the following, the true statement regarding this patient's condition is:

A. Patient requires immediate IVIG therapy.
B. Bone marrow biopsy is necessary to diagnose this condition.
C. The major cause of death is due to shock from exsanguinous GI bleeding.
D. Splenomegaly is present in majority of these patients.
E. Patient requires an immediate platelet transfusion.

Correct Answer: A

This child's clinical presentation is consistent with immune thrombocytopenia (ITP), formerly called idiopathic thrombocytopenic purpura. It is the most common platelet disorder in children and commonly seen in the 1- to 4-year age group. Usually, there is a history of preceding or concomitant viral infection. It is an autoimmune disease that is characterized by the production of autoantibodies which cause platelet destruction and inhibition of platelet production. Signs of chronic disease or infection indicate an alternate diagnosis. Splenomegaly is unusual in ITP.

The diagnosis of ITP is based primarily on the history, physical examination, complete blood cell count, and peripheral smear. Children presenting with newly acquired petechiae, ecchymosis, and thrombocytopenia in the absence of any underlying disease are diagnosed with ITP. Epistaxis, gum bleeding, and hematuria

occur less commonly. Intracranial bleeding is rare. Isolated thrombocytopenia in the CBC is the hallmark of ITP; anemia and/or neutropenia may indicate other diseases. Bone marrow aspiration may show normal or increased megakaryocytes but is not indicated in the routine workup unless the presentation is atypical.

Although ITP is mostly self-limiting with spontaneous remission, treatment is indicated in patients that have mucosal or more significant bleeding. The child in the vignette has moderate bleeding symptoms manifesting as petechiae, gingival bleeding, and severe thrombocytopenia and hence qualifies for pharmacologic management. For pediatric patients requiring treatment, a single dose of IVIG (0.8–1 g/kg) should be used as first-line treatment. Corticosteroids are another option but would require bone marrow aspirate prior to administration if patient has atypical features of ITP. IVIG usually raises the platelet count more rapidly than steroids. Another option is administration of anti-D (antibody directed against D-antigen of red blood cells (RBCs)), recommended only in Rh +, non-splenectomized patients. However, anti-D is relatively contraindicated if hematocrit is low due to bleeding or if there is evidence of autoimmune hemolysis. It therefore is not the best choice for the patient in this vignette as he is already anemic. Hospitalization is indicated for platelet count <20,000/mm^3, IV medication regimen, or spontaneous bleeding (regardless of platelet count).

In patients with active bleeding, local therapeutic measures such as nasal packing and topical phenylephrine for epistaxis or hormonal treatment in excessive menstrual bleeding may be helpful until the aforementioned treatments (IVIG, anti-D, steroids) restore platelets. If bleeding persists despite these measures, plasmapheresis should be performed followed by platelet transfusion at 5–10 ml/kg. Generally, however, platelet transfusion is not indicated as the transfused platelets are rapidly destroyed. Plasmapheresis removes the antiplatelet antibodies and increases the survival of transfused platelets.

Take-Home Message

Petechiae and isolated thrombocytopenia in an otherwise healthy child is ITP. A rare but life-threatening complication is intracranial hemorrhage. Platelet transfusion may not be needed for patients who have ITP and do not have active bleeding.

ABP Content Specification

- Recognize signs and symptoms and life-threatening complications of idiopathic thrombocytopenic purpura.
- Plan the management of acute idiopathic thrombocytopenic purpura.

Question 5

A 16-month-old child is brought by his father on a Friday night for evaluation of cough, breathing difficulty, and diaper rash. He denies any fever, vomiting, or diarrhea. On examination, the child is noted to have bilateral wheezing but is otherwise well appearing with no distress. You have a fourth-year medical student working with you. He notices a white reflex in the left eye. The father had never noticed this before but admits he gets limited time with his son who is primarily in the custody of his mother. You decide to administer an albuterol treatment for his wheezing but are wondering what to do with his eye finding. What is the most appropriate management of this patient?

A. Reassurance and discharge after treatment of the wheezing episode.
B. Treat the wheezing and discharge with outpatient follow-up with his pediatrician for further evaluation.
C. Contact the social worker and childcare services and initiate workup with skeletal survey for suspected child neglect/abuse.
D. Ophthalmology consultation/referral for further management of his eye finding.
E. Treat the wheezing, obtain ocular imaging and admit for surgery the next day.

Correct Answer: D

Differential diagnosis of the white reflex includes retinoblastoma, congenital cataract, coloboma, and idiopathic retinal detachment. The most effective way to diagnose retinoblastoma and to differentiate it from other condi-

tions is by examination with indirect ophthalmoscopy. Therefore, ophthalmology consultation or referral is more appropriate than imaging at this point (choice D). Although admission for further ophthalmologic evaluation possibly under sedation is not unreasonable (especially if follow-up is a concern), admission for surgery is not needed before knowing the diagnosis (choice E). Reassurance and discharging the patient with outpatient follow-up with the primary care without addressing the eye issue is not appropriate; if the diagnosis is retinoblastoma, delay in treatment may be detrimental to the child (choices A and B). At this point, it is not reasonable to suspect child abuse/neglect as you need more history, especially from the mother (choice C).

Retinoblastoma is the most common intraocular malignancy in children and is usually diagnosed by age 2 years. Retinoblastoma occurs in both hereditary (autosomal dominant) and sporadic forms. Two-thirds of patients present with a white pupil or leukocoria which is a white appearance or glow of the pupil. This is most commonly noted by the parents. Other less common features include conjunctival erythema, corneal clouding, ocular misalignment (strabismus), afferent pupillary defect, hyphema, and proptosis.

Retinoblastoma is usually local and therefore cured by enucleation, but with the cost of visual loss. The tumor remains intraocular for 3–6 months following initial signs of leukocoria. Currently, other modalities [i.e., chemotherapy, cryotherapy, laser therapy, and insertion of radioactive plaques] are being investigated as alternatives. Although an unlikely complication, direct extension of the tumor via the optic nerve into the meninges and spinal fluid is a possibility. Rarely, extension into the brain or hematogenous spread to the liver and bone also can occur.

Retinoblastoma is a rapidly growing tumor. It can invade locally as early as 2 months after onset, and there may be extraocular spread within 6 months after onset. Hence, the ophthalmology service should be consulted early to determine if the patient's visual acuity has already been affected and to plan the urgency of examination under anesthesia. Management may be possible on an outpatient basis depending on the preference of the pediatric ophthalmologist and the impact of the tumor on vision.

With early detection and appropriate management, survival rates are close to 95%. Secondary malignancies such as soft tissue sarcomas and osteogenic sarcomas are common causes of death among survivors, primarily in those with hereditary retinoblastoma. Hence, use of orbital CT scans is controversial and is not recommended in these children due to the high risk of occurrence of secondary malignancies.

Take-Home Message

Patients with leukocoria require urgent ophthalmology referral. Retinoblastoma usually spreads outside the eye approximately 6 months after onset.

ABP Content Specification

- Recognize signs and symptoms of retinoblastoma.
- Plan the initial management of patients with retinoblastoma.

Keywords

- Retinoblastoma

Question 6

A 2-year-old girl is referred by her pediatrician for evaluation of an abdominal mass noticed during a routine healthcare maintenance visit that morning. The mother denies any fever, irritability, vomiting, and weight loss, and the child has normal appetite and activity. On examination, the child is well appearing without pallor or signs of respiratory distress. Her vital signs, height, and weight are age appropriate. The only pertinent finding on examination is a firm, smooth mass noted in the left flank, which is non-tender on palpation. The remainder of the examination is unremarkable. The next best step in the management of this child is:

A. Reassure and discharge from the emergency department.
B. Provide a fleet enema and discharge with stool softeners and dietary instructions.
C. Obtain an abdominal ultrasound.
D. Obtain basic laboratory tests and abdominal CT scan.
E. Admit for abdominal MRI under sedation.

Correct Answer: C

This child most likely has Wilms' tumor [given the age and physical examination]. Wilms' tumor is the most common renal tumor in children. It arises from the embryonic renal blastemal cells and is due to a mutation in WT1 tumor suppressor gene on chromosome 11p13. Wilms' tumor is associated with WAGR syndrome (Wilms' tumor, aniridia, GU anomalies, mental retardation) and overgrowth syndromes such as Beckwith-Wiedemann, Soto, hemihypertrophy, and Denys-Drash syndromes; these predispose to Wilms' tumor. Nearly 500 cases of Wilms' tumor are diagnosed annually in the USA with higher risk in African Americans and females. The peak incidence is between the ages of 3 and 4 years with nearly 80% of cases diagnosed by 5 years of age.

Wilms' tumor most commonly presents with a painless mass found incidentally by either the parents or pediatrician in a child who is otherwise well appearing. They are firm or soft masses and usually smooth and are deeply situated in the flank. Associated symptoms such as abdominal pain, fever, anorexia, malaise, vomiting, and weight loss are uncommon. Although microscopic hematuria is very common, gross hematuria occurs in less than 25% of cases. Other uncommon but more serious presentations include hypertension (due to increased renin secretion from renal artery compression) in <15% of cases, anemia, renal venous thrombosis with or without extension into the inferior vena cava, and abdominal compartment syndrome from a massive renal tumor.

The initial management should focus on how ill the patient is and in consultation with a pediatric oncologist and pediatric surgeon. Laboratory evaluation should include a CBC to look for evidence of bleeding, a urinalysis looking for hematuria, liver and renal function tests, and serum calcium to look for rhabdoid tumors or congenital mesoblastic nephroma. Ultrasound is obtained as the initial screening test to define the mass, including its anatomical position, consistency, and presence of hydronephrosis or ureteral obstruction. It appears as a solid mass distorting the renal sinus, pyramids, cortex, and contour of the kidney.

Well-appearing patients without evidence of bleeding may be discharged home if appropriate follow-up with a pediatric oncologist or surgeon is arranged. Hospitalization may be needed if there are concerns regarding follow-up.

Some centers may elect to perform a CT scan with intravenous contrast, but ultrasound is the preferred initial screening test that helps to identify and differentiate Wilms' tumor from other abdominal masses [i.e., germ cell tumors, lymphomas, sarcomas, and neuroblastomas]. The opposite kidney should be carefully evaluated for the presence of tumor.

Take-Home Message

Wilms' tumor commonly presents as a unilateral painless abdominal mass in children younger than 5 years.

ABP Content Specification

- Know the epidemiology and understand the pathophysiology of Wilms' tumor.
- Recognize and interpret relevant laboratory and imaging studies for Wilms' tumor.
- Recognize signs and symptoms and life-threatening complications of Wilms' tumor and its treatment.
- Plan initial management of acute complications of Wilms' tumor and its treatment.

Question 7

A 4-year-old child is brought by his mother for a black eye noticed yesterday after he returned from a grandmother house. He has been staying with his grandmother for the past 6 weeks. His mother reports that "his grandmother doesn't

take good care of him; he lost a lot of weight while he was with her." The patient's grandmother said that she doesn't know how he got this, as he never fell but does play roughly. His mother says he visited her last year for only 2 weeks, and there were no issues at that time. The vitals are unremarkable except for mild tachycardia. On examination, he is not in any obvious distress, and pertinent examination findings include mild pallor, right periorbital ecchymosis, generalized lymphadenopathy, and abdominal fullness with the liver edge palpable 4 cm below costal margin. Upon chart review, you notice that he was seen here few times and two past visits were for constipation. He has lost 2 pounds since his last visit 4 months ago. This patient's presentation is most consistent with:

A. Failure to thrive
B. Child abuse
C. Retinoblastoma
D. Neuroblastoma
E. Wilms' tumor

Correct Answer: D

The constellation of this child's presentation of weight loss, hepatomegaly, lymphadenopathy, and black eye points to neuroblastoma as the most likely diagnosis. His prior ED visits for constipation are likely secondary to the abdominal mass impinging on the GI tract causing constipation.

Neuroblastoma is derived from neural crest cells, found in the adrenal medulla and along the sympathetic chain. It is the most common solid tumor in children other than CNS tumors, with 50% of tumors occurring by age 2 years and 90% of cases diagnosed by 5 years of age. The primary tumor is in the abdomen (65%), specifically in the adrenal gland in more than 50% of cases.

Neuroblastoma has variable clinical presentations. It can cause pancytopenia and bone pain due to involvement of the bone marrow, respiratory distress due to large chest or abdominal masses, and superior vena cava (SVC) syndrome from a posterior mediastinal mass. It may occasionally present as constipation or as an abdominal mass incidentally found in a healthy child. Other presentations include ipsilateral Horner's syndrome (ptosis, miosis, and anhidrosis) from involvement of the cervical sympathetic ganglia, raccoon eyes (proptosis and ecchymosis) from periorbital involvement, or opsoclonus myoclonus (dancing eyes and dancing feet) or subcutaneous nodules. Neuroblastoma can also cause hypertension and diarrhea via secretion of catecholamines and vasoactive intestinal peptide.

The ED management includes focusing on the BP and other vitals in addition to the airway, breathing, and circulation. A complete history and physical examination including a thorough neurologic examination should be done. Laboratory evaluation includes CBC, liver and renal function tests, and urine catecholamines looking for pancytopenia and tumor lysis syndrome (TLS). Abdominal ultrasound is usually the initial study obtained that helps define the location of the mass. Chest or other radiographs may be needed to look for calcifications. CT scans when obtained should include the suspected site of the primary tumor, the surrounding lymph node groups, and the liver (a common site of metastasis). Patients can be discharged in the care of a pediatric oncologist if no evidence of severe systemic illness or uncontrollable pain is present and a thorough evaluation reveals no evidence of life-threatening or organ-threatening problems.

Wilms' tumor is another possibility, but the finding of periorbital ecchymosis points more toward neuroblastoma. Child abuse is always in the differential, but the constellation of the patient's signs/symptoms points more toward neuroblastoma. Retinoblastoma is less likely with this presentation unless it has already metastasized, which is rare in the absence of other eye findings.

Take-Home Message

Neuroblastoma is a malignancy of the neural crest cells that can arise from the adrenal gland or anywhere throughout the sympathetic chain leading to variable presentations.

ABP Content Specification

- Know the epidemiology and understand the pathophysiology of neuroblastoma.
- Recognize and interpret relevant laboratory and imaging studies for neuroblastoma.
- Recognize signs and symptoms and life-threatening complications of neuroblastoma and its treatment.
- Plan initial management of acute complications of neuroblastoma and its treatment.

Question 8

A 6-year-old boy presents with subjective fever, vomiting, and decreased activity for 3–4 days. He was seen at another hospital 2 days ago for acute gastroenteritis and was discharged after receiving ondansetron (Zofran) and intravenous hydration. The mother has migraine but otherwise no significant family or past medical history. On exam, patient is afebrile and nontoxic but looks tired and mildly dehydrated. Vital signs are notable for mild tachycardia. Physical examination is unremarkable other than sluggish gait due to weakness and strabismus of the left eye. The most appropriate next step in the management of this child is:

A. Head CT and neurology consultation
B. Lumbar puncture and neuro consult
C. Ophthalmology consult for evaluation of strabismus
D. Zofran, IV fluids, chemistry panel, and discharge with PMD and ophthalmology follow-up
E. Zofran, PO challenge, and discharge with outpatient PMD and ophthalmology and neurology follow-up

Correct Answer: A

This patient's symptomatology of vomiting, gait problems, and strabismus suggests an intracranial process requiring urgent imaging with a CT scan of the head. An MRI with gadolinium contrast will ultimately be needed if suspecting brain tumors, as CT may not show infratentorial lesions. However, CT scan is the initial imaging study obtained because it is readily available.

Brain tumors can cause increased intracranial pressure (ICP) by blocking CSF drainage. The symptoms depend on the age of the patient. Infants may present with bulging fontanelle, macrocephaly, seizures, vomiting, and irritability, while older children presents with headache and early morning vomiting. Brain tumors should also be considered in the differential diagnosis of new-onset seizures. Diplopia or strabismus, as seen in this patient, due to cranial nerve (CN)-6 palsy is early signs of increased ICP. In the event of increased ICP, the majority of these patients have a normal pupillary exam. Fundoscopic exam is necessary to evaluate for papilledema. Sometimes, increased ICP is detected only on imaging of the brain that reveals enlargement of the ventricles or effacement of the gyri.

Emergent treatment with steroids such as dexamethasone, at a dose of 0.25–0.5 mg/kg every 6 hours [max of 16 mg], is indicated if physical exam or imaging studies are concerning for raised ICP. Keep the patient's head elevated and midline to prevent obstruction of blood flow and lymphatics. Mannitol may also be useful in lowering the ICP, and intubation with hyperventilation may be needed in some situations. Neurosurgical consultation is needed for possible ventriculostomy or debulking procedure. Lumbar puncture may cause rapid changes in ICP and brain herniation and therefore should be avoided if concern about increased ICP (choice B).

Laboratory evaluation includes CBC to ensure the patient's hematocrit and platelets are adequate for any upcoming procedures and serum electrolytes to look for metabolic complications such as SIADH, salt wasting, or DI (from involvement of the pituitary gland).

The decision about whether to admit a patient with a newly diagnosed brain tumor depends on the neurologic status. Patients may have airway, breathing, or circulation problems requiring emergent management due to the tumor compressing the brainstem. Prompt consultation with pediatric oncology, pediatric neurology, and

pediatric neurosurgery is essential to ensure that patients are referred to experienced centers for definitive management. Ophthalmology consult may be reasonable (choice C), but obtaining imaging studies is more appropriate to look for intracranial pathology. Choices D and E are also not appropriate without further workup to rule out intracranial causes of the patient's symptoms.

Take-Home Message
Increased ICP should be considered in the presence of vomiting and neurologic deficits, and imaging studies should be obtained. Strabismus may be an early finding of increased ICP and should raise clinical suspicion.

ABP Content Specification
- Recognize and interpret relevant laboratory and imaging studies for CNS tumors.
- Recognize signs and symptoms and life-threatening complications of CNS tumors and their treatment.
- Plan initial management of acute complications of CNS tumors and their treatment.

Keywords
- Brain tumor
- Increased intracranial pressure

Question 9

An 8-year-old presents to the emergency department with headaches for over 6 months that have become worse over the last week. He was seen by his PMD twice in the last 6 months and was provided ibuprofen with a neurology follow-up, but he missed these appointments. His headaches initially relieved with ibuprofen, but he now reports that the medicines are not helping him. In fact, twice in the last week, he was awakened from sleep due to headache and vomiting. In the ED, his vitals are within normal limits except for mild tachycardia. A head CT was obtained in the ED and revealed an infratentorial mass. All of the following statements regarding CNS tumors in children are true *except*:

A. Brian tumors are the most common solid tumors in children.
B. Most pediatric brain tumors are due to metastasis from solid tumors at other sites of the body.
C. Gliomas are histologically the most common brain tumors.
D. Most pediatric brain tumors are infratentorial.
E. Diplopia or strabismus due to CN-6 palsy is an early sign of increased ICP.

Correct Answer: B

Brain tumors are the most common solid tumors in children and the second most common pediatric cancers overall. They affect children of any age, but the peak incidence is in children between 5 and 10 years. Certain syndromes such as neurofibromatosis type I have an associated increased risk of developing brain tumors such as gliomas.

Brain tumors in children are usually primary, not metastatic. Most pediatric brain tumors are infratentorial and are more common between ages 1 and 10 years, while supratentorial tumors are more common in children younger than 1 year and older than 10 years. Gliomas are histologically the most common brain tumors. Astrocytomas are a subset of gliomas and comprise about 1/3 of all brain tumors, with the majority of them being infratentorial. Primitive neuroectodermal tumors (PNETs), the most common of which is medulloblastoma, are the second most common histologic type and occur mostly in the cerebellum.

Since the symptoms of brain tumors are similar to those of more common illnesses such as gastrointestinal disorders with associated vomiting, the diagnosis may be delayed particularly in young children. Infants with open cranial sutures may present with signs of increased ICP, such as vomiting, lethargy, and irritability. Some infratentorial lesions may obstruct the fourth ventricle and cause hydrocephalus and increased ICP. The sixth CN palsy is an early sign of increased ICP and presents as diplopia or strabismus. Infratentorial tumors may also present with cra-

nial nerve deficits such as facial nerve palsies, dysphagia, truncal ataxia, and gait problems. Herniation of the cerebellar tonsil causes neck pain or stiffness and head tilt toward the tumor. Supratentorial tumors near the optic chiasm may present with vision deficits, while craniopharyngiomas can cause visual disturbances, headache, and endocrine dysfunction. A high index of suspicion is essential in patients with nonspecific presentations.

Take-Home Message

The majority of brain tumors in pediatrics are infratentorial with gliomas being the most frequent type.

ABP Content Specification

- Know the epidemiology and understand the pathophysiology of CNS tumors.
- Recognize and interpret relevant laboratory and imaging studies for CNS tumors.
- Recognize signs and symptoms and life-threatening complications of CNS tumors and their treatment.

Question 10

An 11-year-old girl with history of constipation presents with a 2-week history of worsening low back pain associated with weakness of legs and unsteady gait for 2 days. She denies any fever, URI symptoms, or trauma. Her last bowel movement was 5 days prior to presentation. She has not had any episodes of urinary incontinence. In the ED, she has mild pain and mild tachycardia. The remainder of vital signs are stable. Her chest and cardiac examinations are unremarkable, and her abdomen is soft and non-tender with no palpable masses. Pertinent CNS examination findings include unsteady gait and slightly decreased strength (4/5) in the right lower extremity, but sensation, reflexes, and the rest of the CNS examination are normal. There is also no midline spinal lesions or tenderness. The most appropriate next step in the management of this patient is:

A. Analgesia, MRI of the spine with gadolinium contrast, and neurology consultation
B. Analgesia, CT scan of the spinal cord with contrast, and neurology consultation
C. Analgesia, X-rays of the spine, and neurology consultation
D. KUB, fleet enema, and discharge on polyethylene glycol 3350, dietary instructions, and PMD follow-up
E. Psychiatry consultation to evaluate for conversion disorder

Correct Answer: A

This patient's presentation of low back pain, constipation, abnormal gait, and neurological findings is suggestive of spinal cord compression and therefore requires further evaluation with a spine MRI. Accordingly, choices D and E are not appropriate in this patient.

Spinal cord tumors cause localized pain and neurological deficits. However, these patients may have back pain for 2–4 months before any neurologic deficit is evident. The most common causes of spinal cord compression in children are the sarcomas of the vertebral bodies such as Ewing's and osteosarcoma. They may present with weakness, loss of motor milestones, urinary retention, fecal incontinence, or constipation. Physical examination findings include focal or asymmetric weakness, sensory deficits, and loss of reflexes or an upgoing Babinski reflex. MRI of the spine with gadolinium contrast confirms the diagnosis. A CT scan may not be the best modality when evaluating a spinal lesion, and plain radiographs are not helpful (choices B and C).

In addition to adequate analgesia, management of cord compression begins with steroids, most commonly dexamethasone [0.25–0.5 mg/kg IV as an initial dose]. Multispecialty consultation with neurosurgery, radiation, and pediatric oncology services are needed for planning both acute and long-term management of these patients including surgical decompression, radiation therapy, and chemotherapy once diagnosis is established.

Take-Home Message
Back pain in the pediatric patient should raise clinical suspicion, especially if it is unremitting. Any neurologic deficit requires MRI scan. A CT scan and plain radiographs may not provide adequate information to evaluate spinal cord lesions.

ABP Content Specification
- Recognize and interpret relevant laboratory and imaging studies for CNS tumors.
- Recognize signs and symptoms and life-threatening complications of CNS tumors and their treatment.
- Plan initial management of acute complications of CNS tumors and their treatment.

(This history applies to questions 11 and 12.)

Question 11

A 12-year-old girl visiting from St. Vincent Island presents with right hip pain for 1 week. The parents tell you "She was seen by her doctor in St. Vincent 1 month ago, who said she had high white cells and something wrong in the X-rays." They said the pain got better in 2 days after she took Augmentin. She had a fever for 1 day about 2 weeks ago which has resolved. She denies any recent URI symptoms, rashes, weight loss, or trauma. In the ED, the patient is afebrile and nontoxic appearing with normal vital signs. Physical examination is unremarkable except for limping gait, tenderness over the right hip, and pain upon internal rotation of hip without any erythema, warmth, or swelling of the hip. There is no pallor, but she is noted to have mild hepatosplenomegaly and bilateral inguinal lymphadenopathy. Laboratory evaluations are obtained and are as follows: WBC 240600/mm^3, Hgb 9.4 g/dL, platelet 627,000/mm^3, neutrophils 57%, bands 10%, lymphocyte 6%, meta 7%, myelocytes 12%, and myeloblasts 3%. Her LDH is 1078, but other laboratory tests including LFTs, electrolytes, BUN, creatinine, uric acid, and X-rays are unremarkable.

All of the following statements regarding the most likely diagnosis of this patient are true *except*:

A. Most patients with this condition do not have extremely high WBC counts.
B. Majority of the patients with this condition have hepatosplenomegaly.
C. Fever is the one of the most common presenting symptoms of this condition.
D. Presence of blast cells in the peripheral circulation helps make the diagnosis.
E. Bone marrow studies are not required if blasts are identified on peripheral smear.

Correct Answer: E

Based on the physical examination, CBC, and peripheral smear, this patient most likely has leukemia. Leukemia is the most common malignancy in children and accounts for up to 26% of all malignancies in children under 14 years. Acute lymphoblastic leukemia (ALL) is the most common leukemia. The symptoms are usually due to excessive numbers of immature and malignant WBCs (leukemic blasts, either lymphoid or myeloid) replacing normal marrow hematopoietic cells. This leads to bone marrow failure and hematologic abnormalities such as anemia, thrombocytopenia, and neutropenia. Bone pain (23%), joint pain, and pathologic fractures occur because of the strain on the marrow space from the rapidly proliferating leukemic cells. Fever is a common symptom and is present in nearly 60% of patients. Due to the infiltration of these blasts into extramedullary tissues, patients can also manifest with hepatomegaly, splenomegaly (68%), adenopathy, mediastinal masses, CNS, and testicular involvement. Anterior mediastinal masses can lead to life-threatening airway compromise and superior vena cava (SVC) syndrome. Other features include meningeal symptoms, cranial nerve palsy, headache, seizures, increased intracranial pressure, and visual disturbances due to infiltration of spinal fluid with these leukemic cells. Chloroma (a mass of leukemic blasts in the

soft tissues) can cause compression symptoms if it occurs near the spinal cord.

In addition to focusing on ABCs, the management of a patient with suspected leukemia in the ED includes a thorough history and physical exam including a complete neurologic and genital exam. Obtain a chest X-ray to screen for a mediastinal mass and consider brain imaging if neurologic examination is abnormal. Avoid any sedating procedures until certain that there is no potential for airway compromise from a mediastinal mass. Laboratory evaluation includes CBC, manual differential, and peripheral smear. Automated differentials might count leukemic blasts as either atypical lymphocytes (lymphoid blasts) or monocytes (myeloid blasts), so abnormal numbers of these cell types should raise concern for leukemia.

Almost all patients with leukemia have some hematologic abnormalities, but most patients do not have the extremely high WBC that this patient has. Leukemic blasts in the peripheral circulation help make the diagnosis, and leukemia is most likely if blasts are >20%. But a small percentage of blasts are also seen in other conditions such as myelodysplastic syndromes, myeloproliferative disorders, recovery from an aplastic process, or a leukemoid reaction. Leukemia can also present without peripherally circulating blasts; therefore, specific diagnosis requires a bone marrow aspirate even when the diagnosis seems obvious. The differential diagnosis of pancytopenia in the absence of leukoblasts includes aplastic anemia, infections (usually viral), and marrow replacement by a solid tumor involving the bone marrow in addition to leukemia.

Other laboratory evaluation should include serum chemistries such as potassium, calcium, magnesium, phosphorus, uric acid, BUN, creatinine, PT/PTT to screen for tumor lysis syndrome, renal function, and coagulopathy. The pediatric hem/oncology service should be consulted to guide appropriate workup and management including possible transfer of the patient to a facility that offers specialized care.

Take-Home Message

In a child with pancytopenia, blasts, or hyperleukocytosis, consider the underlying diagnosis of leukemia and initiate screening for metastasis [specifically mediastinal mass].

ABP Content Specification

- Know the epidemiology of leukemia.
- Recognize and interpret relevant laboratory and imaging studies important in making the diagnosis of leukemia.
- Recognize signs and symptoms of leukemia, its life-threatening complications, and its treatment.
- Know the differential diagnosis of leukemia.

Question 12

The pediatric hematology and oncology service is consulted. Further evaluation in this patient reveals a normal CXR and no evidence of coagulopathy. The most appropriate next step in the management of this patient is:

A. Aggressive pain control with NSAIDs.
B. IV antibiotics.
C. Administer corticosteroids to prevent spinal cord compression.
D. IV hydration.
E. Packed RBC (PRBC) transfusion.

Correct Answer: D

Patients with leukemia may develop several complications that should be recognized and treated aggressively in the ED. All patients should receive IV fluids (without potassium) at 1.5–2 times maintenance. Allopurinol (xanthine oxidase inhibitor) is also given orally to decrease production of uric acid. The patient in the vignette is at risk for leukostasis due to extremely high WBC count (hyperleukocytosis) and therefore needs immediate IV hydration to the maximum tolerated volumes (2–4 times maintenance).

Hyperleukocytosis is defined as WBC count >100,000/mm^3. Leukostasis results secondary to sludging of WBCs in the capillary beds, especially in the lungs and CNS, where increased viscosity can cause either thrombosis or

hemorrhage. Hydration should be initiated immediately in the setting of hyperleukocytosis to reduce viscosity. Leukocytopheresis, a technique to reduce blood viscosity acutely, should be initiated immediately in the setting of elevated WBC of >100,000/mm^3 even with mild respiratory or neurologic symptoms. Leukostasis is much more common with myeloid leukemia than with ALL. Use of prophylactic leukocytopheresis in asymptomatic patients with WBC count >100,000/mm^3 in AML or > 300,000/mm^3 in lymphoid leukemia is controversial and should be considered only in consultation with an oncologist.

Transfusion of red blood cells and diuretics should be avoided in the setting of hyperleukocytosis as it can further increase the blood viscosity, unless the patient has severe anemia or is symptomatic from anemia. Even if the patient requires PRBC transfusion, they should be transfused slowly to avoid precipitating heart failure. PRBC transfusion is not required at this point in this patient since this patient is neither severely anemic nor symptomatic from anemia. Since new-onset leukemia may have an associated coagulopathy, coagulation studies should be obtained in all patients and platelets given if <50,000/mm^3 to reduce the risk of spontaneous CNS hemorrhage. Leukopheresis may be contraindicated until coagulopathy is corrected. Opioids are the mainstay of pain control in these patients. Aspirin and other NSAIDs are generally avoided due to their antiplatelet effect in the setting of frequent thrombocytopenia. Acetaminophen can be used to control fever and pain. The rectal route for medication administration or measurement of temperature should be avoided in neutropenic patients to decrease the likelihood of bacterial dissemination of gut flora into systemic circulation.

Tumor lysis syndrome (TLS) is another complication that needs to be managed emergently. It results from the rapid death and destruction of tumor cells leading to increase in potassium, phosphate, and uric acid levels in the blood. TLS is common with acute leukemias and lymphomas, and the risk is highest in ALL with hyperleukocytosis and advanced Burkitt's lymphoma. Therefore, screening for electrolyte abnormalities and preemptive therapy with hydration and allopurinol are appropriate for all patients at risk of TLS.

Fever is one of the common manifestations in leukemic patients. Broad-spectrum antibiotics to cover gram-positive and gram-negative bacteria (including pseudomonas) should be administered if temperature is >39 °C or ANC < 500 or for any localizing signs of a bacterial infection after the blood culture is obtained; lumbar puncture is avoided. However, since the patient in the vignette is afebrile with no signs of infection and normal ANC, there is no indication to start emergent antibiotics. Also, corticosteroid administration is not indicated as there is no evidence of spinal cord compression in this patient. They are actually contraindicated in this setting as they can mask the diagnosis before the bone marrow biopsy is performed.

Take-Home Message

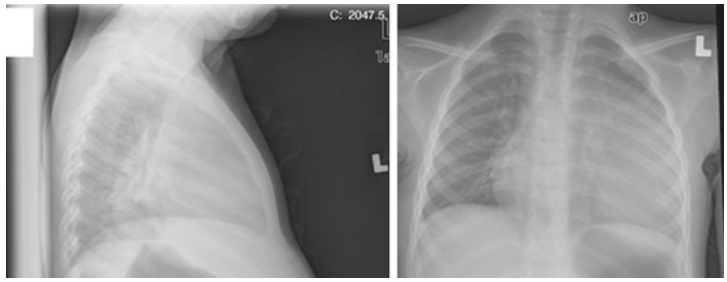
Tumor lysis syndrome is a serious complication of cell turnover. Evidence of elevated phosphate, potassium, and uric acid should be treated aggressively with hydration and allopurinol.

ABP Content Specification

- Recognize signs and symptoms of leukemia, its life-threatening complications, and its treatment.
- Plan the initial management of acute complications of leukemia.

Question 13

A 2-year-old child presents to the emergency department with a 2-day history of fever and cough. On arrival, vital signs are as follows: temperature 102.3 °F, heart rate 140 beats/minute, respiratory rate 28 breaths/minute, blood pressure 112/62 mm Hg, and oxygen saturation 100%. Physical examination is unremarkable with no wheezing or respiratory distress. A chest radiograph is obtained which is as shown in the figure:



- It is unchanged from a previous chest radiograph obtained 6 months ago for a similar presentation.
- During his visit 6 months ago, the patient was hospitalized and treated for pneumonia with IV antibiotics. No follow-up X-rays were done as the patient missed his appointments with his PMD. The most appropriate step in the management of this patient is:
  A. Admit for IV antibiotics.
  B. Discharge on oral antibiotics with PMD follow-up.
  C. Place PPD and discharge on PO antibiotics with PMD follow-up in 2–3 days.
  D. Obtain a chest CT scan with IV contrast.
  E. Pleural fluid aspiration for diagnostic and therapeutic purposes.

Correct Answer: D

This patent's CXR reveals an opacity in the left hemithorax silhouetting the left heart border, which is unchanged from his prior X-ray 6 months ago. The differential diagnosis ranges from an infectious process such as recurrent pneumonia to various mediastinal masses. Hence, further imaging with a chest CT scan with contrast is recommended for further evaluation and to rule out a mediastinal mass (choice D).

Although antibiotics may be reasonable, admission for IV antibiotics without further investigation such as chest CT scan to rule out other entities is not the best step. Since the patient was noncompliant with PMD follow-up during his earlier visit, discharge and outpatient workup is not appropriate in this patient. Accordingly, choices A, B, and C are incorrect.

Effusions are common, especially with anterior mediastinal masses due to leukemia or lymphoma; patient may or may not be symptomatic. Fluid can be drained in the ED for relief of symptoms in symptomatic patients and a sample sent to pathology for cytology if malignancy is suspected. However, drainage is not performed in the ED for diagnostic purposes in asymptomatic patients. Therefore, choice E is also incorrect.

Take-Home Message

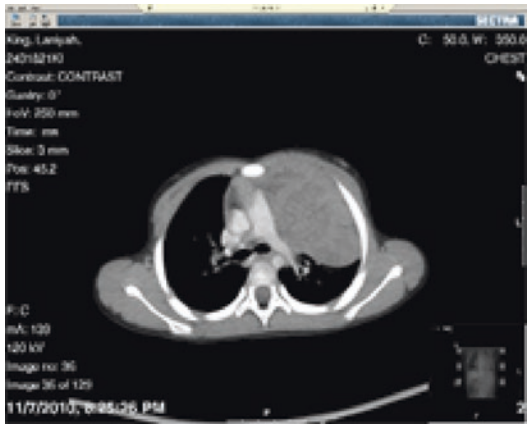
For a persistent pleural opacity, have a high index of suspicion for underlying etiology other than infection. If the patient is able to tolerate it, obtain a chest CT with contrast for better differentiation.

ABP Content Specification

- Know the epidemiology and understand the pathophysiology of Hodgkin's and non-Hodgkin's lymphomas.
- Recognize and interpret laboratory and imaging studies for Hodgkin's and non-Hodgkin's lymphomas.
- Recognize signs and symptoms and life-threatening complications of Hodgkin's and non-Hodgkin's lymphomas.
- Plan initial management of acute complications of Hodgkin's and non-Hodgkin's lymphoma and its treatment.

Question 14

A chest CT with contrast is obtained in this patient, which reveals a large left-sided anterior mediastinal mass as shown in the figure:



His CBC and chemistry are unremarkable except for mild leukocytosis with lymphocytic predominance.

All of the following are true regarding this patient's condition *except*:

A. Lymphomas are the most common thoracic tumors in children.
B. Anterior mediastinal masses are more commonly symptomatic.
C. Infection is a more common cause of lung nodules in children.
D. Respiratory distress is the most common presentation of posterior mediastinal tumor.
E. Elevation of the patient's head can help alleviate symptoms of Superior vena cava (SVC) syndrome.

Correct Answer: D

The majority of thoracic tumors in children arise from the mediastinum. Lymphoma is the most common mediastinal tumor while *Non-Hodgkin's lymphoma* affects children predominantly between two and twelve years of age. *Burkitt's lymphoma* is a type of non-Hodgkin's lymphoma which is associated with Epstein-Barr virus. It is an aggressive B-cell lymphoma with frequent bone marrow and central nervous system (CNS) involvement. There is an increased risk of tumor lysis syndrome upon induction chemotherapy.

The mediastinal masses are divided based on location into anterior, middle and posterior mediastinal masses. The "4 Ts" of the anterior mediastinal tumors include terrible lymphoma, teratoma (benign and malignant germ cell tumors), thymoma, and thyroid carcinoma. Nonmalignant anterior mediastinal masses include adenopathy secondary to infection, sarcoid, and normal thymus. Middle mediastinal masses include lymphoma, pulmonary sequestration, and other developmental anomalies. Posterior mediastinal masses include neuroblastoma and benign lesions such as Schwannoma.

Primary lung tumors are rare in children, but metastasis is not uncommon and typically involves multiple lung nodules in the pulmonary parenchyma or pleura. However, infection is a more common cause of lung nodules than cancer in children.

Anterior and middle mediastinal tumors often present with respiratory symptoms ranging from mild cough to severe respiratory distress; they can also compress the great vessels and cause syncope or SVC syndrome (plethora, facial edema, and jugular venous distension). In contrast, posterior mediastinal masses are frequently identified incidentally on a chest X-ray performed for another reason. They may, however, cause local pain from nerve root involvement or emergencies such as cord compression.

The initial ED management should focus on stabilizing the airway, breathing, and circulation. Since an anterior mediastinal mass may compress the airway below the level of the carina, intubation may not be effective, and management must focus on prevention of respiratory failure by keeping the patient calm and upright and providing oxygen therapy. Supine position, sedation and anesthesia can cause rapid deterioration of the respiratory distress. Sedation and anesthesia can also cause cardiovascular collapse. Empiric steroids should not be given without discussing with an oncologist as they may mask the diagnosis.

A thorough history and physical examination is required including assessment of lymph nodes, and meticulous CNS exam to identify possible cord compression. Lymphomas can present with nonspecific systemic symptoms such as weight

loss, fatigue, unexplained fevers, night sweats, malaise, and itching.

Diagnostic workup in the ED usually includes a chest radiograph that includes a lateral view. An abundance of caution is to be exercised for those in respiratory distress that need chest CT scan. Laboratory evaluation includes CBC (cell counts and identification of blasts) and metabolic screening (including identification of tumor lysis syndrome). Symptomatic patients should ideally be admitted to an ICU in a center with pediatric oncology expertise.

Take-Home Message

Anterior mediastinal masses are caused by the "4 Ts" – "terrible lymphoma," 'thymoma," "thyroid carcinoma," and "teratoma."

ABP Content Specification

- Know the epidemiology and understand the pathophysiology of Hodgkin's and non-Hodgkin's lymphomas.
- Recognize and interpret laboratory and imaging studies for Hodgkin's and non-Hodgkin's lymphomas.
- Recognize signs and symptoms and life-threatening complications of Hodgkin's and non-Hodgkin's lymphomas.
- Plan initial management of acute complications of Hodgkin's and non-Hodgkin's lymphoma and its treatment.

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Toxicology

15

Lee Donner, Evan Mahl, and Andaleeb Raja

Question 1

A 3-year-old girl is found by her mother playing with an empty bottle of lithium. There are no tablets left in the bottle, and none are found in the home after an exhaustive search by the family. The mother thinks there were between 5 and 10 tablets left in the bottle after she took her last dose. The mother calls for advice. What is the most appropriate next step?

A. Administer activated charcoal to the child.
B. Administer syrup of ipecac to the child.
C. Consult with the local poison control center by telephone.
D. Monitor the child for adverse effects, and call her pediatrician should any develop.
E. Rush the child to the nearest emergency department.

Correct Answer: C

The child is assumed to have ingested a toxic quantity of the mother's lithium, a metallic salt used to treat certain psychiatric conditions. While the clear potential for toxic effect of the agent exists, the recommendation at this point would be for the mother to call the local poison control center. Activated charcoal (AC) is an adsorbent used for GI decontamination. It is not commonly available for storage in the home, and its effectiveness in children is limited by its unpalatable taste and texture. It may be used as a GI decontaminant in the emergency department where it may be administered via nasogastric tube in cases where it is indicated. However, as a metallic salt, lithium will not adsorb to AC. AC is also ineffective for and should not be used for decontamination of ingestions of other metals, caustics, and alcohols. Syrup of ipecac was long used as a prometic as a GI decontaminant after toxic ingestions. However, research has shown that it is incompletely and unreliably effective at achieving gastric emptying. Risks of home ipecac use exist, including the risk of pulmonary aspiration even when used appropriately, the risk of emesis impairing the oral administration of an effective antidote when one exists, and the risk of inadvertent use by other household members. For these reasons, it is generally not recommended for storage in the home or to be used without the recommendation of a poison control center. The AAP recommends the first action for a caregiver of a child who may have ingested a toxic substance is to consult with the local poison control center for help at 1-800-222-1222. Monitoring the child for

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_15

adverse effects at home is occasionally an appropriate course of action in ingestions; however, it is inappropriate in the setting of a possible lithium ingestion. This course of action would be appropriate to the caregiver only if recommended by the poison control center for specific ingestions and scenarios. Rushing the child directly to the nearest hospital's emergency department is not the best option as it is best coordinated with the poison control center who can advise regarding the need for hospital evaluation along with immediate interventions that may be needed.

Take-Home Message

Poison control centers are a very valuable community resource that can help reduce unnecessary emergency department visits in addition to providing immediate advice that include immediate interventions and the need for evaluation in an emergency department.

AC has no role in lithium toxicity as it does NOT adsorb metallic salts, caustics, or alcohols.

ABP Content Specification

- Know the role of gastrointestinal tract decontamination.
- Know the role of activated charcoal, including substances not adsorbed by the charcoal.

Question 2

A 6-month-old previously healthy boy is brought to the emergency department after the parents noted a bluish hue to the child's digits. His past medical history is significant for full-term birth by normal spontaneous vaginal delivery. He has met growth and developmental milestone expectations as per his last pediatrician visit. The parents report that he began teething this week and has become fussy for which acetaminophen and topical benzocaine anesthetic gel were used. Vital signs are temperature 98.6 F (37 °C), heart rate 170 beats/minute, respiratory rate 35 breaths/minute, blood pressure 100/70 mmHg, and oxygen saturation 84%. Physical examination shows a lethargic but responsive boy with obvious cyanosis and no signs of trauma. His airway is intact with normal breathing and clear breath sounds bilaterally, regular heart rhythm without murmurs, distal pulses palpable, and no peripheral edema is present. Intraoral examination reveals erupting primary teeth. An arterial blood gas sample, notable for a chocolate brown appearance, is sent for analysis and is notable for a SaO_2 value of 94%. The next most appropriate step is:

A. Administer deferoxamine
B. Administer naloxone
C. Administer sodium nitrate and sodium thiosulfate
D. Administer methylene blue
E. Rapid sequence intubation

Correct Answer: D

This is a case of methemoglobinemia, a condition in which the iron atom of hemoglobin is oxidized from its ferrous (Fe^{2+}) form to the ferric (Fe^{3+}) state by an oxidative stressor. This oxidized form has both impaired oxygen carrying and delivering capabilities, resulting in symptoms of hypoxia. The iron in the ferric state has increased oxygen affinity and shift the hemoglobin dissociation curve to the left. This causes inability to release oxygen molecules and leading to impaired oxygen transport and tissue hypoxia.

Signs and symptoms of clinically significant levels of methemoglobin can include dyspnea, fatigue, decreased exercise tolerance, CNS depression, headache, dizziness, cyanosis, and low SpO_2 reading. Methemoglobin levels can be measured by either venous or arterial co-oximetry testing; this should be done in cases of suspected methemoglobinemia.

Clues in this case include the characteristic "chocolate brown" appearance of arterial blood and the presence of a "saturation gap." The saturation gap is a difference in the pulse oximetry-measured SpO_2 and the arterial gas sample's calculated SaO_2. It occurs because of the impaired ability of spectrophotometry to give an accurate estimate of oxygen saturation by pulse oximetry (SpO_2) in the presence of methemoglobinemia, while the arterial blood

calculated oxyhemoglobin saturation (SaO_2) is calculated from the dissolved oxygen content in the plasma (PaO_2). When the diagnosis of methemoglobinemia is considered, a search for an oxidative stress should ensue to be sure no further conversion of hemoglobin to methemoglobin will take place. In this case, the likely cause is the benzocaine anesthetic that the parents have been using to treat teething pain. While generally safe in adults, the toxic dose is more rapidly achieved in small children and easily reached through mucosal absorption. Other known oxidative stressors include both industrial and dietary sources of nitrates or nitrites, dapsone, phenazopyridine, other topical anesthetics, nitroglycerine, dehydration, or acidosis. Beware that infants may lack the reductase enzyme which is required to reduce the ferric state to restore normal hemoglobin.

The management of methemoglobinemia includes first removing the offending agent. Methylene blue is an antidote that facilitates reduction of the ferric iron back to the ferrous form, thereby regenerating hemoglobin. Methylene blue is indicated for patients with methemoglobin concentration by co-oximetry found to be >30%, or those with any of the following signs or symptoms attributed to decreased oxygen delivery to tissue: unstable vital signs, ischemic chest pain, elevated lactate, or changes in mental status. The dose of 1% methylene blue is 1–2 mg/kg administered intravenously. Since methylene blue acts through the methemoglobin reductase system, it requires the activity of glucose-6-phosphate dehydrogenase deficiency (G6PD). Therefore, it should not be administered to patients with G6PD deficiency. These patients may require exchange transfusion or hyperbaric oxygen therapy.

Deferoxamine is the antidote for iron toxicity. Naloxone is the antidote for opioid toxicity. Sodium nitrate and sodium thiosulfate can help manage cyanide poisoning, but part of the biochemical process involves generating methemoglobin. Administering this in a patient with methemoglobinemia will worsen their condition. RSI will not improve this patient's condition as their oxygenation problem has nothing to do with pulmonary gas exchange.

Take-Home Message

Consider methemoglobinemia in children presenting with cyanosis, particularly when heart and lung exams are unremarkable.

The 'saturation gap' is a difference in the pulse oximetry-measured SpO_2 and the arterial gas sample's calculated SaO_2, and when present, it indicates the presence of another hemoglobin form such as methemoglobin.

Methylene blue is the antidote for methemoglobinemia.

ABP Content Specification

- Recognize the signs and symptoms of methemoglobinemia.
- Recognize and interpret relevant laboratory and monitoring studies for methemoglobinemia.
- Plan the management of methemoglobinemia.

Question 3

A 5-year-old girl presents for evaluation after she swallowed a button (disk) battery 2 hours ago. She denies any pain or difficulty breathing. Vital signs are temperature 98.6 F (37 °C), heart rate 80 beats/minute, respiratory rate 18 breaths/minute, and blood pressure 110/75 mmHg. Her examination is significant for a well-appearing child in no distress, normal voice and phonation, clear and equal breath sounds bilaterally, and a non-tender abdominal examination with normoactive bowel sounds. X-rays of the abdomen show a button battery in the small intestine. The appropriate next step in management should include:

A. Discharge home with instructions to strain the stool and repeat abdominal X-rays in 4 days
B. Emergent colonoscopy
C. Emergent endoscopy
D. Surgical consultation
E. Whole bowel irrigation with polyethylene glycol

Correct Answer: A

Ingestion of a button (disk) battery has potential for great harm, especially when lodged in the esophagus. The complications to visceral organs include pressure necrosis, ulceration, perforation, and even fistula formation with adjacent structures. The possible mechanisms of injury are electrolyte leakage, electrical current injury, heavy metal toxicity, and pressure necrosis.

Button batteries lodged in the esophagus require prompt removal by endoscopy. Those that have passed beyond the esophagus can be expected to pass through the GI tract without intervention but still require monitoring via X-ray in 4 days if 15 mm or larger in diameter. Endoscopic retrieval is recommended for gastric batteries that remain in the stomach for >4 days. If the battery is beyond the stomach, the stool should be searched, and if no battery is found in 10–14 days, a repeat X-ray should be obtained to confirm passage. The patient should return sooner if there is abdominal pain or vomiting. Colonoscopy, abdominal surgery, and whole bowel irrigation are not the recommended approach in management. The National Capital Poison Center in Washington, DC, operates a 24/7 hotline for battery ingestion cases. Call 202-625-3333 for guidance.

Take-Home Message

Ingested button batteries which have become lodged in the esophagus pose risk of catastrophic erosion and/or fistula formation and warrant prompt removal by endoscopy. Those batteries that have passed to the stomach can be managed more conservatively with serial assessment and imaging.

ABP Content Specification

- Plan the management of button (disk) battery ingestion.

Question 4

A 4-year-old boy ingests a 10-mg tablet of methadone, which he obtained from an unlocked medicine cabinet in his home. The medication is prescribed to a grandparent in the home for pain management. The child's parents call 911 after noting a change in his mental status. EMS finds the patient to be lethargic, with miosis and decreased respirations, so they administer naloxone by the intranasal route. Upon arrival to the ED, the patient is awake, alert, and appropriate for age with normal vital signs including pulse oximetry and a normal physical examination. At the end of 1 hour, the patient again becomes somnolent. You place an IV and he responds appropriately to an IV dose of naloxone. The appropriate next step in management is:

A. Administer activated charcoal to facilitate GI decontamination of the remaining methadone.
B. Continue to observe in the ED.
C. Discharge the patient home if he remains alert with normal vital signs after 1 hour, with instructions on home observation to the parents.
D. Initiate a naloxone IV drip and admit to the PICU.
E. Initiate IV lipid emulsion therapy as naloxone has failed.

Correct Answer: D

The child has ingested methadone, an opioid agent with a long half-life, used for both pain management and treatment of opioid addictions. Despite successful reversal of the effects of methadone with naloxone, an opioid antagonist, the signs of opioid toxidrome have returned in this case. The long duration of effect of methadone (half-life: opiate naïve = 55 hours, opiate tolerant = 24 hours) relative to the short duration of effect of naloxone (60–90 minutes) is responsible for this phenomenon. In such situation, a continuous infusion of naloxone should be administered and patient should be monitored in a critical care setting. Activated charcoal will have no effect as the drug will have largely been absorbed by this point. Continued ED observation is not appropriate as the child will need repeated doses of naloxone each time its effect wears off. IV lipid emulsion is a therapy sometimes used as an antidote for other ingestions, such as calcium

channel blockers or anesthetic agents. Its role in opioid intoxication is not established, and an excellent antidote (naloxone) already exists.

Take-Home Message
Patients with methadone overdose require continuous naloxone infusion as the half-life of methadone is approximately 24 hours in opiate-tolerant patients and up to 55 hours in opiate-naïve patients compared to naloxone (60–90 minutes).

ABP Content Specification
- Plan the management of narcotic toxicity.
- Know indications for use of naloxone.

Question 5

The lowest dose of oral acetaminophen at which toxic effects are expected is:

A. 15 mg/kg
B. 50 mg/kg
C. 150 mg/kg
D. 3 grams/day
E. 4 grams/day

Correct Answer: C

While the hepatotoxic effects of acetaminophen may prove fatal, the therapeutic index of the medication is quite safe. Significant toxicity is generally not seen until single ingestions reach 150 mg/kg. Therapeutic doses are found at 10–15 mg/kg. Previously recommended daily limits on adult daily usage were changed to 3 grams/day from 4 grams/day; however, these guidelines are not applicable to the pediatric population.

Take-Home Message
Acetaminophen toxicity occurs with ingestions exceeding 150 mg/kg.

ABP Content Specification
- Recognize and interpret relevant laboratory and monitoring studies for acetaminophen poisoning.

Question 6

All the following may represent clinical manifestations of lead poisoning in children *EXCEPT:*

A. Impaired fine motor coordination
B. Intermittent vomiting
C. Oculomotor nerve palsy
D. Pathologic bone fractures
E. Seizures

Correct Answer: D

Recognition of lead toxicity is challenging, owing largely to its effect on multiple organ systems and often subtle presentations. While lead in the body is mainly stored in bone, pathologic fractures are not reported to be an adverse outcome. Instead, impaired bone growth and short stature are known manifestations. "Lead lines" are dense lines seen on radiographs at the metaphysis of long bones. They represent increased calcium deposition due to lead's effect on both osteoblast and osteoclast activity. The other choices represent manifestations of lead on either the CNS or GI systems. Other CNS manifestations include behavioral and cognitive changes, cranial nerve palsies, hearing loss, and ataxia. GI manifestations include abdominal pain and anorexia. Manifestations may also be noted in the hematologic (anemia, basophilic stippling), renal (decreased reabsorption of amino acids, glucose, and phosphate), cardiovascular (hypertension), reproductive, and endocrine systems.

Take-Home Message
Lead poisoning manifestations can range from being asymptomatic to developing subtle intellectual difficulties to severe symptoms that can affect every body system, particularly the hematologic, renal, and CNS systems.

ABP Content Specification
- Recognize signs and symptoms of lead encephalopathy.

Question 7

A 4-year-old previously well boy is rushed to the emergency department for new seizure-like activity. After initial evaluation, it is determined that he is suffering from acute lead encephalopathy. Blood lead level (BLL) is measured at 72 μg/dL. Chelation therapy is initiated, and the case is further managed in the PICU. The parents grow concerned about their other child, an 8-year-old female. Which of the following is *NOT* an indication for chelation therapy in the sister?

A. Known retained lead shrapnel with BLL 19 μg/dL, worsening academic performance
B. Radiopaque material in GI tract, BLL 51 μg/dL, decreased appetite
C. Acute ingestion of lead paint chips, BLL 45 μg/dL, asymptomatic
D. No known lead exposure, BLL 65 μg/dL, asymptomatic
E. No known lead exposure, BLL 45 μg/dL, asymptomatic

Correct Answer: A

The boy in the question is suffering from lead encephalopathy. Lead encephalopathy is treated with chelation therapy to aggressively lower BLL, regardless of the level. Chelation therapy in pediatric patients without encephalopathy is based on BLL and symptomatology. In general, patients with BLL ≥ 45 μg/dL require chelation therapy, whether they develop symptoms or not. Initiation of chelation therapy of asymptomatic children with BLL 20–45 μg/dL is controversial and dependent on the child's age; specialty consultation is recommended. Chelation therapy at BLL ≤20 μg/dL is not indicated regardless of symptoms. For all BLL, exposure reduction to the lead source is of greatest significance.

Take-Home Message
Chelation is generally recommended when BLL is ≥45 μg/dL. Levels below this in asymptomatic patients require frequent monitoring of lead and iron levels, in addition to providing a lead-free environment.

ABP Content Specification
- Recognize signs and symptoms of lead encephalopathy.

Question 8

A 5-year-old girl with a history of epilepsy is being managed at home for a viral upper respiratory infection (URI) with supportive care and an over-the-counter "cough and cold" medication. She becomes lethargic during her illness and is brought to the ED for evaluation. Besides findings consistent with URI, she is somnolent, although easily arousable, without any other focal findings. After a brief period, she returns to her baseline mental status and normal activity. It is later determined that a medication error took place and is the presumed cause of the child's transient lethargy. What is the most commonly reported out-of-hospital medication error for children of this age group?

A. Drug interaction
B. Inadvertently taking or being given medication twice
C. Incorrect dosing
D. Incorrect formulation or concentration dispensed
E. Incorrect medication

Correct Answer: B

According to an analysis of the National Poison Data System, both the number and rate of out-of-hospital medication errors are on the rise. The most commonly reported type of error is "inadvertently taking or being given medication twice" (27.0%) followed by "another incorrect dose" (17.8%). Wrong or incorrect medications were reported in 7.8% of cases. Other notable trends include higher rates of errors with decreasing age and higher rates of errors with liquid formulations.

Take-Home Message
Inadvertent medication error in the home is a growing risk and is frequently due to giving medication twice.

ABP Content Specification

- Know the major types of ingestions by age.
- Know the epidemiology of fatal ingestions by children.

Question 9

A 9-year-old boy with a history of asthma and environmental allergies begins to act confused while at school. A school nurse calls for EMS. When they arrive, EMS finds the patient tremulous, tachycardic, and diaphoretic. He subsequently has a seizure en route to the hospital. A point-of-care glucose test result is 28 mg/dL, and the patient returns to normal after dextrose injection. It is later determined that he had accidentally been given his father's glyburide instead of loratadine in the morning. Two hours after arrival, the patient remains asymptomatic, and a repeat point-of-care glucose test at this point measures 80 mg/dL. Of the following, the next best step in management should be:

A. Discharge home with instructions for close observation to the parents.
B. Feed the patient lunch and admit to the hospital.
C. Initiate continuous infusion of dextrose.
D. Initiate octreotide infusion and admit to the hospital.
E. Repeat IV dextrose dose.

Correct Answer: B

The presentation of tremors, tachycardia, diaphoresis, altered mental status, and seizures is consistent with symptomatic hypoglycemia. The providers have determined the cause of hypoglycemia in this case to be an accidental ingestion of glyburide. Glyburide, like other sulfonylureas used to treat diabetes mellitus, exerts its mechanism of action by potentiating the release of insulin. The duration of action of the sulfonylureas is characteristically long, approaching 24 hours in the case of glyburide. Delayed effects are not uncommon, and for this reason, cases of sulfonylurea-induced hypoglycemia are best managed as inpatient with serial glucose measurements. Asymptomatic patients with normal glucose level can be managed with normal feeding and serial glucose measurements. If repeated episodes of hypoglycemia occur, administration of octreotide is indicated. Octreotide functions as an antidote to sulfonylurea toxicity by reducing insulin release and secretion. This mechanism of action is by closing voltage-gated calcium channels which are responsible for insulin release. The dose is 1–1.5 μg/kg (up to 150 μg/kg) and can be administered every 6 hours.

Since octreotide does not increase serum glucose level, glucose should be administered to normalize the level. Repeated boluses of IV dextrose may temporarily raise blood glucose levels and improve symptoms. However, with the potentiated insulin secretion caused by the action of the glyburide, these transient spikes in blood glucose can trigger a disproportionate amount of insulin secretion, which can in turn precipitate repeated episodes of hypoglycemia.

Take-Home Message

The long half-life of some medications (sulfonylureas in this case) warrants hospital admission for serial glucose measurements, observation and prompt normalization, and maintenance of serum glucose levels.

ABP Content Specification

- Know which ingestions are associated with delayed toxicity (e.g., oral hypoglycemic drugs).

Question 10

A 17-year-old boy is being evaluated for a suicide attempt in which he took an excessive dose of aspirin 2 hours prior to presentation. He complains of nausea but denies all other physical complaints. There are no co-ingestants. Vital signs are temperature as follows: 99.6 °F, heart rate 110 beats/minute, respiratory rate 22 breaths/minute, blood pressure 115/75 mm Hg, and oxygen saturation 99% on room air. Besides tachypnea, physical exam is unremarkable. A

point-of-care arterial blood gas sample reveals pH 7.5, $PaCO_2$ 30 mmHg, and HCO_3 24 mEq/L. While awaiting serum salicylate level and during observation, which intervention is most appropriate?

A. Acetazolamide IV
B. Hemodialysis
C. N-Acetylcysteine IV
D. N-Acetylcysteine PO
E. Sodium bicarbonate IV

Correct Answer: E

The patient is exhibiting early signs of salicylate toxicity. Tachypnea is a direct result of the effect of salicylates on respiratory drive causing respiratory alkalosis as shown in the blood gas. Patients may soon develop a concomitant metabolic acidosis giving a characteristic mixed respiratory alkalosis and metabolic acidosis. Inducing alkalemia will increase the ionized portion of salicylate in the blood, which reduces its ability to cross into the CNS. By similar effect, alkalinization of the urine will inhibit reabsorption of salicylate, thereby enhancing its renal elimination. This is referred to as "ion trapping." IV sodium bicarbonate is used to achieve this effect with a goal urine pH of 7.5 to 8.0. IV sodium bicarbonate is recommended in symptomatic cases in which hemodialysis is not indicated. While acetazolamide theoretically will enhance elimination by increasing urine pH, it also decreases serum pH, which will increase the non-ionized fraction of salicylate in serum. Hemodialysis is indicated in acute salicylate toxicity cases associated with renal failure, CHF, acute lung injury, persistent CNS disturbances, progressive deterioration in vital signs, severe and refractory acid–base or electrolyte imbalance, hepatic compromise with coagulopathy, and serum salicylate concentration >120 mg/dl or 100 mg/dl at 6 hours.

Take-Home Message
Sodium bicarbonate is helpful in salicylate poisoning due to its ability to reduce CNS complications and enhance renal excretion of salicylates.

ABP Content Specification
- Recognize signs and symptoms of salicylate poisoning.
- Plan the management of acute salicylate toxicity.
- Know the role of enhanced elimination through alkalinization of the urine.
- Know the role of enhanced elimination through hemodialysis.

Question 11

Which of the following oral formulations has the highest elemental iron composition?

A. Ferrous chloride
B. Ferrous fumarate
C. Ferrous gluconate
D. Ferrous lactate
E. Ferrous sulfate

Correct Answer: B

Calculating the total dose of elemental iron in an ingestion can help predict the profile of toxic effects the patient may experience. Owing to a varied range of elemental iron composition in various iron salts, the patient may experience mild or more severe toxic effects. Ferrous fumarate has the highest elemental composition among the above oral formulations, at 33%. This is to say that for every 100 mg of ferrous fumarate, there is 33 mg of iron in the salt. The other formulations' elemental iron compositions are ferrous chloride (28%), ferrous sulfate (20%), ferrous lactate (19%), and ferrous gluconate (12%). Toxic effects can be seen with ingestions of as little as 10–20 mg/kg of elemental iron, while severe toxicity is expected with ingestions over 60 mg/kg of elemental iron.

Take-Home Message
The severity of iron toxicity is related to the ingested quantity of elemental iron. Ingestion of >60 mg/kg of elemental iron is likely to cause significant toxicity and can be life-threatening.

ABP Content Specification

- Recognize signs and symptoms of iron poisoning.
- Recognize and interpret relevant laboratory and monitoring studies for iron poisoning.
- Plan the management of acute iron toxicity, including special issues in the pregnant patient.

Question 12

A 4-year-old girl is brought to the ED by her pregnant mother after she developed abdominal pain associated with nausea, vomiting, and diarrhea. The child has no significant past medical history, and the mother's own history is only significant for uterine fibroids. Initial laboratory evaluation showed the following: WBC 17,000, hemoglobin 10.6 g/dL, sodium 141 mEq/L, potassium 4.0 mEq/L, bicarbonate 20 mEq/L, chloride 100 mEq/L, and glucose 160 mg/dL. An abdominal X-ray demonstrates multiple small, pill-sized radio-opaque objects in the GI tract. A presumptive diagnosis is made, and whole bowel irrigation is initiated with polyethylene glycol. Which of the following is an indication to initiate chelation therapy with deferoxamine?

A. Serum iron concentration 175 μg/dL
B. Blood lead level 104 μg/dL
C. TIBC 575 mcg/dL
D. Blood pH 7.25
E. Failure to pass pills or pill fragments in WBI effluent

Correct Answer: D

The girl in the case is likely suffering from iron toxicity. This is suggested by her GI distress, metabolic acidosis, leukocytosis, hyperglycemia, and low hemoglobin. The mother is suffering from uterine fibroids, a clue that she may need iron supplementation for anemia. This, in conjunction with finding radio-opaque pill-sized objects on X-ray, suggests that the child likely ingested her mother's iron supplements. Iron causes direct injury to GI epithelium, universally leading to GI distress in the early phase of iron toxicity. Nausea, vomiting, diarrhea, and even hemorrhage leading to hematemesis, melena, and hematochezia are possible. Iron then poisons the cellular mitochondria that can lead to significant lactic acidosis. Absence of GI symptoms makes iron ingestion a very unlikely possibility. In iron toxicity, GI symptoms typically occur within the first 6 hours, followed by a "latent" asymptomatic stage and subsequent progression to shock and CNS dysfunction including lethargy, seizures, and coma. Later effects include coagulopathy and liver failure. Delayed sequelae to the initial GI injury can develop with strictures and gastric outlet obstruction. Laboratory findings may include high-anion gap metabolic acidosis, leukocytosis, and hyperglycemia. Peak serum iron concentration can help predict toxicity, and levels >500 mcg/dL is an indication for chelation. Deferoxamine is not the chelating agent of choice for lead exposure. Elevated TIBC *cannot* be used to determine risk of iron toxicity as its measurement has been shown to be factitiously elevated in the setting of iron poisoning. Treatment is focused on reducing absorption through GI decontamination. Indications for deferoxamine include intractable vomiting, lethargy, metabolic acidosis, toxic appearance, hypotension, signs of shock, and serum iron concentration ≥500 μg/dL. A failure to pass iron tablets in WBI effluent should not impact the decision to initiate chelation.

Take-Home Message

Deferoxamine is the chelation agent of choice for iron toxicity and is indicated when serum iron levels are >500 mcg/dL.

ABP Content Specification

- Recognize signs and symptoms of iron poisoning.
- Recognize and interpret relevant laboratory and monitoring studies for iron poisoning.
- Know which ingestions commonly cause metabolic acidosis.
- Know which ingestions are radiopaque.

Question 13

While repairing a superficial forehead wound on a 3-year-old male with cyanoacrylate skin adhesive, the child becomes discomforted and suddenly moves. The adhesive is accidentally applied to the lateral canthus, and the palpebral fissure becomes bonded closed. Which of the following is an appropriate course of action regarding the ocular adhesive exposure?

A. Discharge home with erythromycin ophthalmic ointment.
B. Gently pry the upper and lower lids apart.
C. Dissolve the adhesive with acetone.
D. Dissolve the adhesive with ethanol.
E. Obtain emergent ophthalmology consult.

Correct Answer: A

Caution must be used while using cyanoacrylate skin adhesives near the eye. This is mainly to avoid accidentally gluing the lids shut. There is no toxicity or caustic threat to the eye. These adhesives are used to treat corneal injuries. Expectant management is appropriate, and the adhesive will break down over a few days. Application of ophthalmic ointments (e.g., erythromycin) may help loosen the glue. Prying or trying to force the lids apart may cause physical harm. Acetone or ethanol may be appropriate solvents to break down cyanoacrylate adhesives but is contraindicated in the vicinity of the eye. Though corneal abrasions may result from microtrauma with the hardened glue, emergent ophthalmologic consultation may be unnecessary. The patient may be discharged home with follow-up or outpatient referral to an ophthalmologist.

Take-Home Message
Caution should be used when using cyanoacrylate skin adhesives near the eye as to avoid gluing the eye shut which results in considerable parental anxiety. Petroleum jelly products including eye ointments can help breakdown the glue over a period of time.

ABP Content Specification
- Know which chemicals require immediate eye decontamination.

Question 14

A 16-year-old girl who is visiting with her grandparents arrives to the ED after becoming confused. This started shortly after her arrival to their home. They deny any known medical history except for a well-controlled "psychiatric problem," for which a new medication was started the previous day. Vital signs are temperature 102.9 °F, heart rate 125 beats/minute, respiratory rate 20 breaths/minute, and blood pressure 145/91 mmHg. Her physical examination is remarkable for agitation, diaphoresis, pupils 3 mm equal and reactive, clear lung sounds, normal bowel sounds, increased deep tendon reflexes, and myoclonus. Which of the following is the most probable cause of her presentation?

A. Alprazolam
B. Fluoxetine
C. Haloperidol
D. Valproic acid
E. Scopolamine

Correct Answer: B

The patient in the question is most likely suffering from a severe form of serotonin toxicity known as serotonin syndrome caused by either an increase in dosage of or addition of fluoxetine to her medications. Fluoxetine, a selective serotonin reuptake inhibitor, can cause serotonin toxicity, which is manifested as altered mental status, autonomic dysfunction, hyperthermia, and neuromuscular dysfunction. The signs and symptoms overlap with neuroleptic malignant syndrome (NMS), and differentiating the two can be challenging. Tremors, hyperreflexia, and myoclonus are more consistent with serotonin toxicity, while bradykinesia and lead pipe rigidity are more consistent with NMS. Additional

historical clues include the time course after an exposure to the offending agent; NMS generally occurs days to weeks after exposure to the offending agent, whereas serotonin toxicity tends to precipitate within hours of exposure. While cessation of alprazolam, a benzodiazepine, may cause benzodiazepine withdrawal and mimic some of the signs of serotonin toxicity, the direct effect of benzodiazepines would not fit with the clinical presentation at all. Haloperidol, an atypical antipsychotic, is associated with NMS. Phencyclidine (PCP, angel dust) sometimes causes sympathomimetic effects and altered mental status (AMS) but would not result in the neuromuscular findings noted. Scopolamine, an anticholinergic agent, might also cause AMS, tachycardia, and hyperthermia. However, one would expect to find dry skin, mydriasis, and decreased bowel sounds in the anticholinergic toxidrome.

Take-Home Message
Serotonin toxicity usually presents within hours of exposure to an offending agent with altered mental status, autonomic dysfunction, hyperthermia, and neuromuscular dysfunction. In contrast, NMS occurs days and weeks after exposure to offending agent and manifest with bradykinesia and lead pipe rigidity.

ABP Content Specification
- Recognize the signs and symptoms of serotonin syndrome, including its differential diagnosis.
- Recognize the signs and symptoms of neuroleptic malignant syndrome.

Question 15

The diagnosis of serotonin syndrome is made on the patient in the prior question. Which of the following interventions is *NOT* indicated?

A. Dantrolene IV
B. Midazolam IV
C. Normal saline IV
D. Lorazepam IV
E. Rapid cooling measures

Correct Answer: A

Serotonin syndrome is a serious condition that can be fatal. The most common features include altered mental status, hyperthermia, and increased muscle tone. Excessive hyperthermia, which is largely caused by increased muscular activity, eventually leads to death. The management of serotonin syndrome centers on strong supportive care and reducing body temperature. IV fluids, sedatives, and rapid cooling are critical interventions.

Cyproheptadine is an antihistamine with antagonistic effects at serotonin receptors and may be used in severe cases of serotonin syndrome when the diagnosis is certain. Since it can worsen anticholinergic toxicity, it should not be used, if anticholinergic toxicity remains on the differential diagnosis.

Dantrolene is a skeletal muscle relaxant and sometimes used to help manage muscular rigidity associated with the neuroleptic malignant syndrome and has no role in the management of serotonin syndrome.

Take-Home Message
Current management of serotonin syndrome is to provide supportive care, sedatives as needed, IV fluids, and cooling. Cyproheptadine is an antihistamine with antagonistic effects as serotonin receptors may be useful in patients with severe symptoms.

ABP Content Specification
- Plan the management of serotonin syndrome and neuroleptic malignant syndrome.

Question 16

An 18-month-old boy was witnessed to ingest one of his older sibling's medications for ADHD. Though the child was initially acting normally, the mother called the local poison

control center and was told to immediately visit the nearest ED. On presentation, the patient has a heart rate of 110 beats/minute, respiratory rate of 28 breaths/minute, blood pressure of 75/45 mmHg, and an oxygen saturation of 98% on room air. Pupils are equal and reactive to light. Within 20 minutes of presentation, the patient becomes somnolent and difficult to arouse. The repeat heart rate is 85 beats/minute with a respiratory rate of 8 breaths/minute and a blood pressure of 60/35 mmHg.

Which is the most likely agent causing this patient's worsening condition?

A. Methylphenidate
B. Paroxetine
C. Risperidone
D. Clonidine
E. Depakote

Correct Answer: D

Clonidine is a centrally acting alpha-2 adrenergic agonist. It inhibits the release of peripheral catecholamines, resulting in a decrease of heart rate, contractility, and peripheral vascular resistance. It is commonly used to treat hyperactivity in children. It is also used to treat hypertension in adults and in children with familial dysautonomia. In addition to its alpha-adrenergic effects, clonidine also interacts with GABA, opioid, and serotonin receptors, which can cause sedation.

Though not always effective, naloxone has been reported to reverse decreased respirations and hypotension in the setting of clonidine overdose. Given its excellent safety profile, it is often initiated in acute clonidine ingestion. Some poison control centers may recommend atropine as well to increase the patient's heart rate. A higher dose of naloxone may be required in clonidine overdose which should be titrated to effect and tapered gradually.

Due to its ubiquitous use, upwards of 9000 calls for clonidine overdose are reported to poison control centers in the United States each year. Clonidine ingestions are to be taken very seriously as clonidine is in the group of medicines in which "one pill can kill."

Symptoms include decreased level of awareness, lethargy, bradycardia, bradypnea, hypotension, apnea, and miosis. Though amphetamines are used to treat children with ADHD, they would not be responsible for the clinical presentation of this patient. Depakote, paroxetine, or risperidone may be used as a mood stabilizer in children with severe depression or bipolar disease. They are not generally used for children with ADHD alone and would not explain the patient's worsening clinical status.

Take-Home Message

Clonidine toxicity may cause severe respiratory and cardiovascular collapse especially in young children, even after the ingestion of "one pill." Patients may present with signs and symptoms of opioid toxicity and should be suspected when opioid ingestion is unlikely.

ABP Content Specification

- Recognize the signs and symptoms of clonidine toxicity.

Question 17

A 14-year-old girl is brought by ambulance to the ED reporting visual hallucinations after snorting a street drug 30 minutes prior to arrival. She is accompanied by friends who do not know what she took but that they found her agitated in her bedroom 15 minutes after she texted them that she was going to "sniff something to take her to a fun place." Her heart rate is 120 beats/minute, respiratory rate is 24 breaths/minute, and blood pressure is 142/62 mm Hg. She is agitated and incoherent and unable to express herself in full sentences. Pupils are mydriatic and sluggishly reactive equally, and there is nystagmus noted on examination. Within an hour, she is sleeping comfortably in the ED. Which agent would most likely explain all this patient's symptoms?

A. Gamma-hydroxybutyrate (GHB)
B. Lysergic acid diethylamide (LSD)
C. Ketamine
D. Methylenedioxymethamphetamine (MDMA)
E. Cocaine

Correct Answer: C

Ketamine is a potent hallucinogen, which can cause powerful and disturbing visual hallucinations, agitation, dysphoria, and anxiety. It is typically insufflated through the nose, though it can be taken orally or, rarely, intramuscularly. Patients may present with mydriasis and horizontal nystagmus. In the acute setting, benzodiazepines are a safe and effective choice for sedation. Phencyclidine is structurally related to ketamine and is easily and inexpensively synthesized.

Though lysergic acid diethylamide (LSD), and to a lesser extent, methylenedioxymethamphetamine (MDMA or "ecstasy"), can cause visual hallucinations and agitation, the time course of the case would not be explained by these drugs.

LSD is a potent psychoactive drug, whose effects known as a "trip" can last between 6 and 12 hours. Its effects are thought to be mediated by its 5-HT $_{2A}$-receptor agonist actions. Its effects include:

- Alteration of perception: Sights and sounds appear distorted and fantastic.
- Hallucinations: Visual, auditory, tactile, or olfactory
- Dysphoric reaction or "bad trip": Paranoid delusions and dangerous and impulsive behavior
- Sympathomimetic effects: Mydriasis and tachycardia, hypertension, and hyperthermia (usually precede the psychedelic effects)

Psilocybin has effects which are similar to those experienced with LSD.

MDMA is a chemically modified amphetamine whose effects can last between 2 and 4 hours. The acute effects include euphoria, a heightened sensual awareness, and increased psychic and emotional energy. It can cause life-threatening hyponatremia with free water retention. This may result from excessive ingestion of water or from MDMA-induced syndrome of inappropriate antidiuretic hormone secretion. These patients usually have concentrated urine and a relatively high urine sodium concentration. The patients can experience seizures due to hyponatremia. MDMA is a hallucinogenic agent with strong serotonergic activity and can also cause potentially irreversible neurologic damage to serotoninergic neurons and may present with serotonin syndrome with possible rhabdomyolysis. Tachycardia and hypertension can also occur due to its stimulant activity. In high doses, MDMA can interfere with the body's ability to regulate temperature and results in hyperthermia. Its effects typically last for 2–6 hours.

Gamma-hydroxybutyrate (GHB), another popular club drug, typically causes sedation. It is a lipophilic agent, which is rapidly absorbed and readily crosses the blood-brain barrier. Its onset of symptoms occurs within 15–30 minutes, and peak plasma levels are achieved within 20–60 minutes. In most cases, the duration of unconsciousness lasts 2–6 hours. The typical presentation is rapid recovery from coma, sudden awakening from stupor, or periods of agitation alternating with periods of decreased level of consciousness. Other findings are hypothermia, bradycardia with or without hypotension, miosis with or without nystagmus, and myoclonic jerks. Vomiting is also common, and patients with altered mental status are at risk for aspiration pneumonitis. Consider intubation to protect the airway if significant CNS depression or hypoxia is present. Beware that GHB is not detected on routine urine toxicology screens. The management is mainly supportive. Physostigmine or neostigmine is not recommended in patients with known or suspected GHB intoxication.

Though cocaine may cause agitation and mydriasis, frank visual hallucinations are generally not part of the toxidrome. The clinical findings of seizures, arrhythmia, myocardial ischemia, and hyperthermia occur with cocaine overdose.

Take-Home Message

Ketamine is an increasingly popular drug of abuse due to its hallucinogenic effects but can also cause unpleasant effects such as nystagmus, excessive salivation, muscle rigidity, tachycardia, and hypertension.

ABP Content Specification

- Recognize signs and symptoms of hallucinogen abuse.
- Recognize signs and symptoms of ketamine or PCP abuse.
- Plan the management of acute toxicity of ketamine or PCP.
- Recognize the signs and symptoms of GHB-like agents.
- Plan the management of acute toxicity of GHB-like agents.

Question 18

Before going to bed, a 5-year-old child complains of abdominal cramping and an episode of emesis. At the same time, the mother notices that her bottle of prenatal iron tablets are spilled on the floor and several pills are missing. On presentation to the ED, the child states the he feels better and has normal vital signs.

Which of the following is most helpful in determining the severity of the ingestion?

A. Hypoglycemia
B. Four-hour iron level
C. Prolonged prothrombin time
D. Leukocytosis
E. Hyperglycemia

Correct Answers: B

Iron poisonings continue to be widespread in the United States given the ubiquity of iron pills and the misperception that iron is not dangerous given its presence in multivitamins. Due to this misunderstanding, iron tablets are often not kept out of reach of children, which is unfortunate given that children less than 6 years of age make up two-thirds of all exposures (out of 28,876 reported in 2008). Fortunately, most children have mild symptoms and death is rare.

More than 60 mg/kg is considered severe ingestion. The four-hour iron level in the asymptomatic patient would be helpful to determine the most appropriate management for such patients. For an acute ingestion, a 4-hour level correlates with the severity of toxicity. However, a low level does not necessarily exclude toxicity.

Laboratory findings, depending on the time of presentation after the poisoning, include leukocytosis, increased transaminases and PT/PTT secondary to hepatic injury, and hyperglycemia.

Treatment directed against reducing iron burden in the body includes whole bowel irrigation and IV chelation with deferoxamine.

The indications for deferoxamine administration in the iron toxicity include:

- Systemic toxicity
- Persistent vomiting
- Metabolic acidosis
- Progressive symptoms
- Serum iron level > 500 μg/dL

It can be used in children and during pregnancy.

Activated charcoal does not adsorb significant iron and should not be used.

Take-Home Message

Patients with severe ingestions are most likely to need more invasive treatments such as whole bowel irrigation and chelating agents. A serum iron level >500 μg/dL indicates serious toxicity.

ABP Content Specification

- Recognize signs and symptoms of iron poisoning.
- Recognize and interpret relevant laboratory and monitoring studies for iron poisoning.
- Plan the management of acute iron toxicity.

Question 19

A 6-month-old girl is brought to the ED with altered mental status. She was found lying in her bedroom after a major fire. The furniture around her was burned. In addition to the management of any burns and airway compromise, which medication should be administered immediately?

A. Hydroxocobalamin
B. Sodium thiosulfate

C. Sodium nitrite
D. Amyl nitrate
E. 3% saline

Correct Answer: A

Clinical presentation of cyanide poisoning resembles carbon monoxide poisoning, with severe metabolic acidosis and obtundation. Concomitant poisoning may occur in a closed-space fire in which synthetic material is involved. Since cyanide level is not readily available, treatment needs to be initiated based on the clinical presentation.

Cyanide binds to the ferric iron of cytochrome oxidase a3 inhibiting oxidative phosphorylation in mitochondria. Since oxidative phosphorylation ceases, cells revert to anaerobic respiration leading to a pronounced lactic acidosis and cell death.

Hydroxocobalamin is the preferred agent particularly in patients with concomitant CO and cyanide poisoning. It binds directly to cyanide to produce nontoxic cyanocobalamin (vitamin B12) which is renally excreted. Beware that nitrite components of the cyanide antidote kit should not be used when simultaneous CO and cyanide poisoning is suspected. The nitrite converts hemoglobin to methemoglobin (MetHb), and both CO and MetHb reduce oxygen delivery to the tissues, worsening the patient's metabolic status.

Hyperbaric oxygen may be considered in patients with concomitant CO and cyanide poisoning. It is also required when there is no clinical improvement with hydroxocobalamin treatment.

Take-Home Message
Avoid nitrite administration in patients with concomitant cyanide and carbon monoxide poisoning, given the risk of worsening methemoglobinemia.

ABP Content Specification
- Inhalation injuries/carbon monoxide poisoning.
- Understand the pathophysiology of inhalation injuries and carbon monoxide and cyanide poisoning.
- Plan the management of inhalation injuries and carbon monoxide injuries and carbon monoxide and cyanide poisoning in children.

Question 20

A 2-year-old girl has ingested a small amount of oil of wintergreen, which was left out on a coffee table. She is brought to the ED, which is 1 hour away. Expected signs and symptoms of this ingestion include:

A. Bradycardia
B. Hypertension
C. Hypothermia
D. Tachypnea
E. Tongue fasciculation

Correct Answer: D

Oil of wintergreen (methyl salicylate) is used to make various health products including massage oils and rubs in addition to its industrial uses in flavoring foods, such as gums. A single teaspoon of oil of wintergreen contains 7 g of salicylate (salicylic acid), and one teaspoon can be fatal in a small child. Fatal transdermal absorption of methyl salicylate-containing products has been reported. Salicylic acid acts by uncoupling oxidative phosphorylation in the mitochondria, leading to increased anaerobic respiration and lactic acidosis. Local irritation to the GI tract also occurs.

Symptoms of salicylic acid poisoning include nausea, vomiting, tachypnea (through direct stimulation of medullary respiratory center), tachycardia, and fever.

In acute ingestions, activated charcoal binds salicylates well and should be administered. Repeated doses of charcoal may be considered as it enhances salicylate elimination and may shorten the serum half-life.

Take-Home Message
Non-pharmaceutical preparations of salicylates, including oil of wintergreen, are extremely toxic in small doses due to preparations being highly concentrated.

ABP Content Specification

- Recognize the signs and symptoms of salicylate poisoning.
- Plan the management of acute salicylate poisoning.
- Know the epidemiology and understand the pathophysiology of aspirin toxicity in children.

Question 21

A group of adolescents on a camping trip gathered and cooked several various species of unknown capped mushrooms. Two of them vomited 30 minutes after the meal but then felt well. Ten hours after ingesting the mushrooms, they developed severe abdominal cramps, nausea, and vomiting. On presentation to the ED, one of the patients showed the doctor some photos of the mushrooms, and he mentioned that their liver enzymes must also be monitored. Which of the following mushrooms is he referring to?

A. Amanita muscaria
B. Gyromitra esculenta
C. Amanita phalloides
D. Agaricus bisporus
E. Psilocybe cubensis

Correct Answer: C

Though all the mushrooms listed above (except for *Agaricus bisporus*, the common white button mushroom) are poisonous, only *Amanita phalloides* would explain the delayed gastrointestinal symptoms and potential for fulminant hepatitis.

Gyromitra esculenta (the false morel) contains gyromitrin, which may lead to altered mental status and seizures. The seizures are treated with vitamin B6, or pyridoxine. *Amanita muscaria* (the fly agaric) rarely causes death but can cause ataxia, CNS depression, hallucinations, and delirium secondary to its main toxins, ibotenic acid and muscimol. *Psilocybe cubensis* (i.e., a species of "magic mushrooms") contains psilocin and psilocybin, which can lead to GI disturbance and altered perceptions and sensorium including hallucinations.

Amanita phalloides (in addition to other deadly species such as *A. virosa* and *Galerina autumnalis*) are the most toxic mushrooms, and fatalities can occur from the ingestion of one mushroom alone. Such species contain amatoxins, a group of highly toxic peptides that irreversibly bind to RNA polymerase II, resulting in cell death. Amatoxins are highly stable and heat resistant and are not inactivated by cooking. Fatalities are due to a fulminant hepatitis leading to necrosis and liver failure and the possible need for liver transplantation. Renal injury caused by acute tubular necrosis may also occur.

It is important to note that the presence of early GI symptoms (less than 6 hours after ingestion) does not rule out poisoning by amatoxin mushroom species. Co-ingestion of multiple mushroom species can present with nausea and vomiting early on secondary to the less toxic species, and clinicians should not be reassured by this.

Take-Home Message

In the majority of deadly poisonous mushroom ingestions, symptoms are often delayed 6–12 hours after consumption. On the other hand, mushrooms which cause vomiting within the first few hours of ingestion are often benign, simple GI irritants. That being said, given the risk that a patient may have ingested many different species of mushrooms, the early onset of GI symptoms does not rule out a serious and potential fatal mushroom ingestion. In addition, it is critical to monitor for hepatic and renal failure in patients who have ingested mushrooms containing amatoxin.

ABP Content Specification

- Recognize the signs and symptoms of toxic mushroom ingestion.
- Plan the management of acute mushroom toxicity.

Question 22

A 2-year-old boy was sitting at the family's dinner table while his mother was filling a ritual candelabra with lamp oil. The child grabbed the bottle, sipped it, and developed a constant and severe cough. On presentation, the child is obtunded, tachypneic, and tachycardic, with an oxygen saturation of 90% on a non-rebreather. The lips are erythematous but no stridor is noted.

Which of the following is the most serious concern for a child with this acute ingestion?

A. Direct mucosal irritation and airway edema
B. Toxic effects to the central nervous system
C. Acute renal injury
D. Gastrointestinal strictures
E. Aspiration pneumonitis

Correct Answer: E

Pulmonary injury from hydrocarbon ingestion most often occurs when young children drink from a bottle, secondary to direct injury to the lungs. Aspiration risk is greatest for hydrocarbons with low surface tension and viscosity and high volatility. In general, fluids with a lower viscosity flow more easily.

Symptoms include immediate onset of choking or coughing, which may progress to respiratory distress and grunting, retractions, wheezing, and tachypnea. Ingestion also often causes nausea and vomiting. The diagnosis of aspiration pneumonitis is based on history of exposure and the presence of respiratory symptoms. The initial lung exam may be normal, and chest radiographic findings may be delayed by 12–24 hours. Chest X-ray should be repeated in the appropriate clinical setting if initially normal.

Hydrocarbons such as lamp oil, kerosene, and lighter fluid most often lead to accidental ingestions by children. Though some hydrocarbons may cause renal injury and dermal and mucosal burns, the hydrocarbons composing lamp oil tend to have pulmonary aspiration as their most serious sequelae.

Take-Home Message
The initial chest radiograph in hydrocarbon aspiration may be normal and should not reassure the clinician. Observation is needed to monitor for respiratory symptoms.

ABP Content Specification
- Understand the variability of toxicity in hydrocarbon exposures.
- Recognize the clinical findings of hydrocarbon exposures.
- Plan the management of hydrocarbon aspiration.

Question 23

A 12-year-old boy was foraging in the woods looking to try some hallucinogenic plants he had read about. He obtained the seeds of Jimsonweed and made a tea with them, which was subsequently ingested. One hour later, his father found him talking incoherently with hot, dry skin and brought him to the ED. In the ED, the patient continues to be disoriented with a heart rate of 128 beats/minute, a respiratory rate of 28 breaths/minute, and a blood pressure of 145/75 mm Hg. Pupils are mydriatic and nonreactive. Bowel sounds are absent. An ECG shows sinus tachycardia, and the patient becomes combative. Despite the administration of multiple doses of benzodiazepines, the patient continues to be combative, with violent visual hallucinations. His blood pressure is noted to be 175/100 mm Hg, and shortly thereafter, he has a generalized tonic-clonic seizure.

Which medication is the most appropriate for the management of this patient?

A. Sodium bicarbonate
B. Diazepam
C. Physostigmine
D. Atropine
E. Pralidoxime

Correct Answer: C

Jimsonweed (*Datura stramonium*) is a ubiquitous plant which grows in the United States. All parts of the plant contain varying amounts of the anticholinergic agent such as atropine, scopolamine, and hyoscyamine. The plant can be smoked or taken orally after being brewed in a tea and can result in an anticholinergic toxidrome secondary to competitive antagonism of acetylcholine at the peripheral muscarinic receptors. The anticholinergic syndrome is characterized by dry, flushed skin, mydriasis, dry mouth, tachycardia, changes in sensorium such as hallucinations, and urinary retention.

For patients who are hemodynamically stable, benzodiazepines remain a medical option early in the course of treatment. Physostigmine should be reserved for severe or life-threatening ingestions. Physostigmine, a short-acting reversible cholinesterase inhibitor, can be used for the management of severe anticholinergic syndrome (delirium, tachycardia, urinary retention). Relative contraindications to its use include bronchospastic disease such as asthma, cardiac conduction defects such as AV block, and parkinsonism syndrome. It has been shown to cause bradycardia and heart block, and atropine should be present at the bedside. It also has been reported to cause seizures, particularly with rapid administration or excessive dosing. In excess, it can cause a cholinergic syndrome and induce bronchorrhea, bronchospasm, muscle fasciculations, and weakness, requiring the administration of atropine.

Sodium bicarbonate has a role in sodium channel blockade, such as with diphenhydramine overdose, but may not be helpful in this situation. Atropine and pralidoxime would be indicated in organophosphate poisoning and would potentially exacerbate the present symptoms.

Take-Home Message

Anticholinergic agents are ubiquitous in the plant world, even in large urban areas, and should be considered in the differential diagnosis of patients presenting with anticholinergic syndrome.

ABP Content Specification

- Recognize signs and symptoms of anticholinergic poisoning.
- Plan the management of acute anticholinergic toxicity.
- Recognize signs symptoms of common toxic plants.
- Recognize and interpret relevant laboratory and monitoring studies for the ingestion of toxic plants.
- Plan the management of acute toxicity of plants.

Question 24

An adolescent is fighting with his parents and locks himself in the bathroom. An hour and a half later, he comes out complaining of abdominal pain and not feeling well. He states that he took something and then passes out.

On presentation to the ED, he is tachycardic and tachypneic. His basic metabolic panel is as follows: sodium 135 mEq/L, potassium 3.9 mEq/L, chloride100 mEq/L, bicarbonate 12 mEq/L, BUN 10 mg/dL, creatinine 0.8 mEq/dL, and glucose of 75 mg/dL. The pH of the venous blood gas is 7.05, pCO_2 is 25 mm Hg, and bicarbonate is 11 mEq/L. Of the following toxins, which is the most likely cause of his presentation?

A. Diazepam
B. Isoniazid
C. Aspirin
D. Methanol
E. Isopropyl alcohol

Correct Answer: C

Numerous medicines and toxins can cause an increased anion gap metabolic acidosis. The mnemonic generally used to remember the causes of anion gap acidosis is MUDPILES. This stands for methanol/metformin, uremia, diabetic and

other ketoacidosis, paraldehyde, isoniazid/iron/inborn errors, lactic acidosis, and ethylene glycol and salicylates.

Diazepam would generally present with altered sensorium and decreased mental status. Isoniazid, although known to produce profound acidosis, would also likely present with intractable seizures.

Methanol is also associated with a metabolic acidosis, but it is usually delayed at least 8 hours because the parent compound, which is nontoxic, undergoes conversion to formic acid, its toxic metabolite. A latent period therefore precedes toxicity. The toxicity presents with CNS depression, metabolic acidosis, and visual changes such as photophobia or blurred or "snow field" vision. The severity of acidosis correlates well with formic acid levels.

Ethylene glycol is a direct irritant to the GI tract and has CNS-depressant effects. The toxicity is mediated through the acid metabolites, glycolate and oxalate. This causes crystal deposition mainly in the renal tubules and the CNS. Although artificial, the progression of clinical features following ingestion of ethylene glycol is described in three stages: neurological, cardiopulmonary, and renal.

- Neurological: CNS depression, seizure, and coma
- Cardiopulmonary: Worsening acidosis (due to glycolic acid accumulation), resultant Kussmaul breathing, tachycardia, rarely hypotension, and hypocalcemia (due to formation of calcium oxalate crystals)
- Renal: Renal failure due to calcium oxalate crystal deposition in the proximal tubules

Consider methanol or ethylene glycol poisoning in a patient with an unexplained acidosis.

Isopropyl alcohol metabolizes to acetone and is associated with ketosis without metabolic acidosis. Although it elevates the osmolar gap, unlike methanol and ethylene glycol, it is not the anion gap. The central-nervous-depressant effect is more severe than that which occurs in ethanol poisoning, and it ranges from lethargy to stupor or coma.

Take-Home Message

A good mnemonic to remember the causes for patients presenting with anion gap acidosis is MUDPILES. Additionally, presence of osmolar gap suggests toxicity from alcohols (ethanol, methanol, ethylene glycol).

ABP Content Specification

- Know which agents cause metabolic acidosis.

Question 25

A 2-year-old girl drank from a bottle of newly opened children's acetaminophen. The parents bring the child to the emergency department 1 hour after ingestion. The patient's vital signs are normal and she is asymptomatic. Her shirt is stained with the medicine and the bottle is empty. What is the most appropriate management plan for this patient?

A. Send an immediate acetaminophen level.
B. Send the patient home without lab tests since it was not likely a toxic dose.
C. Immediately give a dose of oral N-acetylcysteine.
D. Immediately initiate intravenous N-acetylcysteine.
E. Give activated charcoal and wait to draw a 4-hour acetaminophen level.

Correct Answer: E

Acetaminophen ingestion remains a significant reason for children to present to the emergency department given its wide availability in over-the-counter formulations, though most ingestions do not lead to severe illness and mortality is rare. However, acetaminophen in toxic doses can cause a fulminant hepatitis requiring

liver transplantation. Though likely conservative, most references report an amount over 150 mg/kg (7.5 g in adult) to be concerning for potential serious toxicity. Given the difficulty of accurately calculating the amount of acetaminophen ingested and possibility of co-ingestions, it is usually prudent to check a level and observe for other symptoms.

Given that the bottle is empty, it is best to assume that the full bottle was ingested. A typical bottle contains 120 ml, and at 160 mg/5 ml, it has 3840 mg of acetaminophen, which is well over the toxic dose for a typical 2-year-old child.

The Rumack-Matthew nomogram is intended to risk stratify patients starting at the four-hour mark, and lab values drawn earlier are not valuable in guiding management.

Though intravenous N-acetylcysteine is generally well tolerated in children, it can be associated with an anaphylactoid reaction and should not be given empirically before an acetaminophen level is obtained. Reactions appear to occur more frequently in patients with lower acetaminophen levels; such reactions may be as high as 15–20%. Dosing errors can lead to dilutional hyponatremia, seizures, status epilepticus, intracranial hypertension, and cerebral edema. Charcoal has shown to decrease acetaminophen levels if given within 2 hours of ingestion.

Take-Home Message

Although IV N-acetylcysteine has many benefits over oral NAC, the IV formulation should not be given empirically without an acetaminophen level, given the risk of severe anaphylactoid reactions in children.

ABP Content Specification

- Recognize the signs and symptoms of acetaminophen poisoning. Recognize and interpret relative laboratory and monitoring studies for acetaminophen poisoning. Plan the management of acetaminophen toxicity.

Question 26

An 18-year-old comes to the emergency department after he fell at a party. He sustained a 3-cm laceration to his forehead. While suturing his laceration, he reveals that he and his friends were using drugs at the party. Which of the following illicit substances is most commonly used by adolescents in the United States?

A. Amphetamines
B. Cocaine
C. Lysergic acid diethylamide (LSD)
D. Marijuana
E. Phencyclidine (PCP)

Correct Answer: D

More than half of American youth have tried an illicit drug by the time they finish high school. Among adolescents, marijuana is the most widely used illicit drug. More adolescents have tried marijuana than any other illicit substance except alcohol. In 2015, 39% of high school students reported using marijuana in the United States. The recent Monitoring the Future survey has shown a significant increase in "vaping" among 8th grade and high school students. The use of illicit drugs other than marijuana in the same group of students has been holding steady at the lowest levels in over two decades. Marijuana use declined among 8th graders and remains unchanged among 10th and 12th graders compared to 5 years prior, despite the changing state marijuana laws during this time period. It is important to note that the adolescents participating in surveys reporting drug use are those who have stayed in school and that the rate of alcohol and drug use in school dropouts is likely to be significantly higher.

ABP Content Outline

- Plan acute medical management of patients who abuse substances.

Take-Home Message
Marijuana is the most commonly used illicit drug in the United States. The use of cocaine, heroin, and other designer drugs has remained steady over the last few years. There is a recent increase of "vaping" among adolescents.

Question 27

A 15-year-old girl is found wandering in the streets and is brought to the emergency department via EMS. She is sweating, hyperactive, confused, and tremulous. On physical examination, she is tachycardic and hypertensive with dilated pupils. She has no nystagmus. Of the following, the MOST likely diagnosis is:

A. Overdose of amphetamine
B. Inhalation of cannabis
C. Overdose of a selective serotonin reuptake inhibitor
D. Ingestion of phencyclidine
E. Ingestion of alcohol

Correct Answer: A

The young girl in the vignette shows signs of an acute amphetamine overdose. Amphetamines can be administered orally, smoked, injected, and snorted. An acute overdose can cause arrhythmias, hypertensive crisis, hyperthermia, seizures, and coma, but most patients present with anxiety/paranoia, tachycardia, and mild hypertension.

Phencyclidine (PCP) ingestion may be similar. Effects of PCP intoxication include illusions and hallucinations, and patients usually present with nystagmus. Cannabis and alcohol cause drowsiness and impaired coordination. Serotonin syndrome can also present with confusion, sweating, tremulousness, and altered mental status and can have clonus, hyperreflexia, muscle rigidity, tachycardia, and hypertension.

ABP Content Outline
- Recognize signs and symptoms of abuse of amphetamines, including ecstasy.
- Plan the management of acute toxicity of amphetamines, including ecstasy.

Take-Home Message
Hyperactive agitated patients with tachycardia, hypertension, and mydriasis should be suspected of ingesting CNS-stimulant drugs such as amphetamine or PCP.

Question 28

A 19-year-old male is brought to the emergency department via EMS. He was found wandering the streets and has altered mental status. On physical examination, his temperature is 97.2 F, heart rate is 60 beats/minute, respiratory rate is 8 breath/minute, and blood pressure is 95/67 mmHg. He has pinpoint pupils, and he is responsive only to painful stimuli. Of the following, the best next step in management is:

A. Activated charcoal via NGT
B. Intravenous atropine
C. Intraosseous epinephrine
D. Oral flumazenil
E. Intravenous naloxone

Correct Answer: E

The young man described in the vignette has clinical signs of opiate overdose. The classic presentation is altered mental status, pupillary miosis, and depressed respirations. Patients may also present with hypothermia, hypotension, and bradycardia. The next best step in management is the administration of naloxone, which can be both diagnostic and therapeutic. Naloxone is an opioid antagonist that works rapidly by displacing narcotics at central opioid receptor sites. Several doses may be required for sustaining the

beneficial effect. In addition to the preferred intravenous route, naloxone may be given SC, IM, or intranasally, though titration is less reliable with these routes. After administration, improvement in the patient's mental and respiratory status is almost immediate. A lack of response should prompt evaluation for alternate diagnoses.

Beware that naloxone administration can precipitate withdrawal in patients who are addicted to narcotics. This is manifested by agitation, diarrhea, vomiting, diaphoresis, tachycardia, hypertension, pulmonary edema, arrhythmia, and seizures.

Depending on the type of opioid ingestion, a naloxone drip might be required due to the relatively short half-life of naloxone compared to certain opioids. Atropine and epinephrine are used in bradycardia. Flumazenil is a benzodiazepine antagonist and is indicated in benzodiazepine overdose.

However, flumazenil should not be used in patients who have an unknown ingestion. Flumazenil administration may precipitate seizures in benzodiazepine-dependent patients. Activated charcoal would not be indicated as the patient has altered mental status and signs of opiate overdose.

Opioid withdrawal syndrome presents similar to a flu-like illness. The presentation includes rhinorrhea, sneezing, yawning, lacrimation, abdominal cramping, hyperactive bowel sounds, leg cramp, piloerection, nausea, vomiting, diarrhea, and dilated pupils.

ABP Content Outline

- Recognize signs and symptoms of narcotic poisoning.
- Plan the management of acute narcotic toxicity.

Take-Home Message

The presentation of altered mental status, pupillary miosis, and depressed respirations should prompt suspicion of opiate overdose and initiation of naloxone therapy.

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Psychosocial Emergencies

16

Sara Cortes and Christopher Kelly

Question 1

A 15-year-old girl was at school when she was noted to have a possible 3-minute seizure. She was in the principal's office for cutting class when she began shaking her arms and legs. She has no prior history of seizures and denies any head trauma. Upon arrival to the emergency room, she has a second episode. There is flailing of the upper and lower extremities, which you were able to stop by holding her arm down. Her eyes are blinking repeatedly, but there is no visible nystagmus. Her body is shaking from side to side. This episode lasts for approximately 2 minutes after which the patient is fully awake and alert. Her vital signs show a temperature of 97.9 °F, heart rate of 87 beats/minute, RR of 12 breaths/minute, and oxygen saturation of 100% on room air. Her physical exam including the neurological examination is unremarkable. A bedside blood glucose level is 89 mg/dL. Which of the following is likely to be true?

A. Patient has a positive urine drug screen.
B. Patient requires an emergent head CT scan.
C. Patient will have a normal EEG.
D. Patient is at risk for having these events while sleeping.
E. Patient will be started on an anticonvulsant.

Correct Answer: C

Somatization disorders are identified by profound physical symptoms without any medical explanation for them. They typically arise in moments of stress or anxiety, and there is speculation that they may occur for secondary gain. Conversion disorder is a type of somatization that typically involves altered motor or sensory function, which doesn't fit with known disease processes or anatomy. There are conflicting beliefs as to whether conversion disorder represents a purely psychiatric disorder or if it represents a complex presentation of an unknown medical condition. There is however a strong association with depression and anxiety. Patients typically have vague complaints, inconsistent histories, and lack of physical examination findings. True seizures typically present with rhythmic contractions of muscles. The young girl in the vignette is suffering from a psychogenic non-epileptic seizure (PNES). The sudden onset

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_16

of these very disordered asynchronous movements with variable intensity is not typical for seizures. The fact that this occurred during a stressful event makes it highly suspect for a somatization disorder. The patient's erratic movements along with a lack of a postictal period are significant clues that this will not have an organic cause. The patient is usually responsive to painful stimuli and may cry or moan during the event. Forced eye closure is often seen more in PNES, and there is an absence of tachycardia and cyanosis.

A head CT should only be considered if there is a suspected life-threatening lesion such as a mass or hemorrhage. An MRI and EEG may be ordered, but again both should have no evidence of pathology. These events are common during stressful or anxiety-producing situations, are usually witnessed, and thus are not evident during sleep. Once organic pathology can be excluded, treatment for the underlying psychosocial disorder requires extensive psychotherapy. Anticonvulsants are not indicated and furthermore may result in significant toxicity.

Take-Home Message

Somatization disorders are identified by profound physical symptoms without medical explanation.

Anxiety and depression are strongly associated with conversion disorders.

ABP Content Outline

- Recognize signs and symptoms of somatoform disorders.
- Plan the management of somatoform disorders.

Question 2

A 2-year-old boy fell off the slide at the park. He has an obvious deformity to his left forearm, and he is crying in pain. There are no other obvious injuries. The mother, who witnessed the fall, states there was no head injury or loss of consciousness. Initial evaluation and treatment should include all of the following *except:*

A. Assessment of pain should be performed using a validated pain scale such as the Wong-Baker Faces Pain Scale.
B. Refrain from splinting until after obtaining radiographs to prevent overmanipulation of the injured arm.
C. Consider parenteral pain medication.
D. Consider distraction techniques such as television, music, or reading.
E. Perform a complete examination to ensure no other injuries are present.

Correct Answer: B

The child in the vignette has an obvious deformity indicating a fracture, which will most likely require reduction. A secondary survey should be performed to rule out occult injury. Pain management is an important but often difficult part of caring for the sick or injured child. Limited communication skills often hinder the evaluation and may lead to underestimation of their pain. There are several tools for pain assessment even among nonverbal children, such as Wong-Baker Faces Pain Scale, the Neonatal Infant Pain Scale (NIPS), and FLACC scale. Because of the diversity and complexity of the clinical issues present, pain treatment, including choice of drug, dosage, route, and mode (continuous vs. intermittent) of administration, must be tailored to the individual patient and analgesics given in the overall context of what is best for the patient. Reassessments should be performed regularly throughout the visit to determine the need for additional doses and to monitor for adverse effects. Distraction techniques, such as television, music, or reading, as well as relaxation techniques and biofeedback all serve as good adjuncts to pharmaceutical interventions for the child in pain. Child life specialists are valuable in helping manage pain and reduce anxiety.

Take-Home Message

Objective pain scales, especially for nonverbal children, improve pain assessment. In addition to medication, pain management should include age-appropriate distraction, relaxation, or biofeedback.

ABP Content Outline

- Know the techniques for assessment of pain in pediatric patients.
- Know the need for pain alleviation in the pediatric patient.
- Understand essential principles of pain management, including pharmacologic and nonpharmacologic agents.
- Know the actions of and indications for various drugs appropriate in pain management and sedation.

Question 3

A 6-year-old girl fell of the monkey bars and has an obvious deformity to her right elbow. You note that her right hand has diminished pulses and is cool to touch. The child is in significant pain and is very anxious. The best means of achieving emergent reduction would be:

A. Papoose the child and perform a local hematoma block with buffered lidocaine.
B. Administer an appropriate dose of IV midazolam.
C. Administer an appropriate dose of IV ketamine.
D. Administer an appropriate dose of IV morphine.
E. No medication should be given as it may delay reduction.

Correct Answer: C

The child in the vignette has a displaced supracondylar fracture with evidence of vascular compromise. It requires rapid reduction to prevent any further injury. Sedation and pain control should always be provided prior to the procedure. Papoosing a child will only immobilize the patient and would be suboptimal for a frightened child. Sedation with midazolam, a sedative, does not offer any pain control. Parenteral pain medications such as morphine are an appropriate choice for initial pain control but would not provide any sedation or anxiolysis. Ketamine, a dissociative anesthetic, provides significant sedation, anxiolysis, amnesia, and analgesia. It is an excellent agent for short but painful procedures such as laceration repair and fracture reduction. Side effects include vomiting, emergence hallucinations (typically in older patients), and rarely laryngospasm and apnea. It can be given in conjunction with local pain therapy to maximize the total effect.

Take-Home Message

Pain management should be provided prior to painful procedures.

Painful procedures require both sedation and analgesia.

Local analgesia can be used in conjunction with systemic sedation and analgesia to reduce pain.

ABP Content Outline

- Know the need for pain alleviation in the pediatric patient.
- Understand essential principles of pain management, including pharmacologic and nonpharmacologic agents.
- Know the actions of and indications for various drugs appropriate in pain management and sedation.

Question 4

A 17-year-old girl arrives in the emergency department with a suspected shoulder dislocation. The child is very anxious and in a moderate amount of pain, which increases with any movement of her right arm. She has good sensation and function of her hand. She last ate about 4 hours ago but had some water throughout the game. She is an otherwise healthy child with a Class 1 Mallampati score. As you prepare to sedate her to reduce the dislocated shoulder, all of the following are required *except:*

A. Suction device
B. Appropriate monitoring device including continuous HR, pulse ox, BP, and CO_2 if available
C. Bag valve mask device
D. High-flow nasal cannula
E. Appropriate imaging studies (i.e., radiographs)

Correct Answer: D

The goal of moderate or procedural sedation is to provide sedation, anxiolysis, and pain control so the provider can successfully perform the procedure without harm to the child. It typically involves one or a combination of drugs which decreases the level of consciousness while maintaining their protective reflexes. All children should have a medical examination prior to undergoing the procedure. This involves assessment of airway patency, cardiopulmonary status, and general physical health of the patient. Although it is recommended that patients be NPO for several hours prior to non-emergent procedures, suction devices should be readily available to help clear obstructed airways and minimize the risk of aspiration. A dedicated provider must be present to provide continuous monitoring of heart rate, BP, and oxygen saturation. There should be a record of all vital signs obtained until the child has regained an appropriate level of consciousness. End-tidal CO_2 monitoring offers a better indicator of early respiratory compromise during sedation, especially if direct visualization of the patient's breathing is not possible. If such compromise should occur, reversal agents and other supportive measures should be undertaken to mitigate the problem. Most medications used during moderate sedation have some depressive effect on respiratory effort. Hypoxia and hypoventilation are not uncommon adverse events. Whereas high-flow nasal cannula may help alleviate hypoxia, it won't improve hypoventilation. Proper airway rescue equipment is required at each sedation, including a bag valve mask, to provide positive pressure ventilation if necessary. This equipment must be age and size specific to the patient and should be readily available. Intubation supplies should also be accessible. Procedural sedation should be undertaken only by providers skilled in airway management and cardiopulmonary resuscitation.

Take-Home Message

Procedural sedation provides sedation, anxiolysis, and pain control while maintaining a patient's protective reflexes.

Hypoventilation and hypoxia are the most common adverse events.

Age- and size-appropriate airway rescue equipment should be readily available during procedural sedation.

ABP Content Outline

- Know the need for pain alleviation in the pediatric patient.
- Understand essential principles of pain management, including pharmacologic and nonpharmacologic agents.
- Know the actions of and indications for various drugs appropriate in pain management and sedation.

Question 5

A 3-week-old infant is brought to the emergency department for fever and irritability. She had an uneventful pregnancy and was born full term via normal spontaneous vaginal delivery. The parents noticed the child was fussier than usual last night and this morning had a fever to 101 °F. You have a strong suspicion for serious bacterial illness in the child. After rapidly obtaining a CBC, blood culture, urinalysis, and urine culture, you obtain consent for a lumbar puncture. The baby's mother is very concerned about the infant experiencing pain. Your best approach is:

A. Advise the mother that infants do not remember events at this age, so they do not require pain medicine.
B. Apply lidocaine/prilocaine (EMLA) cream for 1 hour before starting the procedure.
C. Apply EMLA cream for 15 minutes before starting the procedure.
D. Administer oral sucrose just before local injection of lidocaine for the procedure.
E. Sedate the child with a dose of midazolam before starting the procedure.

Correct Answer: D

The lumbar puncture is a critical procedure performed emergently in infants and children when meningitis or CNS infection is suspected. These children often present with fever, irritability, and

bulging fontanelles. The procedure invokes a lot of fear and anxiety among parents, and this needs to be addressed before obtaining consent. Parental presence during the procedure has been shown to alleviate some of the anxiety and is therefore recommended. It has been well established that infants feel pain, and control of that pain has significant short-term and long-term benefits. Several assessment scales have been developed, including the Neonatal Infant Pain Scale (NIPS) and Face, Legs, Activity, Cry, Consolability (FLACC) scale. EMLA, a topical local anesthetic consisting of lidocaine and prilocaine, is a good choice for pain control. It is applied to the skin and covered with an occlusive dressing for approximately 60–90 minutes for it to be effective. Unfortunately, waiting that long in a potentially septic patient would be ill advised. On the other hand, the duration of 15 minutes would not provide considerable time for the medicine to be effective and is therefore also a poor choice. Oral midazolam would only sedate the child and not provide any analgesia. Non-pharmaceutical therapies are great adjuncts for pain management in infants. Sucrose is given regularly in NICUs and has been shown to decrease pain as measured by minimizing markers of pain such as crying and changes in vital signs. Lidocaine without epinephrine is usually administered as a local anesthetic in a 1% solution, taking effect within minutes. Oral sucrose during administration of local anesthetic would be the best approach to this time-sensitive procedure.

Take-Home Message

Parental presence during lumbar puncture alleviates patient and parent anxiety.

Topical anesthetics provide good pain control but have longer time to effect than infiltrative agents.

Sucrose provides pain relief in infants.

ABP Content Outline

- Plan the use of topical agents for pain management.
- Plan the use of infiltrative agents for pain management.
- Know the effect of parental presence for lessening pain during an invasive procedure.

Question 6

A mother brings in her two children, ages 5 and 2 years, to the emergency department for cough and fever. While getting a medical history from the mother, the two children start arguing over a mutual toy. The older sister hits her younger sister, making her cry. You intervene, stating "it isn't nice to hit your baby sister" to which she replies, "Daddy gets mad and hits mommy until she cries." You complete your history and physicals and diagnose both children with simple upper respiratory infections. There is no evidence of injury or neglect to either child. Your best intervention is:

A. Nothing, the children are your patients, not the mother.
B. Confront both the mother and father with the allegations.
C. Try to observe the mother for any visible sign of bruising during the interview.
D. Contact the police and make an anonymous report.
E. Offer counseling and a safe place for the mother and her children.

Correct Answer: E

Exposure to domestic violence can have both short- and long-standing effects on the emotional and psychological well-being of the pediatric patient. Intimate partner violence (IPV) is defined as physical, sexual, or emotional trauma perpetrated by a spouse or partner. It is estimated that more than 1 in 3 women and more than 1 in 4 men have been a victim of IPV in the United States. One in 4 women have been a victim of severe physical violence. Children exposed to IPV have been shown to have problems with both externalizing and internalizing behaviors. Externalization is demonstrated by increased anxiety, trouble sleeping or having frequent nightmares, and increased aggressive behavior that often manifests in physical confrontations. Children exposed to IPV are more likely to become victims of IPV as adults or become perpetrators themselves. The scenario in the vignette

raises concerns regarding the safety of the child in the home environment and cannot be ignored. It is recommended that pediatricians routinely screen for IPV in both their older patients and their parents, utilizing effective and safe means such as the HITS Screening Tool for Domestic Violence. Signs of past abuse may not be evident on casual visual exam and so this cannot be used as screening tool. Many women are fearful of further abuse, so often they don't seek medical attention for fear of retaliation. The examining physician should never interrogate the alleged perpetrator, and the mother should only be questioned in private. Even if screening is negative, the process opens a dialogue and demonstrates that the physician is concerned and may be a source of help. Each state varies in regard to mandated reporting of domestic violence. Counseling and alternate housing should be discussed, and notifying local law enforcement agencies may be justified if the child is in imminent danger. There is also a National Domestic Violence Hotline, 1-800-799-SAFE.

Take-Home Message

Exposure to domestic violence can have both short- and long-standing effects on the emotional and psychological well-being of the pediatric patient.

Children exposed to IPV are more likely to become victims of IPV as adults or become perpetrators themselves.

Practitioners should routinely screen for domestic violence.

ABP Content Outline

- Plan the intervention for a parent/caretaker who is a possible victim of domestic partner violence.
- Know the epidemiology of violence as it impacts children and adolescents.
- Understand the dynamics of family violence as it impacts children and adolescents. Know the role of the physician as part of a multidisciplinary team concerned with the care of a child or adolescent witness to domestic or community violence.

Question 7

A 15-year-old girl is brought into the emergency department by her parents because they have noticed she has lost a significant amount of weight recently. She has had no fevers, vomiting, or diarrhea but admits to an intentional 30-pound weight loss over the past few months. The teenager states that she feels fine and is not sure why she was brought to the hospital. She explains her weight loss is a result of a strict diet and vigorous exercise routine. She works out twice a day, getting up at 5:00 am to work out before school and again after school. She refuses to eat with the rest of the family, taking her plate to her bedroom where she eats in private. She appears obsessed about her weight and calorie intake despite being underweight. Her mother has even found diet pills in her bedroom on occasion. She has become withdrawn from family and friends. On examination, you see a frail, gaunt depressed teenager. She makes little eye contact and remains quiet throughout the visit. All of the following are associated with her condition except:

A. Hypothermia or cold intolerance
B. Evidence of fine hair on the face and back
C. Tachycardia and hypotension
D. Amenorrhea
E. Signs and symptoms of mitral valve prolapse

Correct Answer: C

Anorexia nervosa is defined by several criteria in the DSM-V and is estimated to affect 0.3% of all teenagers. Approximately 10% of these patients are male, typically younger teenagers. Extreme weight loss usually is a result of low calorie intake and excessive calorie expenditure. These patients may also present with delayed puberty, abnormal eating behaviors, excessive exercise, and unhealthy body image obsession. They have an intense fear of gaining weight despite the fact they are grossly underweight. Food becomes an obsession for the individual who often develops rules regarding what and how much they consume. They have a distorted sense

of self and do not recognize the severity of their weight loss. Patients typically suffer from a variety of complications all stemming from severe malnutrition. There is often evidence of lanugo, fine hair growth on the face and back, as well as thinning of hair on the head. The skin itself tends to be thin and dry, and patients have a tendency for hypothermia. Secondary amenorrhea occurs because of disruption of the hypothalamus secretion of gonadotropin-releasing hormone as well as excessive exercise. Menstrual dysfunction may coincide with delayed or stunted puberty, including failure of breast development. Finally, there are several cardiovascular changes that occur with the weight loss. Cardiac size and output are diminished, and patients often present with palpitations and chest pain due to mitral valve prolapse. To conserve calories, the body starts to decrease its metabolism manifested by bradycardia and hypotension. This, compounded by cardiac dysfunction and volume depletion, is one of the primary reasons for hospitalization.

Take-Home Message

Anorexia nervosa is associated with intense fear of gaining weight despite being grossly underweight.

Decreased metabolism leads to bradycardia and hypotension.

Hospitalization is necessary for cardiac dysfunction, hypotension, and volume depletion.

ABP Content Outline

- Recognize the signs and symptoms of eating disorders.
- Plan the acute management of eating disorders.
- Recognize and interpret relevant laboratory, imaging, and monitoring findings in eating disorders.
- Recognize the complications of eating disorders.

Question 8

A 16-year-old boy with a history of congenital HIV dies due to a fatal gunshot wound to the chest. He is brought into the emergency department pulseless and apneic, and despite your best resuscitative effort, the patient succumbs to his injuries. His parents are present and are visibly distraught. Your intern asks about the possibility of organ donation. Your best response is:

A. Ask the parents if they would like to donate their child's organ as soon as the child is pronounced.
B. Involve an organ procurement organization to discuss with family.
C. Patients who suffer from a cardiac death (as opposed to brain death) cannot donate organs.
D. Have the intern ask the parents if they would like to donate their child's organs after a brief period and not at the time the child is pronounced.
E. Do not ask about organ donation because he is HIV positive.

Correct Answer: B

The sudden or unexpected death of a child is always a tragic event. Pediatric organ donation can have a profound effect on both donor and recipient families. Approximately 3% of people awaiting organ donation in the United States are under the age of 17. Unfortunately, many of these children die waiting for organ transplantation due to weight and size constraints. Therefore, organ donation can be a lifesaving intervention and should be a topic discussed with every family. This needs to be performed by knowledgeable and trained professionals and should be approached in a very delicate manner. Most institutions are mandated to utilize local organ procurement organizations (OPO) to assist with the process. The Organ Procurement and Transplantation Network is one such national system which has been developed to create policies, protocols, and criteria to ensure proper procedure. Professionals who are trained in the medical and psychosocial aspects of organ donation ensure that the processes of death and donation remain separate, but are still done in a timely manner. This commonly occurs with patients who have been declared brain-dead while their

bodies remain on life support. However, more and more donations are being performed after the declaration of death based on cessation of cardiac activity. Time is crucial as there is a window of about 60 minutes for warm ischemia before tissue damage. Aside from skin and corneas, it is a reasonable way to increase the supply of valuable organs such as liver and kidney. Furthermore, new guidelines allow for donation by donors who are HIV positive. The HIV Organ Policy Equity Act allows for HIV-infected patients to donate to HIV-infected recipients.

Take-Home Message

Organ donation should be offered to every family by a trained professional.

Tissue damage begins 60 minutes after cardiac arrest.

ABP Content Outline

- Know the principles of family management that should be implemented when a child dies.

Question 9

EMS calls in a notification of a 3-year-old child who is in cardiac arrest after being found unresponsive in her bed by her stepfather. EMS intubated the child in the field and started chest compressions. When she arrives to the ED, she is in asystole. Blood glucose is 75 mg/dL. You notice several bruises to her torso. She has no significant past medical history, and there are no known cardiac or pulmonary issues. She takes no medications and is otherwise a healthy child. Resuscitative measures are continued without change in clinical status. Pupils are fixed and dilated. There is cardiac standstill on bedside sonogram. Despite your best efforts, the child does not survive. Her mother arrives from work and is distraught, stating she was perfectly well when she left the house earlier that day. What is the next most appropriate step?

A. Prevent the parents from seeing the child as they may interfere with evidence.
B. Contact the medical examiner and local law enforcement agency immediately.
C. Allow the parents to grieve alone with their child.
D. The police should be notified only if you can be certain that the child died from injuries because of abuse.
E. The attending physician should perform a thorough forensic examination if abuse is suspected.

Correct Answer: B

Fatal child abuse, although uncommon, must always be considered in the untimely death of a child. Homicide is the fourth leading cause of death under the age of 4 years. According to data collected by Children's Advocacy Centers, nationwide, approximately 1700 children annually die from inflicted wounds in the United States, most being under the age of 1 year. African American and Native American families appear to be at increased risk. Other factors include poverty, interpersonal, or medical problems that contribute to increased family stress. The child in this vignette has multiple injuries that should raise the physician's concern for the possibility of neglect and abuse. This determination however is very difficult to make during resuscitation. Parents should always be allowed to be present during resuscitation if desired. Most families have a sense of closure when present during the resuscitation of a child. Even when abuse is suspected, it is important to not interfere with the grieving process of family and friends. The physician must balance the need for collection of forensic evidence with the emotional support of a family who has just suffered a great loss. Local law enforcement agencies should be notified immediately, as well as the medical examiner that would perform a forensic examination if deemed necessary. This typically involves a complete autopsy, review of any prior medical records, and a crime scene investigation. The emergency room is not a crime scene, and the body may be moved to another location or the morgue. Families should be allowed to see and hold their deceased child afterward; however, this should be done in a supervised fashion so that no evidence is tampered with. Of note, even when

there is no evidence of abuse on initial examination, postmortem studies show that abuse is more common than previously suspected. Most states, in conjunction with the AAP, recommend autopsies for unexpected or unexplained deaths in all children.

Take-Home Message
Unexpected death should prompt consideration of fatal child abuse, and autopsy is recommended.

Parents should always be allowed to be present during resuscitation.

The physician should balance the need for collection of forensic evidence with the emotional support of a family.

ABP Content Outline
- Differentiate by age the etiologies of sudden unexplained death.
- Recognize features that differentiate deaths due to child abuse from deaths due to other causes.
- Know relevant data gathering in the diagnosis of sudden unexplained infant death.

Question 10

All of the following are true about adolescent alcohol abuse *except*:

A. Screening for alcohol use/abuse should begin at the age of 14.
B. There is usually a family history of alcohol abuse.
C. Adolescents are much more likely to participate in binge drinking.
D. There is a higher incidence of mental illness and suicide attempts in adolescents who drink.
E. Adolescents are more likely to drink if they have friends who drink.

Correct Answer: A

Alcohol is the most widely abused substance among teenagers in the United States. It is estimated that 40% of high school students consume alcohol. According to the CDC, adolescents who consume a significant amount of alcohol at an early age are more likely to suffer from physical, mental, and legal issues, as well as being more likely to suffer from an alcohol abuse problem later in life. Alcohol abuse is defined as recurrent usage which leads to interference with daily responsibilities. It may also be defined as usage which repeatedly places the individual in a harmful situation and causes significant interpersonal problems or even problem with the legal system. There is a higher incidence of teenage alcohol consumption where there is a family history of substance abuse. Children of alcoholics, especially if both parents have a dependency, have a greater propensity to mistreat alcohol. Adolescents are also more likely to drink if they have friends who drink as a means of social acceptance. This usually involves episodes of binge drinking (consuming more than 4 drinks at a time). Adolescents who may already have difficulties with their peers, for example, antisocial behavior, ADHD, or learning disabilities, may be at higher risk. Alcohol consumption has been linked to an increase in adolescent violence, sexual assault, and thoughts of suicide. Screening tools such as the Car, Relax, Alone, Forget, Friends, Trouble (CRAFFT) Questions have been developed to aid the caregiver in detection of this potentially lethal problem. It is recommended that screening should begin by the age of 11 years. Along with questioning patients, family history of substance abuse may also indicate potential for dependency issues in youths and adolescents.

Take-Home Message
Alcohol is the most widely abused substance among teenagers in the United States.

There is a higher incidence of alcohol abuse in children with a family history of alcoholism, friends who abuse alcohol, or difficulties with peers.

Screening should begin by the age of 11 years.

ABP Content Outline
- Recognize signs and symptoms of substance abuse.
- Plan the management of substance abuse.

- Plan the assessment of substance abuse, including use of toxicologic screening examination.
- Recognize the signs and symptoms of alcoholism. Recognize the complications of alcoholism in adolescents.

Question 11

Which of the following is a typical reaction to the death of a loved one?

A. A 3-year-old that keeps asking when his loved one will return
B. A 6-year-old who begins to have nightmares and trouble in school
C. A 15-year-old who starts experimenting with drugs and alcohol
D. A and B only
E. All the above are typical reactions to the death of a loved one.

Correct Answer: E

Death of a loved one is something almost all children will experience during their childhood. The grief reaction to the loss of a loved one varies with each developmental stage of a child, dealing with the loss of a sibling, parent, or pet in his or her own way. They also respond to the collective grief of the family unit. This process of experiencing and coping with loss is important for all ages, and children should not be protected from it. Euphemisms for death should be avoided as they may confuse young children. Telling them a loved one "is sleeping" may conjure up fears of going to bed at night. Parents should be honest and talk at appropriate age level when discussing death either before or after the actual event. In the preschool child, the finality of death is often misunderstood. For them, this is only a temporary displacement, and therefore questions about the deceased returning are commonplace. The preschool child may cry, become withdrawn, or act out and may regress somewhat in their development (i.e., potty training or thumb-sucking). The school-aged child has already developed strong emotional attachments and often develops severe anxiety and fear of separation. They transfer the sense of loss to surviving family members and tend to become clingier at home. This may also manifest itself with cognitive difficulties such as poor performance at school and somatic complaints such as "bellyaches." Finally, the adolescent understands that death is final and universal and will often have thoughts of their own mortality. They tend to question if this is a form of punishment. It is not uncommon for them to engage in more risky behaviors as they try to deal with feelings of anger and guilt. Depression is also common in this age group. As with all age groups, maintaining routines is critical to helping children deal with the death of a loved one. Presence of children at a funeral depends on the emotional and developmental needs of the individual child but may serve as a means of not further isolating a child who already is suffering grief and loss.

Take-Home Message

The grief response to death depends on developmental age: preschoolers believing death is temporary, school-age children regressing and becoming clingier, and adolescence considering their own mortality.

Children should be included in the grieving process as to not further isolate them.

ABP Content Outline

- Know the principles of family management that should be implemented when a child dies.
- Differentiate by age grief reactions of the family members after the sudden death of a child.

Question 12

A parent asks you for recommendations on how to curb the amount of violence his son watches on television. Your response should include all the following *except*:

A. The child should watch no more than 4 hours of TV in their bedroom each day.
B. Children should not be exposed to video games depicting crimes and violence against other human beings.

C. Children should be encouraged to have a healthy alternative to television such as sports or reading.
D. Parents should utilize the rating scale for broadcast television.
E. All the above are excellent recommendations.

Correct Answer: A

Physicians have a certain responsibility to educate their patients and their families about the dangers of excessive exposure to violence on television. Recent studies show the average child watches approximately 4 hours of TV a day. This almost doubles when all forms of media are taken into consideration. Children's television is the most violent of all programming. Images of excessive violence, gun usage, and murder of characters are often followed by images of them unscathed. This exposure to even fictional violence has been linked to an increase in aggressive behavior among children. It creates a false perception that violence is acceptable, even for the "good guy." Therefore, it is important to help parents set up healthy guidelines for their children. Limiting television viewing to less than 2 hours a day is recommended. Alternative recreation should be encouraged, such as outside play, sports, or reading. Children should not be exposed to programs depicting violence against other human beings or play video games where such behaviors are rewarded. The national television industry has developed a rating system for broadcast television that helps parents determine which programs may not be appropriate for their child. This is best enforced when the child views television in a common area such as the living room, den, or kitchen. Some violence, when portrayed in a realistic way and depicting the sense of loss and ramifications of such actions, can be used as a teaching tool when positive family discussion occurs after viewing these programs together.

Take-Home Message
Through fictional depiction of violence in the media, children learn the false notion that violence is acceptable and even rewarded.

Media usage should occur in a common area and be limited to less than 2 hours per day.

ABP Content Outline
- Know the epidemiology of violence as it impacts on children and adolescents.
- Recognize the signs and symptoms of exposure to violence in children, adolescents, and adults.

Question 13

A mother brings in her 15-year-old daughter after she was missing for the past 24 hours. The child states she was at her friend's house, but her mother doesn't believe her. The mother is demanding you check her to ensure that she is still a virgin and wants her tested for drug use. You question the child alone, and she states that she did nothing wrong and does not want to be tested. She appears to be in no distress and is acting normally. She is well dressed and nourished, and a general screening exam shows her to be in good physical health. The child states she hates living at home. Her mother is very controlling and strict. She denies any physical abuse. Your best course of action is:

A. Check a noninvasive urine sample for pregnancy, STI, and drug use.
B. Check a noninvasive urine sample for pregnancy, STI, and drug use but don't disclose the results to the mother.
C. Check a urine sample only for drug use.
D. Perform a pelvic examination to look for evidence of sexual intercourse and STI.
E. Do not perform any of the above now.

Correct Answer: E

The physician must find the delicate balance between patient privacy and safety when it comes to confidentiality and teenagers. Topics like abuse, sexual activity, and drug use should be discussed openly with a patient; however, this might not be done if the patient fears you will disclose this information to his or her parents. This is

often compounded by billing services for care that may disclose confidential information to a parent inadvertently. The child in the vignette was a runaway but has no symptoms. She denies any sexual activity or illicit drug use. With a normal examination and no symptoms of either, it would be inappropriate to test the patient without her permission. In addition, with no symptoms, there is no medical indication for testing. Furthermore, an invasive pelvic examination is completely contraindicated if the child refuses and may be viewed as an assault if it proceeds. The most appropriate course of action is to perform no testing now and encourage a healthy dialogue between the patient and her parent or another responsible adult. Further dialogue can occur between the physician and the patient, ensuring confidentiality if the child is in no imminent harm.

Take-Home Message

Confidentiality should be maintained with teenage patients as long as the patient is not in imminent harm.

Screening of runaways should begin with a thorough history and physical exam, with the patient's consent.

Screening tests should not be routinely performed.

ABP Content Outline

- Know the risk factors associated with an adolescent runaway.
- Plan the management of a patient who is a runaway.

Question 14

A young mother frantically brings in her 3-month-old infant, screaming "he's not breathing!" You quickly assess the child, who is cold, apneic, mottled, and lifeless. Bedside glucose is 110 mg/dL. Resuscitative measures are begun while you question the parent. She states the baby was a late preterm birth but had a relatively uncomplicated postnatal course. She did receive late prenatal care, but all her testing was normal. She laid the baby down next to her in bed as she always does, with a row of pillows separating the baby from the edge. The baby fell asleep right away, sucking on her pacifier, and when the mother woke up several hours later, she found the baby facedown and blue. She tried blowing air into the baby's mouth and nose but then ran to the hospital when she saw no improvement. The baby has no vital signs and has cardiac standstill on bedside sonogram. All the following are risk factors for SIDS *except:*

A. Maternal age
B. Prematurity
C. Co-sleeping
D. Maternal smoking during pregnancy
E. Not having a home apnea monitor

Correct Answer: E

SIDS is believed to be linked to problems with the respiratory center of the brain and often has no early indicators. There have been multiple risk factors linked to this tragic event, of which proper sleep hygiene seems to be one of the biggest. Since the AAP began its back to sleep campaign in 1992, there has been a significant decrease in the number of SIDS cases. Babies should never cohabitate in the same bed as a parent. This not only stems for the potential for smothering by the adult, but more so that the bedding is not designed for an infant. Their bedding should be firm; the use of pillows and soft blankets poses the potential for airway obstructions and should therefore be avoided. The use of pacifiers while sleeping has been shown to decrease the incidence of SIDS, although the mechanism is unknown. Risk factors include delayed or no prenatal care, prematurity and low birth weight, maternal smoking during pregnancy, and young maternal age. There is also increased risk in multiple pregnancies and siblings of infants who have died of SIDS. An overwhelming majority of SIDS cases are associated with one or more risk factors, which makes those that are preventable more important. This is evident when looking at preterm infants and sleep position. In one study, preterm infants were almost 5 times more likely to die from SIDS than

full-term infants. This number almost quadrupled if the preterm infant is allowed to sleep prone, hence the strong recommendation of the AAP for placing infant supine as early as possible. Of course, "tummy time" is still recommended while awake to help with head control and muscle development. Unfortunately, there is still no evidence that home apnea monitors prevent SIDS, and therefore they are not routinely recommended.

Take-Home Message

SIDS is defined as the unexplained death of an infant, after autopsy, even after a thorough death scene and clinical history review have taken place.

Risk factors include delayed or no prenatal care, prematurity and low birth weight, maternal smoking during pregnancy, multiple gestations, and young maternal age.

Pacifier use may reduce the risk of SIDS.

ABP Content Outline

- Differentiate by age the etiologies of sudden unexplained death.
- Recognize features that differentiate deaths due to child abuse from deaths due to other causes.
- Know relevant data gathering in the diagnosis of sudden unexplained infant death.

Question 15

You evaluate a 5-month-old infant for refusal to move his left leg. The mother states that his leg fell through the slats of a futon just prior to arrival, and since then, he cries with any movement of his leg. The mother tells you that she was in the kitchen when the event occurred. The child and her boyfriend were in the bedroom, and she did not witness the fall. The baby has not begun to cruise or crawl. The baby goes to daycare in the day, but the boyfriend watches him at night as the mother has 2 jobs. The child has primary care in the hospital clinic, with no recent sick visits. He is up to date on his immunizations. On examination, you note several bruises on his arms and back as well as tenderness to palpation of his left thigh. He has pain to movement of the left lower extremity as well.

Which single factor is associated with increased likelihood of physical abuse in this child?

A. The mother has stable employment.
B. Bruising on the infant's extremities
C. Parents of Asian descent
D. The child goes to daycare
E. The mother was abused as a child.

Correct Answer: E

In the United States, approximately 5–35% of children are abused at some time during childhood. Despite increased utilization of child protective activities, there has not been a significant change in admission rates or physical abuse deaths since the 1970s. Up to 2500 children die as a result of child abuse annually, with children less than 1 year disproportionately affected. This number is thought to be underreported. Physical abuse occurs more in African American and Native American populations than Caucasian and Hispanic populations. In the United States, Asian populations have the lowest rate of child abuse. This difference is thought to be multifactorial, with poverty factoring highly into the difference.

Parents are the most common perpetrators of abuse at 81% of cases, with fathers more involved than mothers. Nonbiological parents, or live-in paramours, are next most common at 12%. Perpetrators typically have risk factors for abuse including young or single parents, unstable living situation, or were child victims of abuse. Some perpetrators have alcohol or drug dependence, although this is not the majority. Families in poverty with financial troubles, including job loss, are at higher risk of abuse.

Children under the age of 3 years, with medical problems, or who have been abused previously are at increased risk for abuse, as are stepchildren and children who are adopted or in foster care.

Bruising is the most common injury in child abuse. Bruising on the back, buttock, thighs, genitalia, neck, and ears is consistent with non-

accidental injury rather than bruising on the forehead, extremities, and front of the body. Bruising in pattern or clusters is also concerning for an inflicted mechanism.

Take-Home Message
Up to 35% of children are abused during childhood, with bruising, extremity injuries, and burns being the most commonly encountered form of abuse. Children less than 3 years and/or with chronic medical conditions are at the highest risk of abuse.

ABP Content Specification
- Know the factors that contribute to physical abuse of children.
- Recognize the common signs and symptoms of physical abuse in children.

Question 16

A 5-month-old baby is brought to the ED for decreased movement of the right leg. There is mild swelling of the mid-thigh and it seems painful to the touch. You order a plain radiograph of the right lower extremity. The radiograph shows a spiral fracture through the femur. What is your plan of care for this patient?

A. Splint the leg and discharge with orthopedics follow-up
B. Splint the leg and admit for orthopedic surgery
C. Splint the leg and admit for social services and orthopedic consultation
D. Splint the leg, report case to child protective services, and discharge home
E. Splint the leg, report case to child protective services, and admit the patient

Correct Answer: E

Fractures are the second most common injury in child physical abuse, present in 55% of child abuse cases. There are no pathognomonic findings associated with inflicted versus accidental fractures. In any patient with a fracture, the history and physical examination should correlate with the radiographic findings. The patient's age and stage of development are extremely important to take into consideration, as lower extremity injuries in nonambulatory children are due to abuse in 80–90% of cases.

The location of the fracture should be noted, as femur and posterior rib fractures are more likely associated with physical abuse with younger age. Fractures in uncommon locations, such as the scapula, vertebrae, or pelvis, should also raise concern. Vertebral fractures in the absence of a history of high-force trauma are consistent with abuse. Finger fractures, bilateral long bone fractures, and complex skull fractures without a corresponding history are all highly suspicious for abuse.

Primary care and ED physicians have acknowledged that even with ongoing child abuse education, they do not report all cases of suspected abuse. However, Flaherty et al. demonstrated that physicians who reported an event to child protective services (CPS) had seen at least one other child with an injury suggestive of abuse within the prior 12 months. This finding suggests that physicians who look for child abuse will more likely find it. Physicians are mandated reporters of child abuse in all 50 states. While reporting guidelines vary from state to state, any suspicious injuries should be reported to the state CPS. Parents should always be informed that a report to CPS is being made. In addition, children under 2 years old should undergo a skeletal survey and retinal exam, which is often best performed while inpatient.

Take-Home Message
There is no fracture pattern pathognomonic for abuse, but metaphyseal chip fractures and fractures in posterior ribs, scapula, pelvis, and vertebrae are highly suggestive of abuse.

ABP Content Outline
- Recognize common fractures associated with bony injuries characteristic of physical abuse.
- Know the need to report physical abuse cases to the proper authorities.
- Know the physician's role in working with a multidisciplinary team concerned with the care of a physically abused child.

Question 17

A 9-year-old girl presents to your ED with vaginal burning for the past 3 weeks. She has had no discharge, bleeding, or foul smell. She has never had this complaint before. Over the past 6 months, she has become more withdrawn and anxious according to her mother. She has not disclosed any reason for her change, although her mother has asked on many separate occasions. Her mother initially thought she had some irritation from new underwear and gave her zinc oxide cream to apply in the vaginal area. However, the pain has worsened to the point that the girl cannot sit comfortably. Her mother admits she should have been evaluated earlier but has not been able to take time off from her new job that she started 6 months prior. Maternal cousins babysit the girl after school, as her father lives in another state and has limited contact. There is a 15-year-old male cousin in the house, who regularly accompanies the girl while his mother cooks dinner.

On examination, you find an anxious girl with normal vital signs. She has multiple lesions on the labia consistent with condyloma accuminata. The rest of her physical examination is unremarkable. After your examination, the child dresses and is talking comfortably with her mother. What is your next step in management of this child?

A. Ask the mother to step out and talk to the girl privately with a female chaperone.
B. Discuss with mother that condyloma accuminata frequently occurs with autoinoculation in this age group and refer to dermatology.
C. Advise the mother to start the HPV vaccination series early.
D. Call child protective services as condyloma accuminata could have only been transmitted via sexual abuse.
E. Perform a speculum examination with a female chaperone to collect vaginal cultures, explaining what you will do in developmentally appropriate language.

Correct Answer: A

According to the AAP and CDC, there are four categories of sexually transmitted infections and level of concern for sexual abuse. Gonorrhea, chlamydia, syphilis, and HIV are considered almost exclusively sexual abuse. However, genital warts, condyloma accuminata, and herpes simplex virus (HSV) may be caused by sexual abuse or autoinoculation. Condyloma accuminata should raise suspicion for sexual abuse in children over the age of 2 years. Sexual abuse should be a concern when HSV is found in children over 5 years old who have no history.

As in this case, if sexual abuse is considered, the parent and child should be interviewed separately. The physician should not broach the concern for abuse with the parent in the presence of a child. Likewise, the child should be allowed to talk privately with the physician in a supportive environment without the parent present. The physician should never ask leading questions but allow the child to express his/her own story. Documentation should be the child's and parent's words in quotations. Often, children are then referred to specialists in sexual abuse and forensic interviewing.

Children often will not disclose sexual abuse but will rather present with anogenital, somatic complaints or behavioral issues. The child that discloses sexual abuse should be taken seriously and reassured that his/her health and safety are the physician's primary concern. Anogenital complaints can range from discharge or lesions, such as in this case, to vaginal bleeding or anal pain, itching, or swelling. Vague somatic complaints such as headache, abdominal pain, or fatigue may also commonly be seen. Behavioral issues also present in a variety of ways. Children may become more anxious and withdrawn or conversely more aggressive. Sexual abuse may be manifested as sexual behavior problems. These manifestations can occur up to 3–4 years after the sexual abuse. Children who have been sexually abused display sexual behaviors 2–3 times more than children who have not, and the amount of increase is positively correlated with the severity of the abuse.

Take-Home Message

Sexual abuse presents most commonly with anogenital, somatic, or behavioral complaints.

Children suspected of being sexually abused should be interviewed privately, with a chaperone present.

Outside of the newborn period, gonorrhea, chlamydia, syphilis, and HIV are considered almost exclusively due to sexual abuse.

ABP Content Outline

- Know the factors that lead to sexual abuse of children.
- Understand the ways in which children reveal sexual abuse.
- Understand the short-term and long-term consequences of sexual abuse in children.
- Recognize the signs and symptoms of sexual abuse in children.
- Know the relationship between sexually transmitted diseases and sexual abuse of children.
- Know the principles of interviewing victims of sexual abuse (e.g., avoiding repeated interviews, interviewing family and children individually).

Question 18

A 12-year-old premenarchal girl presents for epigastric pain that has occurred on and off but has worsened in the past 2 weeks. She has had no emesis but slightly decreased appetite. The pain is not changed by eating. She has no weight loss. She has no dysuria, hematuria, or frequency. Her vital signs at triage were normal, except her heart rate was 125 beats per minute. The triage nurse mentioned to you that the patient appears incredibly nervous. As you proceed to the physical examination, she discloses that she has been sexually abused by her 23-year-old stepbrother for the past 2 years. She is tearful, as is her mother, and cannot remember when she last had sexual contact with him. While tearful, the mother is supportive of her daughter. How does this information change your physical examination and management?

A. I would perform a full physical examination with inspection of the outer genitals and anus and collect vaginal cultures and/or nucleic acid amplification tests (NAATs) for GC/chlamydia based on local legal requirements and refer them to the local child abuse assessment center.
B. I would refer the family to the local child abuse assessment center without further evaluation.
C. I would perform my routine physical examination and perform a forensic evidence kit.
D. I would perform my routine physical examination and admit for vaginal examination under anesthesia.
E. I would perform a full physical examination with inspection of the outer genitals and anus and collect vaginal cultures and/or nucleic acid amplification tests (NAATs) for GC/chlamydia based on local legal requirements, and notify the police to come to the ED.

Correct Answer: A

For victims of sexual abuse, balancing examination and further trauma is paramount. A full physical examination, therefore, should be performed by a physician comfortable with anogenital examination. A child who does not have genital complaints, such as in this case, should have a routine anogenital examination done to document any outward injuries but can then be referred to an appropriate child abuse assessment center for further evaluation and care. Unless there is obvious vaginal bleeding, a speculum examination need not be performed in any prepubescent female. Moreover, vaginal examination, if vaginal injury is suspected, should be performed under anesthesia.

Certain examination findings are suspicious for abuse, but in most cases, the physical examination will be completely normal. A normal examination does not exclude sexual abuse, as fondling or oral-genital contact do not often leave signs and the anogenital tissue heals rapidly.

Sexually transmitted infection (STI) screening should be considered in prepubertal children with certain risk factors. These include penetration of the

genitalia or anus, abuse by a stranger or person known to have STI or at higher risk for STIs, or the child has already had one STI. Recent literature has shown that NAATs from both urine and genital swabs are highly sensitive and specific for the organisms tested in pre- and postpubescent children. However, in medicolegal cases of sexual abuse, genital culture is still preferred for its high specificity. Some US legal systems do not accept NAATs in sexual assault or abuse cases in prepubertal children, so culture is still generally recommended.

Forensic evidence collection should be performed if the last encounter was within 72–96 hours (depending on local practice). However, studies have shown that evidence is unlikely to be collected from a child after the first 24 hours.

Notification of the police is important, and it may be done by the physician and also by the family. Furthermore, there is no need to have them come to the ED.

Take-Home Message

Evaluation of a child victim of sexual abuse should be performed within 72–96 hours by a physician comfortable with the anogenital examination.

Outside of this period, routine examination and referral to the local child abuse assessment center is appropriate.

Normal anogenital examination does not exclude sexual abuse.

ABP Content Outline

- Know the significance of specific findings on physical examination and evaluation of a sexually abused child.
- Know the principles of forensic medicine in victims of sexual abuse (e.g., documentation, chain of evidence, court testimony)
- Know the indications for hospitalization of a sexually abused child and describe indications for examination of such a patient under anesthesia.
- Recognize and interpret relevant laboratory studies for the evaluation of victims of sexual abuse.
- Plan the evaluation of a sexually assaulted child.

Question 19

A 17-year-old female is brought into the emergency department by her friends. She was at a party with them last night, and they found her this morning without her panties on. Her friends tell you that she walked away from them with her 18-year-old boyfriend. She does not remember the events of the night and is concerned that she was sexually assaulted. She reports that she is not sexually active although her boyfriend has been pressuring her recently. She is tearful and anxious, asking for her parents multiple times. She tells you that she has vaginal pain but no bleeding or obvious discharge. She does not want to have any examination done until her mother arrives. She has the same clothing on from last night and has not showered. Her parents are on their way but have not arrived in the ED yet.

You have been credentialed to perform the forensic sexual assault examination. What is your main concern in this patient's care?

A. You need to begin the forensic examination kit immediately.
B. You need to contact local authorities immediately.
C. You need to create a safe environment for this girl with someone to sit with her.
D. You need to contact anesthesia and obstetrics/gynecology services for an examination under anesthesia.
E. You need to provide postexposure prophylaxis and emergency contraception immediately.

Correct Answer: C

The laws regarding sexual assault of an adolescent vary by state, and the physician must be sure to understand the laws in the state he/she practices. These laws can be found through the Rape, Abuse, and Incest National Network, https://www.rainn.org/public-policy/laws-in-your-state. In the instance of a 17-year-old with an 18-year-old boyfriend, most states do not mandate reporting if the victim does not wish to report. In all events, a victim should be offered a forensic examination if the event took place

within 72–96 hours (depending on local practice). Patients can refuse any portion of the forensic examination with no negative consequences. Once evidence is collected, the physician collecting that evidence must assure that the chain of evidence is complete. Each hospital will have its own procedures for this to occur, but in the acute setting, the physician should not leave evidence unattended until passing it to the appropriate official. Documentation should clearly state the patient's story as much in her own words with quotations as possible and the physical findings as the physician sees them, without passing judgment. In this history and examination, the physician is not in the position of advocate for the patient; rather, he/she must collect the evidence. Because of this, it is often helpful to have a counselor, social worker, or sexual assault-trained nurse who can fill the role of patient advocate.

The acute management of the sexually assaulted patient includes the discussion of postexposure prophylaxis for gonorrhea, trichomonas, chlamydia, HIV, and pregnancy. Emergency contraception should be offered once a negative urine pregnancy test has been confirmed. Progestin only contraceptive pills are the most commonly used. Any victim of anal, vaginal, or oral penetration should be offered prophylaxis for gonorrhea, trichomonas, and chlamydia with 250 mg ceftriaxone IM, 2 g metronidazole orally, and 1 g azithromycin orally once or 100 mg doxycycline twice daily for 1 week. Risks and benefits of postexposure prophylaxis for HIV should be discussed with the victim and offered. Pregnancy and HIV prophylaxis are both more effective when given sooner as opposed to later, but in this situation, the brief delay that is caused by waiting for the patient's mother is likely not significant.

Take-Home Message

Sexual assault is an acute event on unwanted sexual contact.

Evidence collection, via detailed history and forensic physical examination (if within 72–96 hours), and medical treatment should be the role of the physician.

The acute management of the sexually assaulted patient includes the discussion of postexposure prophylaxis for gonorrhea, trichomonas, chlamydia, HIV, and pregnancy.

ABP Content Outline

- Understand the differences between sexually abused children and adult rape victims.
- Know the principles of forensic medicine in victims of sexual abuse (e.g., documentation, chain of evidence, court testimony).
- Plan the evaluation of a sexually assaulted child.
- Plan the management of rape victims, including the indications for postexposure prophylaxis and emergency contraception.

Question 20

A 6-month-old boy is sent in to the emergency department by his PMD for failure to thrive. The baby has not gained weight over the past 2 months. Mom states that the baby drinks 6 oz. of cow's milk formula when hungry. She cannot give an estimated number of feeds in the day. He's had no vomiting or diarrhea. Mom appears to not engage with the baby. On exam, the baby is emaciated with sunken eyes, weight 6 kg, length 65 cm, HR 125, and RR 26. He has long fingernails with scratch marks on his face. He smells of urine. Which statement is true?

A. Children with nonorganic FTT will have body odor as a sign of neglect.
B. Children with nonorganic FTT will have oral stimulatory behavior where organic FTT will not.
C. Children with nonorganic FTT will have weight depressed significantly more than height where organic FTT will not.
D. Children with nonorganic FTT will more often come from families in poverty.
E. Children with nonorganic FTT will present as infants.

Correct Answer: D

Failure to thrive (FTT) in the broadest definition is the inadequate growth and development of an infant or child. Most often, this is defined by the inadequate gain of weight compared with norms for age and gender of the child. This definition is misleading as there are many growth variants within the population, so it must be used with caution. Often, height velocity remains normal with failure to thrive due to both inorganic and organic causes.

Organic causes of FTT include cystic fibrosis, cerebral palsy, celiac disease, cardiac disease, renal disease, and inborn errors of metabolism. Children with inborn errors of metabolism, depending on the cause, often present with body odors. As an example, children with phenylketonuria will often have a mousy smell. Nonorganic causes of FTT are by far more common and include poor feeding technique or diet selection, as well as neglect. Poverty is the leading risk factor for FTT, although children with FTT can come from all economic levels.

Signs and symptoms of neglect are neither sensitive nor specific, so an overall picture of the child and family situation must be considered. Severe diaper rash can be seen as an overall sign of neglect but can also be seen in organic failure to thrive. Oral self-stimulation and greedy feeding are both nonspecific and can be seen with neglect. Neglect can be categorized into physical, educational, or emotional neglect. In situations of physical neglect, children are often dirty, without proper clothing, and/or have long, dirty fingernails and hair. They are often underweight, as in FTT. Some children appear flat or apathetic, while others cling to strangers. Physical neglect can also be manifested in medical neglect or failure of the parent to obtain or complete medical therapy for the child that results in harm to the child. Educational neglect is the result of truancy not corrected by the parent. As it is often difficult to determine, a multidisciplinary consultation is extremely valuable in making a judgment of neglect. Just as in cases of abuse, the clinician is a mandated reporter of cases of neglect.

Take-Home Message

Neglect is often difficult to determine in the emergency department but is as reportable as other, more common, forms of child abuse.

Hospitalization in FTT should be considered for children not improving with outpatient management or who are <70% their expected weight.

ABP Content Outline

- Know the factors that lead to neglect of children.
- Recognize the signs and symptoms of nonorganic failure to thrive as a manifestation of neglect.
- Recognize signs of neglect other than nonorganic failure to thrive.
- Know principles of a general management plan for neglected children.
- Know the indications for hospitalizing a child who has failed to thrive.
- Know the physician's role in reporting cases of child neglect.

Question 21

An 8-year-old girl presents with vomiting and abdominal pain for 1 week. The symptoms have progressively worsened and she now cannot tolerate clear liquids. She has had no change in stooling. Per her mother, she has no known trauma. Her mother gives you all of her history as the patient is withdrawn and tired appearing. She lives with her mother and live-in boyfriend, and mom dismisses any question of safety in the household. On examination, her temperature is 98.5, HR 117, and BP 104/65. She has clear lung sounds and otherwise normal cardiac examination. On abdominal examination, she has epigastric tenderness that radiates to the back. She also has ecchymosis on her lower thoracic back. You suspect physical abuse. Which set of laboratory studies would be most helpful to corroborate with your diagnosis?

A. Complete blood count, electrolytes, liver function tests
B. Complete blood count, lipase, urinalysis
C. Lipase, electrolytes, urinalysis
D. Lipase, liver function tests, urinalysis
E. Electrolytes, liver function tests, type and screen, coagulation tests

Correct Answer: D

This patient is presenting with traumatic pancreatitis from suspected physical abuse. In this case, there is no history of trauma, but unexplained bruising with a history and physical examination is consistent with pancreatitis.

Physical abuse can present with such findings as splenic rupture, liver laceration, duodenal hematoma, hematuria, dysuria, and pulmonary contusion. These are afebrile illnesses with usually no history of trauma or history of minor trauma not compatible with the physical exam findings. Findings of inconsistencies in the history, unexplained bruising, or other injuries should raise the clinician's suspicions for injuries that might mimic common illnesses.

Children often will not reveal trauma during the initial history and exam for fear of retaliation. Therefore, the physician must maintain a high level of suspicion.

Physical abuse can be manifested in any system, so in addition to a thorough physical examination, laboratory assessment should include lipase, LFTs, and urinalysis.

Physicians are mandated reporters of child abuse in all 50 states. While reporting guidelines vary from state to state, any suspicious injuries should be reported to the state CPS. Parents should always be informed that a report to CPS is being made. In addition, children who are hospitalized should have a social service evaluation and specialist consults, depending on the injury, who work together to ensure adequate outpatient follow-up and support systems for the child to thrive in his/her environment when discharged from the hospital.

Take-Home Message

Physical abuse can manifest in any organ system.

Screening laboratory studies, including lipase, LFTs, and urinalysis for pancreatic, liver, and renal injuries, should be performed in cases with inconsistent histories or other incongruent injuries.

ABP Content Outline

- Recognize unusual or subtle signs of physical abuse in children.
- Recognize the signs of common illnesses or injuries that may mimic physical abuse.

Question 22

A 17-year-old male presents to the ED for leg pain. He complains of dull aching in his hip and knee and walks with a limp. He has been seen in your ED 4 times within the last 2 months with the same complaint. His review of systems, including fevers, weight loss, and headaches, is negative. On examination, he has normal vital signs. There is no tenderness or swelling in either joint, and he has full active range of motion against force. Previous x-rays have been normal. He appears withdrawn and has an unusually flat affect. You suspect that his complaint may be psychosomatic in nature.

His parents are present in the room and appear concerned due to his condition. They tell you that he was asked to leave his varsity soccer team due to his academic performance about 3 months ago.

What is the best screening method in the emergency department for depression and suicide risk in this patient?

A. Administer adolescent depression checklist, self-reported.
B. Evaluate blood work for underlying medical causes.
C. Administer adolescent and parent depression checklist.
D. Interview the patient indirectly about his feelings, confidentially.
E. Combine direct patient interview with adolescent and parent depression checklist.

Correct Answer: E

Depression refers to a spectrum of psychiatric disease that feature symptoms of low mood and anhedonia. The *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-V) classifies major depressive disorder (MDD) as 2 or more consecutive weeks of at least 5 of the 9 symptoms present in the following table. Patients with less than 5 of these symptoms often still warrant diagnosis of subclinical depression or dysthymia.

Adolescents with depression can present with more typical adult symptoms of depression,

withdrawal, and feelings of sadness or worthlessness. Often, however, they may also present with behavior changes or psychosomatic and/or vague complaints. A child or adolescent with multiple presentations for vague complaints should trigger a thorough psychosocial evaluation, as up to 50% of adolescents are not diagnosed with depression until they reach adulthood.

Depression has a genetic basis and symptoms tend to cluster together, so screening the family for risk factors is important. Adolescent patients may not readily discuss feelings of sadness or purposelessness unless directly questioned and therefore are often not diagnosed prior to suicide attempt or adulthood. Research has shown that direct questioning regarding depression and suicide do not increase the risk of an adolescent attempting or completing suicide. Thus, a direct, nonjudgmental interview technique combined with adolescent and parent questionnaire is the best technique for diagnosing depression and judging suicidality. Multiple depression screening questionnaires exist, such as the Beck Depression Inventory, as well as suicide screening tools, such as the "ask suicide-screening questions" (ASQ).

Management of adolescents with depression focuses primarily on the patient's safety. Safety planning and education while in the ED are paramount. Family education includes removing potentially lethal means of suicide from the home, engaging the patient in his/her own care, and establishing early follow-up. Patients with mild to moderate depression with good family support are best managed as outpatients either by their primary care physician or by their mental health consultant. Patients with moderate to severe depression, depending on their symptoms, are also often best managed in the outpatient setting but need to have good social support and clear 48-hour mental health follow-up. If these are not in place or the patient is actively suicidal, hospitalization is warranted for psychiatric stabilization.

Psychotherapy and selective serotonin reuptake inhibitors are the mainstays of treatment but are not indicated in the emergent setting.

Criteria for major depressive disorder

Symptom	Example
Depressed mood most of the day, most days	Feeling sad, tearfulness, irritability
Diminished interest in all or almost all activities	Acutely decreased school performance
Significant weight loss or gain or change in appetite most days	Weight increase of >5% in a month Satiety with one meal a day
Insomnia or hypersomnia	
Psychomotor agitation or retardation most days	Observed to move slower at school
Fatigue or energy loss most days	
Feelings of worthlessness or excessive guilt	"I ruin everything when I walk into the room."
Diminished ability to concentrate or think	Unable to finish a project
Recurrent thoughts of death, suicidal ideation, or attempt	

[a]Adapted from DSM-V

Take-Home Message

While depression in adolescents may present with typical adult depression symptoms, children and adolescents tend to present with vague, somatic complaints.

Patients should be directly questioned regarding depression and suicidal ideation, but parental perception also gives information that the patient may not wish to disclose.

Most patients are better managed outpatient with good follow-up plan in place.

ABP Content Outline

- Know the etiology and understand the pathophysiology of depression.
- Recognize signs and symptoms of depression in pediatric patients.
- Know indications for hospitalization or referral of a depressed child or adolescent.
- Recognize the potential for suicide

Question 23

Over the course of a week, you treat five patients for attempted suicide. Which patient has the highest likelihood of completing his/her next suicide attempt without appropriate intervention?

A. A 15-year-old girl who took a handful of acetaminophen after breaking up with her boyfriend. She immediately called her mother, who brought her to the ED. She was alert and tearful on arrival.
B. A 14-year-old boy who was found with his belt tied around his neck in the bathroom at school. He arrived by ambulance, confused but spontaneously breathing and responsive to touch. His single father was contacted but was unable to come to ED when called.
C. A 17-year-old boy who cut his wrists with razor blades. He had superficial, horizontal lacerations in varying stages of healing. His parents are aware of this behavior, and he is followed by a psychiatrist.
D. A 12-year-old girl who told a friend that she would jump in front of a train after a fight with her mother. Her mother is at the bedside, and the patient denies wanting to harm herself now.
E. A 7-year-old girl who is in foster care due to sexual abuse by the father, who discloses to her teacher that she wants to die.

Correct Answer: B

In general, more attempts are made as age increases. Females are about twice as likely as males to have suicidal ideation, but males are about three times more likely to complete suicide. This is thought to be related to the lethality of the method chosen, with males generally choosing more violent methods, such as firearms.

Risk factors for suicide attempts are previous suicide attempts, psychiatric history, family history of psychiatric disorders, and a history of physical or sexual abuse. It is estimated that one quarter to two-thirds of adolescents who have attempted suicide will have at least one more attempt.

When assessing suicide attempts for risk stratification, four dimensions of the scenario need serious consideration: lethality, suicidal intent, impulsivity, and support network. These broad categories do not work in isolation but as a whole to give the clinician a picture of the patient's ability to complete a suicide attempt. Unfortunately, there is no one predictor of which patient will complete suicide on a subsequent attempt. The most that we can predict is if a patient is at higher risk, warranting closer follow-up or hospitalization. When interviewing a patient, consider the mnemonic "is path warm?" from the American Association of Suicidology to identify warning signs.

- I: Ideation
- S: Substance abuse
- P: Purposelessness
- A: Anxiety
- T: Trapped feeling like there is no way out
- H: Hopelessness
- W: Withdrawal
- A: Anger
- R: Recklessness
- M: Mood change

Medical lethality refers to the physical state of the patient on arrival to the physician: vital signs, level of consciousness, and acute medical complications. The lethality of the method chosen often correlates with the actual state of the patient on arrival but needs to be considered with caution. For instance, a patient may have thought ten tablets of a medication would be lethal but found that there was no effect of the medication. Thus, she may be still actively suicidal and choose a more lethal method for the next attempt.

Intent refers to the patient's mental state now and at the time of the event: continued suicidal thoughts, premeditation, suicide note, method of suicide attempt (violent vs. ingestion), severity of attempt (all pills vs. some), etc. Patients who are unable or unwilling to talk with you pose a challenge in this arena. Evidence of intent, such as method and suicide note, helps us somewhat determine the patient's mental state. However, lack of this evidence is not proof that the attempt was low risk.

Impulsivity refers to the patient's past and current behavior: history of impulsivity, impulsive suicide attempt, and continuing to show impulsive decision-making in the ED. Patients who are impulsive are generally at higher risk. Alcohol and illicit drugs, often found in conjunction with depression and suicide, tend to lower the behavioral threshold of impulsive decision-making.

The balancing factor is the support network, including the patient's inner strengths, such as patient's ability to acknowledge the problem and remain positive toward the future, and support structure including family member presence in ED, ability of family to work with the patient, and physicians to keep the patient safe. The ability of the family to provide a safe environment for the patient and stay with the patient all the time factors largely into the decision to send a patient home after a suicide attempt.

Within the construct of the above four categories, patient B is at the highest risk. Patient A showed impulsive behavior after a stressful event but has a supportive parent and shows good judgment. Patient C has a history of psychiatric illness, making him higher risk, but seems to be following his pattern of cutting rather than making a suicide attempt. He also has supportive parents and follow-up care. Patient D exhibits impulsive behavior, after fighting with her mother. She has chosen a violent method but again shows good judgment and has good parental support. Patient E, although she has difficult life circumstances, is young and has not made an attempt.

Take-Home Message

When planning the management of a child with suicidal ideation or attempt, consider the medical lethality, intent, patient impulsivity, and support network.

ABP Content Outline

- Know the causes of suicide in children and adolescents.
- Understand the concepts of lethality and intent in the pathophysiology of suicide attempts.
- Recognize subtle or hidden suicide attempts.
- Plan the management of a child who has attempted suicide, for example, hospital options, family capability, psychiatric consultation.

Question 24

A 14-year-old female is brought in by ambulance for bizarre behavior beginning at school today. She has a history of developmental delay, with no known underlying cause that the school official is aware of. The school official tells you that she is verbal, with a developmental age of about 5 years. She states that the teacher noticed the girl was sleepier than usual and telling her that she saw fairies flying around the classroom. On examination, the girl tells you that she sees several fairies in the room. Her vital signs are within normal limits, except for a mild tachycardia, as the girl is excited and anxious about the fairies. She is not oriented to place or time but is oriented to self. She does not know where she is, believing that she is in her home. The remainder of her physical examination is unremarkable. What is your first step in management of this patient?

A. Obtain blood glucose testing
B. Consult psychiatry
C. Order lorazepam intramuscular injection
D. Obtain brain CT scan
E. Obtain urine for pregnancy test and drugs of abuse screen

Correct Answer: A

Organic causes of psychosis tend to manifest with global impairment (decreased level of alertness, impaired orientation, and impaired recent memory) that is not suppressible and visual or tactile hallucinations. The differential diagnosis within this category involves potentially reversible mechanisms such as hypoglycemia, cerebral hypoxia, drug toxicity, and medical illnesses.

Psychiatric psychoses typically manifest with auditory hallucinations, and normal recent memory and orientation. The psychiatric disorders should only be considered once the medical disorders have been excluded.

On presentation, acutely psychotic patients require a full set of vital signs, including pulse oximetry and blood glucose. Hypoglycemia and cerebral hypoxia are potentially fatal and reversible and must be recognized and treated immediately. Patients who are agitated should be controlled to assure their safety and the safety of the medical staff. Verbal de-escalation techniques should be employed first, but if not effective,

physical and chemical restraints may be considered. While the evidence is lacking in pediatric medicine as to the appropriate approach to restraints, the general consensus is that physical restraints should be employed prior to chemical restraints. The mainstays of chemical restraints are the benzodiazepines either intramuscularly or intravenously. Typical antipsychotics are also frequently used when the cause is suspected to be psychiatric.

Further evaluation of children and adolescents with acute-onset psychosis is guided individually by the history and physical examination. Many adolescents with psychosis present with a drug intoxication or signs of a known toxidrome. These patients will not require much ancillary testing beyond the initial blood glucose, pregnancy test for females, and, perhaps, a drugs of abuse screen. However, a child with fever, visual hallucinations, and altered mental status will require a much more extensive workup, including blood work and a lumbar puncture after neuroimaging. A patient with a history of psychiatric disease presenting with psychosis should be evaluated for an underlying medical cause on presentation but, often beyond this, will need only a pregnancy test for females and possibly a psychiatric consultation.

Take-Home Message

Acute nonorganic psychosis presents with no alteration in orientation or concentration, and hallucinations are more commonly auditory in nature.

Acute medical treatment generally occurs with benzodiazepines.

ABP Content Outline

- Recognize features that differentiate organic psychosis from nonorganic psychosis.
- Plan the management of a psychotic patient.

Question 25

The parents of a 6-week-old, full-term girl bring her to the emergency department for prolonged crying. The baby has been crying nonstop for the past 4 hours. The parents have tried feeding, changing her diaper, changing her clothes, and walking with her but cannot console the baby. The baby cries until she is red in the face, and they worry she is in pain. She has gained weight between her last doctor's visit and today. On examination, the otherwise well-appearing infant is crying and difficult to console. She is afebrile with a rectal temperature of 37.5° C, heart rate 146 beats/minute, respiratory rate 36 breaths/minute, and oxygen saturation of 99% on room air. She has an open and flat anterior fontanelle. She has no rash or bruising on skin examination and no hair tourniquets. She has no oral lesions and her oral mucosa is moist. Eye examination, including fluorescein staining, reveals no retinal hemorrhage or corneal abrasion. Her abdominal and genitourinary exam shows a soft, nondistended abdomen with no hernia. She has no apparent long bone tenderness and moves all extremities equally. What is your diagnostic workup of this child?

A. CBC, blood culture, urinalysis, urine culture, CSF studies and culture
B. Abdominal radiograph, CBC, blood culture
C. Urinalysis, urine culture
D. Head ultrasound
E. Reassurance as this is likely colic

Correct Answer: C

Crying in infants is a common complaint with usually a benign cause. In fact, all infants cry to a varying extent, with an average of 42 minutes to 2 hours per day of crying in the first 3 months of life. Persistent or excessive crying can be distressing to parents as they can believe that the infant is in pain or ill or that they are "failing" the infant in some way. Broadly defined, colic is paroxysmal crying within the first 3 months of life that occurs over 3 hours a day for more than 3 days of the week in an otherwise healthy infant. Wessel's criteria specify that the duration of symptoms be over 3 weeks. Colic often occurs in the evening or the same time each day.

Colic is a diagnosis of exclusion, although it may be considered in infants, as in the vignette,

who are presenting classically. A detailed history should be obtained on all infants presenting with crying, including feeding and growth history, perinatal history focusing on risk factors for sepsis, and a psychosocial history. Physical examination should be equally detailed, with the goal of determining any potentially fatal or reversible cause of the crying. Potentially fatal causes of crying that should be considered include electrolyte disturbance such as hypernatremia, congestive heart failure, supraventricular tachycardia, meningitis, intussusception, and volvulus. The more common, reversible causes include corneal abrasions, hair tourniquets, and excess stomach gas.

After a thorough history and physical, a consideration of urinalysis and culture is warranted as occult UTI can cause prolonged crying, even in afebrile infants. Consideration of more extensive workup should be maintained for any infant who is not consolable but is most often unnecessary. Observation in the ED with a consolable child who feeds well is appropriate. This allows the physician to observe parent-child interactions and soothing techniques while also giving the parents a "safe place" in which to express their fears and frustrations. How the physician handles this situation will often color the parents' perception of the medical system in the future.

Take-Home Message

Consider urinalysis and culture in infants with prolonged or difficult to control crying. Observation in the emergency department of consolable, otherwise well, infants gives the family a safe place in which to communicate their fears.

ABP Content Outline

- Plan the evaluation and management of colic.
- Plan the evaluation and management of prolonged crying in infancy.

Question 26

A 23-month-old boy is brought in by ambulance for possible seizure. He dropped his lollipop in the park, which got all muddy. He picked it up and was crying hysterically. He then "turned blue" and crumpled to the floor. The episode lasted about 30 seconds, and he appeared dazed after. He was back to his baseline prior to EMS arrival. On arrival to the emergency department, vital signs are all within normal limits for age, including blood glucose measurement. He is interactive with his mother and his exam is normal. What is your disposition for this child?

A. Admit for neurologic workup
B. Admit for observation
C. Discharge with neurology follow-up
D. Discharge with reassurance
E. Admit for cardiac workup

Correct Answer: D

This patient had a breath-holding spell, requiring no further workup but anticipatory guidance for the parents and caregivers. Breath-holding classically presents as cyanotic or pallid, with pallid breath-holding more associated with tonic-clonic movement. This occurs with vigorous crying secondary to anger, frustration, pain, or fear. The first episode generally occurs prior to 2 years old, with 80–90% occurring prior to 18 months. Recurrence is extremely common, with spells occurring up to 6 times per week. However, spells tend to stop by the age of 4–5 years.

Cyanotic breath-holding spells occur with a minor precipitant that the parents may not even consider correlating with the cyanosis. The child cries for a brief period and holds his breath in expiration. Cyanosis and loss of consciousness occurs faster than may be expected. With prolonged episodes, posturing or generalized seizures may occur.

Pallid breath-holding spells are less common and occur with a minor fall or blow to the head or upper body. These events are more difficult to distinguish from seizures, as tonic-clonic movements are more common. The child may be confused or dazed after the event, which typically lasts less than 1 minute. Pallid breath-holding is related to a profound bradycardia that can be reproduced with ocular pressure.

The diagnosis of breath-holding is most often made on history and physical examination, but in

difficult cases, video EEG and EKG can be useful. Clues to a non-epileptic etiology are the profound color change associated with breath-holding spells and the history of provocation. If the precipitant is nontraumatic or there is a family history of sudden death, a more detailed cardiac evaluation should be pursued. In classic presentations of breath-holding, no workup is necessary, although some physicians have advocated checking a hemoglobin level to assure no anemia.

Breath-holding spells related to anger or frustration have a high tendency to recur, especially when the child notes a large secondary gain of parental concern. Anticipatory guidance, therefore, is extremely important. Parents should be advised of the benign nature of these spells and advised to treat the child as if he/she were having a normal tantrum.

Take-Home Message
Management of breath-holding spells focuses on behavioral management and parental reassurance.

ABP Content Outline
- Plan the evaluation and management of breath-holding.

Question 27

A 15-year-old girl is brought by ambulance for chest pain and shortness of breath. She had sudden onset of these symptoms at school according to the teacher accompanying her. Her teacher notes that she has been more reserved and difficult to engage in class over the past few months and has missed several days of class for no apparent reason. On examination, her vital signs are as follows: HR 112 beats/minute, RR 30 breaths/minute, BP 135/78 mmHg, and O_2 saturation 100%. She is tearful, flushed, and taking shallow, fast breaths and is unable to speak to you. Lungs and heart examination reveal no adventitious sounds. She has spasm of her hands and feet. What is your initial management?

A. Albuterol nebulization
B. 100% oxygen via NRB
C. Rebreathing into paper bag
D. IV antibiotics
E. Racemic epinephrine nebulization

Correct Answer: C

This patient is experiencing an episode of hyperventilation. Hyperventilation occurs when ventilation is more than the patient's needs. It is often associated with emotional stress and occurs in the adolescent population. Patients will feel chest tightness and shortness of breath, with the possibility of light-headedness and visual disturbances. The spasms in her hands and feet are typical of carpopedal syndrome and, while alarming to the patient and family members, are completely reversible. The patient should be told to rebreathe into a paper bag. 100% oxygen is not required, it would exacerbate her problem, as she needs the carbon dioxide. Albuterol, racemic epinephrine, 100% NRB, and IV antibiotics are not necessary.

The differential diagnosis of hyperventilation includes asthma, metabolic acidosis, drug intoxication, and severe pain, but most serious diagnoses can be excluded based on history and physical examination. Blood glucose measurement and urine pregnancy testing for postpubertal females are recommended, but in classic presentations, further workup is not required.

Management for acute anxiety focuses on assuring the child that he/she is in a safe place. Initial management, as mentioned above for children with hyperventilation, is slowing the respiratory rate and rebreathing carbon dioxide, using a paper bag. Once a diagnosis of anxiety attack has been made, the child should be placed in a quiet room with minimal stimulation, with a caretaker. The physician should verbally calm the child and acknowledge his/her fears. If the child is exhibiting aggressive behavior or outbursts and is a harm to himself or the staff, a benzodiazepine is an appropriate medication to utilize.

Take-Home Message
The primary goal of management in a child or adolescent presenting with hyperventilation is to decrease the respiratory rate and calm the child.

ABP Content Outline

- Plan the evaluation and management of hyperventilation.
- Recognize signs and symptoms of acute anxiety, including hyperventilation.
- Plan management of acute anxiety, including hyperventilation.
- Recognize the features and plan management of school refusal.

Question 28

A 6-year-old girl is brought to the emergency department by her parents for altered mental status at 12 am. The parents tell you that she went to sleep at 8 pm normally, and they found her standing in the kitchen, uttering incoherently in response to their questioning about 1 hour ago. She did not recognize them for several minutes and seemed distressed when they tried to lead her back to bed. She then returned to bed on her own and appeared to fall back asleep. She does not remember these events and is "back to her normal self" according to the parents. On examination, the girl has normal vital signs and is cooperative, developmentally appropriate, alert, and oriented. She tells you that her parents woke her from sleep and brought her to the hospital, but she does not know why. A complete examination, including neurological examination, is normal.

What is your disposition of this patient?

A. Admit for emergent video EEG
B. Discharge with anticipatory guidance
C. Admit for inpatient MRI
D. Discharge with urgent neurology consultation
E. Admit to neurology service for evaluation

Correct Answer: B

The patient in this vignette has somnambulism or sleepwalking. Sleepwalking and night terrors fall into the category of arousal disorders. They occur often in the first third of the night as a person transitions from deep non-REM sleep to light non-REM sleep. As such, in each, the child is difficult to arouse and may appear afraid of their surroundings or parents. Parents should be advised that this can recur but is benign and self-limited. Sleepwalking and night terrors have a genetic predisposition and typically occur in preschool and school-age children, with an estimated prevalence of 15% for sleepwalking and 40% in night terrors. Typically, children will outgrow this before adolescence.

The main concern in somnambulism is keeping a sleepwalking child safe. Anticipatory guidance should include locking all outside doors and windows and placing a bell or alarm on the child's door.

Night terrors are also benign and self-limited but cause significant distress to the parents. Very rarely is treatment needed as the frequency of events is low. However, investigations of children with suspected arousal disorders, including video EEG and sleep studies, should be undertaken when there are atypical features in the history or physical examination or an underlying condition, such as obstructive sleep apnea, is suspected. If the frequency of events is more than a few times per month, treatment with low-dose benzodiazepines is an option. Behavioral modifications, including assuring that children get adequate sleep and anticipatory awakening, have also been successful in reducing the frequency of events.

In contrast, nightmares occur during REM sleep, and thus, the child can recall much more of the unpleasant dreams. Children frequently awaken spontaneously from nightmares. Nightmares tend to occur in the final third of the night or the early hours of the morning. Movement is usually not a strong feature as movement is actively suppressed during REM sleep. Children may find it difficult to go back to asleep after a nightmare.

Frequent nightmares may be a signal for psychological evaluation as this has been described in children with anxiety disorders and post-traumatic stress disorder. Most often, however, the treatment is reassurance. For children with frequent nightmares that cause significant distress, outpatient psychology services should be offered.

Take-Home Message
Sleep disorders, including somnambulism, night terrors, and nightmares, are most often treated conservatively with anticipatory guidance.

ABP Content Outline
- Plan the evaluation and management of sleep disorders, including parasomnias (sleepwalking, night terror, nightmares)

Question 29

A 6-year-old boy is brought from school for psychiatric evaluation after hitting another child repeatedly in the face. The school counselor with him tells you that the boy is often aggressive and acts out frequently. The mother arrives about 1 hour later, and you overhear her berating the child. She does not stop her tirade against him when you enter the examination room, and you note the child is withdrawn and anxious appearing. Witnessing this interaction, you are concerned for emotional abuse. You have the mother leave the examination room with security to speak with the child. He tells you that his mother often speaks to him like this, and he thinks that he is "worthless, like she says…."

Which statement is true regarding emotional abuse?

A. Emotionally abused children are withdrawn and passive.
B. Emotional abuse can occur independently of other types of abuse.
C. When they become adults, victims of emotional abuse tend to have high self-esteem.
D. Typically, a physician can pick up emotional abuse in a single ED visit.
E. Children are never removed from the household for emotional abuse.

Correct Answer: B

Emotional abuse is the most common and yet most underreported form of abuse in children. The estimated prevalence of emotional abuse is 10%. It is defined in many ways but involves the impairment of normal development and psychological growth of a child, as defined by the National Center of Child Abuse and Neglect (NCANDS). All other forms of abuse have a component of emotional abuse, but it can occur independently.

Often, it is difficult to identify emotional abuse without witnessing the family dynamics several times. There are several different components of emotional abuse, including corruption, ignoring, isolation, terrorizing, and overpressuring. The severity of emotional abuse depends on the malicious intent and harm to the child.

Victims of emotional abuse exhibit a wide range of behaviors, from withdrawal to acting out. Children can be emotionally labile and may have problems with alcohol or drug abuse in adolescence. The consequences of emotional abuse are felt into adulthood, with low self-esteem and psychiatric disorders.

Management includes involving social work and child protective services and informing the parent in a constructive, sensitive manner. Often, family and parental therapy with social support can correct the abusive behavior. In severe cases, the child may need to be removed from the household.

Take-Home Message
Emotional abuse occurs independent of all other forms of abuse but is a component of all forms of abuse.

ABP Content Outline
- Recognize the signs and symptoms of emotional abuse.

Question 30

A 2-year-old boy is brought to your ED by his mother for vomiting. He has had several episodes of emesis after meals daily for the past 3 weeks. He has had no diarrhea or fever and no abdominal pain. He has been seen in two different EDs with lab work, abdominal ultrasound, chest and abdomen radiographs, and a CT of the abdomen all within normal limits. Mother provides you with

copies of all the reports. On examination, the boy appears well hydrated with a heart rate of 110 beats/minute, respiratory rate of 14 breaths/minute, oxygen saturation of 99% on room air, and temperature of 98.9 °F. His blood glucose is 87 mg/dL. His cardiovascular examination is within normal limits. His abdomen is soft, nontender, and non-distended. You monitor him during an oral challenge with liquids, then solids, from your pantry given by your nurse technician, and he eats hungrily with no emesis. Mother appears upset that he is eating well from someone besides her. What piece of social history would correlate most with your diagnosis of Munchausen syndrome by proxy?

A. He attends daycare.
B. He lives with large extended family, including maternal grandparents.
C. Father is an airline pilot, travelling 6 days a week.
D. He sleeps with his mother.
E. Mother drinks a glass of wine daily.

Correct Answer: C

Munchausen syndrome by proxy is a rare, but potentially lethal, form of child abuse in which the parent or guardian seeks medical attention for a factitious illness in a child. The American Psychiatric Association in the DSM-V calls it factitious disorder imposed on another, with four major criteria for diagnosis:

- "Falsification of physical or psychological signs or symptoms, or induction by injury or disease, in another, associated with identified deception.
- The individual presents another individual (victim) to others as ill, impaired, or injured.
- The deceptive behavior is evident even in the absence of obvious external rewards.
- The behavior is not better explained by another mental disorder, such as delusional disorder or another psychotic disorder."

In factitious disorder by proxy, the parent feels a need to assume the sick role, or caregiver of the sick, to seek attention. In the vast majority of cases, the perpetrator is the mother. It may be considered in patients with strange histories of illness and extensive medical workups that reveal no diagnosis. The parent, although seeking medical attention, does not appear overly concerned for the child and displays exaggerated or deceptive behaviors. Parents in this case may inflict injury or illness on the child for the secondary gain of attention from multiple sources, including medical staff. Symptoms cover all organ systems but most commonly are abdominal, neurological, or psychological. Death occurs most often from poisoning or suffocation.

Characteristically, there is an unsupportive marital relationship, poor social support, and an overinvolved parent, often mother. Large support networks and school enrollment are protective factors against Munchausen by proxy. Co-sleeping and alcohol consumption in moderation do not correlate with this disorder. The signs and symptoms resolve or improve rapidly when the parent is absent or when the patient is observed. Often, the parent has a psychiatric disorder diagnosed beyond Munchausen by proxy.

This is a form of child abuse and should be reported to appropriate child protective services. Children most often will need hospitalization for observation, and a child protective team consultation should be sought.

Take-Home Message
Munchausen by proxy is a form of child abuse that should be reported to child protective services.

ABP Content Outline
- Recognize signs and symptoms of possible Munchausen syndrome by proxy.
- Plan the management of Munchausen syndrome by proxy.

Question 31

A 10-year-old boy is brought in by ambulance with a school official for violent behavior. He has a long history of school property damage and

detentions. On arrival, he yells and curses at the teacher and paramedics because they are restraining him. He appears calm on history, when allowed to talk, and denies the violent behavior at school. He tells you the school "doesn't like me, and I don't care."

His physical examination is normal, although you note mild micrognathia and close set eyes.

What finding supports a diagnosis of conduct disorder in this patient?

A. He has had suicide attempts.
B. He has a history of truancy.
C. He has long, dirty fingernails.
D. He has microscopic blood on urinalysis.
E. He has an above average IQ.

Correct Answer: B

Conduct disorder implies repetitive, socially unacceptable behavior in the absence of any other diagnosis. This includes aggressive or violent behavior, such as assault or vandalism, and nonaggressive behavior, such as truancy or lying, that violate the law or major social normative behaviors. Conduct disorder is a diagnosis made in school-aged and adolescent children, with 25% of girls and 40% of boys developing antisocial personality disorder in adulthood. Children with conduct disorder are diagnosed across all socioeconomic levels, although adults with antisocial personality disorder are far more likely to be in lower socioeconomic classes.

As there appears to be a genetic component to conduct disorder, children diagnosed with conduct disorder often have parents with poor parenting skills. These children are at high risk of neglect and child abuse, which is often perpetuated in their children. These children are also at risk for involvement with gangs, in an attempt to "fit in." In addition, there is a genetic overlap between attention deficit hyperactivity disorder (ADHD), oppositional defiant disorder, and conduct disorder. It is estimated that 20% of children with ADHD also have conduct disorder. Treatment of ADHD with medications and behavioral interventions lowers this number significantly.

These children often have minor facial abnormalities, lower IQs, and a low resting heart rate. Dirty fingernails would be more associated with neglect. Children with conduct disorder have higher-risk behaviors but are generally not more suicidal than the general population. Hematuria is not associated with conduct disorder.

Take-Home Message
Children with conduct disorder are at high risk of morbidity and mortality due to risk-taking behaviors.

ABP Content Outline
- Recognize the features and plan management of conduct disorder.

Question 32

A 16-year-old girl is brought into the emergency room by her parents who noticed swelling of her face. The patient also reports epigastric tenderness and intermittent swelling of her legs and feet. On physical examination, the patient is afebrile, and there is swelling of parotid and submandibular glands, epigastric tenderness, and intermittent edema. Serum electrolyte concentrations include the following: sodium, 133 mEq/L; potassium, 2.1 mEq/L; chloride, 89 mEq/L; and bicarbonate, 30 mEq/L. Of the following, the best INITIAL step in the management of this adolescent is to:

A. Order a normal saline bolus
B. Measure the serum amylase concentration
C. Consult gastroenterology
D. Ask her about her eating behavior
E. Reassure the parents and discharge the patient home

Correct Answer: D

Bulimia nervosa (BN) is an eating disorder in which patients have recurrent episodes of binge eating accompanied by inappropriate compensatory behaviors such as self-induced vomiting, laxative abuse, misuse of diuretics or enemas,

fasting, or vigorous exercise. A binge episode involves eating more food in a discrete period than most people would eat along with a feeling of loss of control. DSM-5 criteria for BN require objective binge episodes and subsequent compensatory behaviors at least once per week for 3 months. Patients with BN may be of any weight. Classic clinical manifestations of BN are salivary gland enlargement due to stimulation by binge eating and vomiting, dental enamel erosion by gastric acids because of chronic vomiting, calluses over knuckles (Russell's sign) due to repeated self-induced vomiting, and fluctuations in body weight with intermittent lower extremity edema. A hypokalemic hypochloremic metabolic alkalosis is a typical finding in patients who have a history of chronic vomiting. Electrolyte abnormalities may also be seen due to chronic vomiting or medication misuse.

Indications for hospitalization of the patient who has BN include failure of outpatient treatment; medical complications such as dehydration, electrolyte abnormalities such as hypokalemia, or associated electrocardiographic abnormalities (e.g., prolonged QTc interval, bradycardia, or dysrhythmias); Mallory-Weiss tear; gastric rupture; acute food refusal; and uncontrollable binge eating and purging. Acute psychiatric emergencies, such as suicidal ideation or acute psychosis, and evidence of a comorbid diagnosis that interferes with the treatment of the eating disorder such as severe depression or substance abuse also are indications for inpatient treatment of adolescents who have eating disorders.

ABP Content Outline

- Recognize the signs and symptoms of eating disorders.
- Plan the acute management of eating disorders.
- Recognize and interpret relevant laboratory, imaging, and monitoring findings in eating disorders.

Take-Home Message

Recognize clinical manifestations of bulimia nervosa that include salivary gland enlargement (due to stimulation by binge eating and vomiting), dental enamel erosion (gastric acids from chronic vomiting), Russell's sign (calluses over knuckles), edema, and fluctuations in body weight.

Question 33

An 18-year-old girl comes into the emergency department for a pregnancy test. She reports her last period was 8 weeks ago, and she regularly engages in sex for money and does not use condoms. On further interviewing, she reveals she ran away from home at the age of 15 and has been living on the "streets" since then. As compared to housed youth, runaway youth are more likely to:

A. Complete high school
B. Engage in high-risk sexual behavior
C. Prone to less mood and anxiety disorders
D. Have better overall health
E. Engage in low substance abuse

Correct Answer: B

Homelessness affects child health and development in many ways. Homeless youth have higher rates of acute and chronic health problems than low-income children with homes. Many of the acute medical problems are associated with poor and crowded living conditions. Diseases like as asthma, influenza, pneumonia, lice, and scabies are significantly more common.

Homeless children are more likely to skip meals, and when they do eat, they consume foods with low nutritional quality and high fat resulting in high rates of obesity and malnutrition. Frequent moves may interrupt education and impact school performance. Runaway youth face even more challenges than homeless youth in families. They are more frequently exposed to violence, more likely to engage in high-risk sexual behaviors, and more likely to have teenage pregnancies, engage in substance abuse, experience violence, and have anxiety and mood disorders. Female teenagers are also more likely to become victims of sex trafficking.

ABP Content Outline

- Know the risk factors associated with an adolescent runaway.
- Plan the management of a patient who is a runaway.

Take-Home Message

Homeless teenagers are prone to worse outcomes including high-risk sexual behavior and exposure to violence.

Question 34

A 17-year-old girl is brought to the emergency department by her parents for evaluation of acute left leg weakness for the past week. She denies trauma, recent illness, or fever. On physical examination, she is afebrile with stable vital signs. She is unable to move her left leg and cannot feel light touch on exam. Reflexes are present and symmetric. The rest of your examination is normal. On further interviewing, she reveals that her 15-year-old brother recently died in a car accident. Of the following, the most likely diagnosis is:

A. Depression
B. Lumbar disc herniation
C. Left femur fracture
D. Stroke
E. Conversion reaction

Correct Answer: E

Conversion disorder is a non-intentional physical symptom that occurs in response to emotional distress resulting in significant impairment. The physical symptoms can be motor or sensory. In children, conversion disorders occur equally among boys and girls, but in adolescents, they are more frequent in girls. Recent family stress or conflict often precipitates physical symptoms. Other common conversion symptoms include abdominal pain, chest pain, hyperventilation, syncope, dizziness, pseudo-seizures, blindness, and/or paralysis. It is important to rule out medical and organic causes before diagnosing conversion disorder.

ABP Content Outline

- Recognize signs and symptoms of somatoform disorders (conversion disorders, chronic pain syndrome).
- Plan the management of somatoform disorders (conversion disorders, chronic pain syndrome).

Take-Home Message

Consider conversion disorder when findings do not make neurological sense.

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Child Abuse

17

Julia N. Magana and Mary T. Ryan

Question 1

A 6-month-old girl, born at 27 weeks' gestation, with chronic lung disease, presents to the emergency department; she is apneic and pulseless. A chest X-ray film shows multiple posterior–medial rib fractures. Extensive resuscitation is unsuccessful and the patient is pronounced dead. Social work is involved and reports the baby lived with the mother who is a young single parent. Also, in the home are her new boyfriend, three siblings, and maternal grandparents.

Which of the following is NOT a risk factor for child maltreatment?

A. Living with extended family
B. Single parent
C. Preterm birth
D. Nonbiological male living in the home
E. Chronic illness

Correct Answer: A

Factors that lead to child physical abuse are complex and diverse but can be classified into three categories: child, parent, and environment (Table 17.1). This child had multiple risk factors; living with grandparents, however, is not a risk factor. The presence of safe, stable, nurturing relationships is protective. While risk factors for abuse are described, the diagnosis should not be based solely on the presence of risk factors.

Take-Home Message

Risk factors for child physical abuse are complex and diverse and can be classified into three categories: child, parent, and environment. The provider should not make the diagnosis of abuse based solely on the presence of risk factors.

ABP Content Specification

- Know the factors that contribute to physical abuse of children.

Question 2

A 3-month-old girl is brought to the emergency department for evaluation of "excessive crying" and "poor feeding.". She is accompanied by her 18-year-old mother. She was born full-term by vaginal delivery, and has met her growth parameters since birth. She is bottle-fed and her mother is her only caretaker. The mother brought her today as she reports they were both

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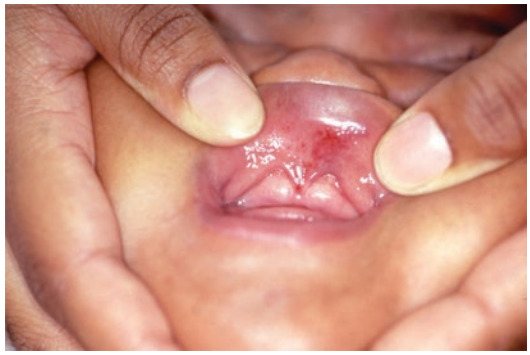
M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_17

Table 17.1 Factors and characteristics that increase the risk for maltreatment

Child	Parent	Environment (Community & Society)
Emotional/behavioral difficulties	Low self-esteem	Social isolation
Chronic illness	Substance abuse/alcohol abuse	Poverty
Physical disabilities	Young maternal or paternal age	Unemployment
Developmental disabilities	Parent abused as a child	Low educational achievement
Preterm birth	Depression or other mental illness	Single parent
Unwanted child	Poor knowledge of child development or unrealistic expectations for child	Nonbiological male living in the home
Unplanned pregnancy	Negative perception of normal child behavior	Family or intimate partner violence

Adapted from Flaherty et al., reproduced in AAP, The evaluation of suspected child physical abuse; page 1339

"up all night," "she won't eat at all today," and "she won't stop crying." The mother denies any trauma.



Physical examination shows stable vital signs. Oral examination is shown (see image question 2). The remainder of the physical examination is unremarkable. When asked about the findings, the mother suggests "maybe it's a cold sore" as the mother had one last week.

All of following are true of this finding *except*:

A. In an older child, this can result from a simple fall.
B. Transmission of herpes simplex from mother to child is common and may present like this.
C. This may be the result of forced feeding.
D. This can result from a slapping injury.
E. Suturing is not required and most heal with conservative measures.

Correct Answer: B

Discussion

The image depicts a tear to the upper labial frenulum with an associated upper lip contusion. In an ambulatory child, this injury can result from a simple fall. When present in an older child, the examiner should also evaluate for broken, impacted, or aspirated teeth.

In the case of this 3-month-old girl, there is no report of trauma and this finding is suggestive of being "force fed" or of a "slap"-type injury. Force feeding injuries may occur from inexperience, frustration, or both, and warrant further evaluation of the child's safety as well as the support system in the home.

The majority of frenulum tears heal uneventfully.

While transmission of herpes from caregiver to child is a common occurrence, the lesions in herpes appear as vesicles, which heal with crusting. Lip swelling may be seen with herpes, but it does not result in tears to the frenulum or frank contusion of the lip as seen in this image.

Take-Home Message

The provider should correlate a torn frenulum, or any injury on a nonambulatory child, with the mechanism described to evaluate whether there is concern for nonaccidental injury. Bruises, burns, oral injuries, and fractures are rare in a nonambulatory child.

ABP Content Specification

- Recognize the common signs and symptoms of physical abuse in children.

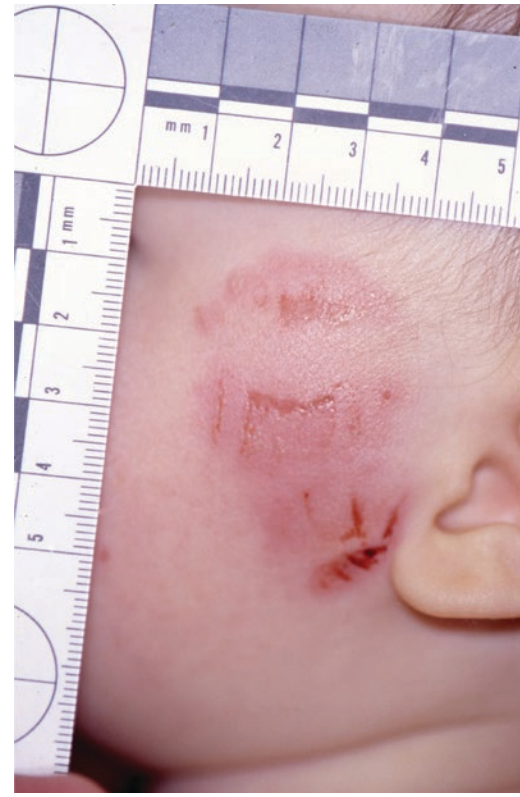
Question 3

An 11-month-old boy was picked up from daycare when his father noted this finding (see the image). It was not present when the child was dropped off. The day care worker states, "he must have fallen when trying to walk and hit his face." She reports they were very short staffed so she can't say for sure what happened. The father suggested that it looked like a bite. The staff member agreed that it was possible, adding: "young children often bite each other." The father brought the child to the emergency department for further evaluation.

Which of the following is the most appropriate initial step in patient care?

A. Assure the father that the injury will likely heal and prescribe antibiotics—no further action is needed.
B. Measure the intercanine distance, and if it is >3 cm, report to Child Protective Services.
C. Contact Child Protective Services to report patterned injuries consistent with bite marks likely obtained at day care with concern for poor supervision.
D. Explain to the father that children biting children is a common occurrence, but he can choose to take the child out of daycare if he chooses.
E. Contact police to report battery.

Correct Answer: C



Discussion

The image (image question 3) shows an injury suggestive of several bites. There are 3+ arched abrasions, associated linear abrasions as well as significant contusions. The injury is not consistent with the mechanism of a fall, as offered by daycare staff. The appearance is classic for a human bite. Patterned injuries are rarely accidental.

Bite marks are described as patterned, circular, or oval, with or without central ecchymosis. Further investigation may be needed to determine if the bite is from an adult, child, or even an animal. A forensic dentist with experience in the bite mark analysis is best qualified to make this determination. If the injury is from an adult, nonaccidental/inflicted trauma is an immediate concern. The intercanine distance can be documented, but the previously proposed 3-cm cutoff measurement is not reliable enough to differentiate between adults and children. If the bites are from another child or children and went unnoticed by staff, there is a concern for lack of adequate supervision. Most bite-related injuries heal well with local wound care and oral antibiotics if there is skin breakdown.

Day care centers are regulated to ensure the health and safety of children. Adequate staff-to-child ratios are specified and centers are required to keep records of and notify parents/guardians of

injuries or illnesses occurring while in their care. Failure to comply with state regulations is a serious offense and may result in citations, fines, closure, and even criminal charges.

Take-Home Message
Patterned injuries, such as bites, are concerning for inflicted injury and require evaluation. The age of the biter is difficult to determine and is best left to a forensic dentist.

ABP Content Specification
- Recognize unusual or subtle signs of physical abuse in children.

Question 4

A 10-day-old boy presents to the emergency department with his grandparents who noticed a large left parieto-occipital bogginess. He has been nursing well and the review of systems is normal. The swelling does not cross the sutures and he has no other signs of trauma and normal vital signs. The grandparents confirm that he was born in a local hospital, but have few other details. Which of the following is the next best step in evaluating the child?

A. Partial Thromboplastin Time, Prothrombin Time and International Normalized Ratio (PTT and INR)
B. Child Protective Services investigation
C. A head CT scan
D. Call mother or birth hospital to obtain birth history
E. Urine organic acids

Correct Answer: D

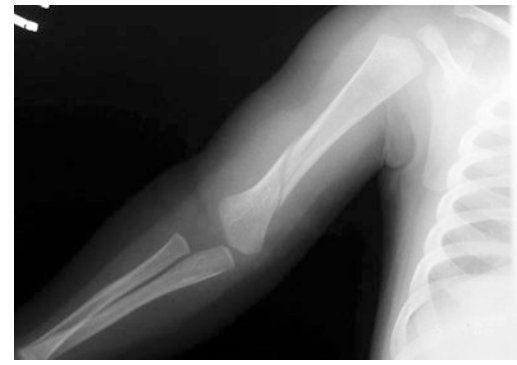
Discussion
Birth-related injuries can present later with apparently "new" scalp hematomas. Concerning findings such as scalp hematomas, soft tissue injuries, retinal hemorrhages, and subdural hemorrhages (SDH) can be seen in complicated deliveries such as forceps deliveries or vacuum extractions. The least invasive and best next step is to obtain a thorough birth history. While a head CT scan and referral to Child Protective Services may ultimately be warranted, a thorough history should be the first step. Vitamin K deficiency can lead to severe intracranial and intraretinal hemorrhages. It is associated with prolonged PT. Lack of vitamin K injection in "home births" is a risk factor. This patient was born in a hospital and is at very low risk for vitamin K deficiency and/or late hemorrhagic disease of the newborn.

Take-Home Message
A thorough medical and trauma history is important to differentiate between inflicted trauma and accidental trauma. Birth trauma is common and should be in the differential in neonates with apparent head injury.

ABP Content Specification
- Recognize the signs of common illnesses or injuries that may mimic physical abuse.

Question 5

A 5-month-old boy is brought by his mother for evaluation of "fussiness" and cough without a fever. He is otherwise in his usual state of health. He is afebrile and consolable when lying in bed. The mother's new boyfriend (not the biological father) is the caretaker while the mother works. On examination, he is noted to have nasal congestion and occasional coughing and is irritable when held. Vital signs and growth parameters are stable. He has mild swelling of his right arm and cries when it is moved. Skin examination is normal.



Right humeral X-ray film is shown (image question 5). The mother is unaware of any trauma but her boyfriend reports that on the previous day, the boy fell when walking while holding onto the couch. Orthopedics is consulted and the arm is immobilized. Which of the following is the most appropriate next step in patient care?

A. Discharge home with very close follow-up with orthopedics and caution this mother for closer supervision to avoid further falls.
B. Admit the child for workup of possible metabolic bone disease.
C. Obtain a skeletal survey, and if positive for additional findings, notify local child protection reporting agencies.
D. Notify local child protection agency and obtain a skeletal survey, head CT scan, and ophthalmological evaluation.
E. Obtain a skeletal survey and notify child protection services.

Correct Answer: D

Discussion

The image shows a spiral fracture of the humerus. Spiral fractures occur from rotational traction forces—twisting or pulling motion—applied to the long axis of the bone. Spiral fractures of the humerus and femur in the premobile child are suspicious for child abuse. An accidental spiral fracture can be seen in a mobile child and may occur with a history of twisting motion even in the premobile child. Careful review of the history and mechanism is essential (Table 17.1). When assessing fractures for an abusive injury, consider two questions: (1) Is the child developmentally capable of performing such an act? (2) Does the mechanism described explain the injury?

In this case, the child is premobile and there is no history to suggest a fall involving a torsional mechanism, so it is highly suspicious for nonaccidental injury. The report that the 5-month-old "fell when he was trying to walk" should alert the physician that there is an inconsistency between the history provided and the child's developmental level and ability. Traditional teaching is that some fractures are more specific for abuse than others.

A skeletal survey is prudent to screen for occult skeletal injuries in children <2 years old with suspected abuse. Since abused infants may not demonstrate neurological signs or symptoms despite the presence of CNS injury, head CT or MRI should be strongly considered in infants with fractures suspicious for abuse. CT scan remains the study of choice for initial evaluation of suspected inflicted head injury in the emergency department (ED). A careful ophthalmological examination is also required to evaluate for retinal hemorrhages. His comprehensive evaluation may require hospitalization.

Indications for obtaining a skeletal survey

All children <2 years with obvious abusive injuries
All children <2 years with any suspicious injury, including unexplained bruises, oral injuries, or patterned skin injuries in nonambulatory infants
Infants with unexplained and unexpected sudden death (often postmortem by medical examiner/coroner)
Infants and young toddlers with unexplained intracranial injuries, including hemorrhage and hypoxic–ischemic injury
Infants and siblings <2 years and household contacts of an abused child
Twins of abused infants and toddlers

Injuries that raise the concern for child abuse

- No history of injury
- History of injury not plausible—mechanism described not consistent with the type of injury
- Inconsistent histories or changing histories provided by caregiver
- Fracture in a nonambulatory child
- Fracture types of high specificity for child abuse (e.g., posterior rib fractures)
- Multiple fractures and fractures of different ages
- Other injuries suspicious for child abuse, for example, frenulum tear
- Delay in seeking care for an injury

Take-Home Message

Child abuse should be in the differential for any fracture in a nonambulatory child that is incon-

sistent with mechanism of injury. The most concerning fracture types are classic metaphyseal lesions, posterior rib fractures, scapular fractures, spinous process fractures, and sternal fractures.

ABP Content Specification

- Recognize common fractures associated with bony injuries characteristic of physical abuse.

Question 6

A previously healthy 13-month-old Hispanic girl presents to the emergency department with hand swelling discovered while being picked up at the daycare center. She is otherwise acting normally. There are no other signs of trauma on physical examination. A hand X-ray shows a nondisplaced transverse left mid-shaft, mildly dorsally angulated third metacarpal fracture. She has a gray–blue tint to her sclera. There is no report of trauma while at the daycare. She is in day care 5 days a week, stays with the mother weeknights, and with the father on weekends. She has no history of fractures, burns, or bruises. The fracture was immobilized in the emergency department. You requested a skeletal survey but it could not be obtained.

Which of the following is the most appropriate next step in patient care?

A. Obtain a head CT scan.
B. Report to Child Protective Services (CPS) and admit for further evaluation.
C. Obtain COL1A1 and COL1A2.
D. Discharge home with mother to obtain skeletal survey.
E. Discharge home and follow-up with her pediatrician.

Correct Answer: B

Discussion

This patient has a transverse metacarpal fracture without a trauma history, which is suspicious for nonaccidental injury. A complete skeletal survey is warranted in this child but could not be obtained. Also, the patient has multiple caregivers and this fracture is concerning for inflicted injury. Admission allows time for a more thorough history from all caretakers, further medical testing, consultation, observation, and treatment of injuries in a protected environment without separating the family. CPS should be contacted because of the specificity of this fracture for inflicted injury without a trauma history so they can investigate further.

Blue sclera can be seen in young patients without osteogenesis imperfecta (OI). But in this case, a multidisciplinary child abuse evaluation is warranted. Genetic testing is used selectively by specialists to evaluate for osteogenesis imperfecta and other diseases and requires follow-up beyond the ED.

A head CT scan should be obtained if there are signs or symptoms concerning for head injury. The 2014 AAP Clinical Report on Evaluating Children with Fractures for Child Physical Abuse notes "because brain injuries are often occult, head imaging should be considered for any child younger than 1 year with a fracture suspicious for abuse." This child does not have any signs or symptoms of head injury and is older than 1 year, so a head CT scan is not necessary.

In this case, discharge would be feasible if CPS is able to investigate environments in a timely manner and the patient is scheduled to be seen by a child abuse pediatrician for a skeletal survey and evaluation. The specialist should also be in agreement with this plan to follow up. A discharge with a completed skeletal survey without a provider follow-up and without CPS referral would not be prudent. Discharge with only pediatrician follow-up, without a CPS referral, specialist involvement, and skeletal survey could place the patient at unnecessary risk.

Take-Home Message

If the provider has concern for the child's safety in the home environment, admission is warranted.

ABP Content Specification

- Know indications for hospitalizing a child with possible nonaccidental injury.

Question 7

A 4-month-old male infant presents to the emergency department with a mild cough and nasal congestion. His lungs are clear to auscultation; he is well hydrated and happy and has normal vital signs. You notice a small, circular, dark patch in the suprapubic region that is tender and consistent with a bruise. The parents are both just as surprised as you are to see the bruise. They do not know where it came from, but wonder if it came from the car seat buckle since that is where it makes contact on him. They have no history of car accidents and are not aware of him crying when they buckled him in the car seat.

Which of the following is the most appropriate next step in management?

A. Put the baby in the car seat, and if the bruise is within 2 inches of the buckle, send the baby home with follow-up with the pediatrician.
B. Examine the rest of the skin for injuries, obtain a bleeding history, ask social service to evaluate the family for psychosocial risk factors, and consider ordering liver function tests.
C. Call Child Protective Services for inflicted injury.
D. Order a CBC, PT, aPTT, INR, Von Willebrand Factor antigen, Ristocetin cofactor, factor VIII level, Factor IX level.
E. Admit for skeletal survey, head CT, and abdominal CT scan.

Correct Answer: B

Discussion

It is rare to see a bruise on a nonambulatory child, especially in the torso, ears, or neck. These bruises warrant a multidisciplinary evaluation. Sentinel injuries are defined as bruises or intraoral injuries or other relatively minor, but suspicious injuries in infants <12 months of age. Abused children are more likely to have a history of sentinel injuries than nonabused children. Sentinel injuries are an opportunity to evaluate the safety of the child's environment.

In this case, the next best step is to perform a full skin examination to look for other injuries and obtain a bleeding history from the patient and family. Have social work take a thorough psychosocial history that they can report to Child Protective Services if needed. An aspartate transaminase (AST), alanine transaminase (ALT), and lipase may help to screen for intra-abdominal injury.

Take-Home Message

The complicated diagnosis of physical abuse is best made by a multidisciplinary team. The ED provider should be able to recognize injuries concerning for abuse, do a thorough trauma evaluation, and communicate to the team concerns for abuse.

ABP Content Specification

- Know the physician's role in working with a multidisciplinary team managing a physically abused child.

Question 8

A 7-year-old girl with mild cerebral palsy was seen by her pediatrician for constipation. During the visit, the girl disclosed that her 16-year-old cousin "touched her." She was referred to the emergency department for further evaluation. On examination, she has normal vital signs and is 45% percentile for height and weight. She has no skin injuries and external genital examination is without trauma and Tanner 1. She is shy and reluctant to discuss the situation.

Which of the following is true of child sexual abuse (CSA)?

A. The majority of CSA offenders are strangers.
B. It is rare for an offender to also be a minor.
C. CSA is more likely in children <10 years of age.
D. Most CSA occurs in day care or school.
E. Physical disabilities are a risk factor for CSA.

Correct Answer: E

Discussion

Child sexual abuse (CSA) is said to occur when an adult or adolescent exploits a child for sexual gratification. It can involve a wide range of

actions and does not necessarily involve direct sexual contact. The spectrum of activities includes genital exposure of the offender to the child, visualizing and/or photography of the child's genitals, touching the child through clothing, or coercing a child to touch the offender. The abuse can involve an isolated offender or include a wider range of individuals; it can include producing/selling child pornography and child exploitation for prostitution.

The majority (>90%) of offenders are known to the child. Up to 30% are relatives and an additional 60% are acquaintances of the family with less than 10% being strangers. In the United States, in more than 30% of cases, the offender is also a minor, typically an older adolescent. CSA is reported more commonly in girls, but boys may be less likely to disclose, thus skewing the data. Adolescents have the highest rates of sexual assault. Physical disabilities, prior CSA, and absence of a protective parent are other risk factors.

Take-Home Message

Most offenders are known to the child and can be a minor themselves. High risk factors include adolescence, physical disabilities, female gender, prior CSA, and absence of a protective parent.

ABP Content Specification

- Know the risk factors for sexual abuse of children.

Question 9

A 6-year-old girl presents with constipation and increased aggression at school. Symptoms began after staying with her extended family, while parents traveled in the previous month. When her mother picked her up, she had blood in her underwear. The mother reports that her daughter seems more withdrawn than usual. The mother is concerned for abuse. The pediatrician referred her to your emergency department. On examination, she has stable vital signs, 45% percentile for height and weight, no skin findings, Tanner stage 1 genitals that appear normal. She appears shy and reluctant to discuss the situation.

Which of the following is the most appropriate intervention?

A. Have the mother ask the child questions about abuse in your presence, document the response, and call Child protective services (CPS)/law enforcement.
B. Reassure the family that the absence of findings on examination makes abuse highly unlikely and treat with polyethylene glycol 3350.
C. Ask the child if her cousin touched her, and if she says yes or does not respond at all, report to CPS.
D. Obtain vaginal, vulvar, anal, and oral swabs for DNA and call law enforcement to pick up the samples.
E. Discuss the case with the mother outside patient room, document any spontaneous child disclosures, and report to CPS/law enforcement.

Correct Answer: E

Discussion

Children can reveal sexual abuse in many ways, including trauma findings, behavior changes, disclosure, sexualized behaviors, constipation, and psychosomatic complaints. Some children never disclose at all. Providers need to have a high index of suspicion and keep Child Sexual Abuse (CSA) in the differential for unexplained behavioral and chronic somatic complaints. The emergency department is rarely the best place for CSA evaluations. Providers trained in these procedures, with the correct equipment, are best at performing CSA interviews and examinations. The emergency department may not provide adequate space or skills to perform an adequate forensic interview/examination.

Interview caregivers separate from the child and prepubescent children should be interviewed about the potential crime by trained professionals. The provider should write down exactly what the child said and what prompted the disclosure. Sexual assault evidence collection is of value in the acute setting only—who collects the evidence and what constitutes

"acute" varies by region. The yield is maximum <96 hours. The practitioner should be aware of and adhere to the regional practices where they work.

The majority of children who are victims of CSA have a normal examination, making forensic interview by trained investigators extremely important. Early referral to Child Advocacy Centers ensures access to a nonurgent examination when colposcopy/photography is needed and the multidisciplinary support services are required for long-term care for children and families affected by CSA.

Take-Home Message

- Children may reveal sexual abuse in a myriad of ways—trauma findings, behavior changes, direct disclosure, sexualized behaviors, constipation, psychosomatic complaints, etc.
- Quote exactly what the child says if there are any disclosures by the child.
- Young children are best interviewed by people trained in child interviews in a child advocacy center, not in the emergency department.

ABP Content Specification

- Understand the ways in which children reveal sexual abuse.

Question 10

An 11-year-old previously healthy girl is sent by the pediatrician to the emergency department for further evaluation of vaginal discharge that is chlamydia PCR positive. Her genitals are Tanner stage 3 with scant, thin white discharge, but otherwise normal anatomy. She denies a history of any consensual sexual contact. When the social worker is talking with the mother, the girl discloses that her mother lives with a boyfriend who has been "touching my pee pee and bottom." Her last contact with him was six nights ago.

What is the next best step in management?

A. Tell the patient it is unlikely that she got chlamydia by fondling and ask her what really happened.
B. Report to CPS and/or law enforcement and then do an evidentiary examination including speculum examination.
C. Repeat the chlamydia PCR and, if positive, report to authorities.
D. Report to CPS and/or law enforcement that the child has findings of sexual contact, and disclose sexual contact with mother's boyfriend.
E. Obtain a pregnancy test, tell the mother your concerns, and that they should move out but don't report to authorities.

Correct Answer: D

Discussion

Child sexual abuse (CSA) is characterized by progressive victimization by someone the child trusts. This typically follows the pattern of engagement, sexual interaction, secrecy, disclosure, and recantation. Children are less likely to have apparent injuries and are less likely to disclose within 72 hours of the event. The priority is child safety and reporting to authorities based on local protocol (law enforcement, Child Protective Services, or both).

The highest chance of recovery of biological evidence exists if the Sexual Assault Evidence Collection Kit is collected within 72 hours from the event.

The main priorities are evidence collection, law enforcement involvement, diagnosis of infections, and safety of the child. It is reasonable to obtain a pregnancy test and repeat the chlamydia PCR and/or a culture for chlamydia- as there are false positives for PCR, but an 11-year-old child cannot consent to sexual contact with someone older than 18 years, making reporting mandatory. Chlamydia infection is diagnostic of CSA in a patient without a history of consensual sexual contact. Chlamydia and gonorrhea are unlikely to be contracted by fondling alone, but partial disclosure is not unusual.

Take-Home Message

Children are less likely than adult sexual assault victims to disclose acutely. Chlamydia and gonorrhea infection are diagnostic of CSA in a

child without a history of consensual sexual contact.

ABP Content Specification

- Understand the differences between sexually abused children and adult rape victims.

Question 11

A 12-year-old girl presents to the emergency department with her father after she was removed from the mother's home due to child sexual abuse (CSA) by the mother's live-in boyfriend. She has been withdrawn, refusing to sleep in her own room, afraid to leave her father's side to go to school, and eating poorly. On examination, she is quiet but has an otherwise normal examination. The father has been reading on the internet that there are many long-term consequences to CSA and wants to know what to expect/what he can do to help mitigate possible sequelae.

Which features are NOT protective against subsequent adolescent risk-taking behavior nor seem to mitigate the effects of prior abuse?

A. Religiosity
B. Positive family support
C. Female gender
D. Involvement in extracurricular activities
E. Trauma counseling

Correct Answer: C

Discussion

Victims of child sexual abuse (CSA) are at risk in both short and long terms for many poor psychological, social, and medical outcomes. These have been best described using the Adverse Childhood Experiences (ACEs) tool. Women who were victims of child sexual abuse report increased sexually transmitted infections, teen pregnancy, risky sexual behaviors, becoming repeat victims of sexual abuse, and much more. Psychological sequelae include, but are not limited to, depression, anxiety, posttraumatic stress disorder (PTSD), sexualized behaviors, suicide attempts, substance abuse, eating disorders, sleep disturbances, personality disorders, somatization, early pregnancy, school failure, self-injury, psychosis, and repeat victimization. Long-term victims are at risk for many chronic medical problems, including obesity, hypertension, and even asthma and chronic obstructive pulmonary disease.

The problems described in this case are common and frustrating for parents. Treatment includes addressing child safety, physical, and mental health. The child should receive ongoing trauma counseling. A retrospective review has identified protective features such as self-esteem, self-efficacy, familial and social support, peer group characteristics, school climate, religiosity, perceptions of the future, and involvement in extracurricular activities. Female gender has not shown to be protective and may put her at higher risk for PTSD.

The non-offending caregiver is at risk for emotional, psychosocial, and financial strain. The caregiver's supportive response has been associated with positive emotional and behavioral outcomes among abused children. The father should be made aware of the risk factors and provided local resources to help the family through this difficult time now and into the future.

Take-Home Message

Victims of child sexual abuse (CSA) are at risk for many psychological, social, and medical outcomes for short and long terms. Trauma counseling and a supportive environment reduce sequelae.

ABP Content Specification

- Understand the short-term and long-term consequences of sexual abuse in children.

Question 12

A 16-year-old girl presents to the emergency department with her "uncle" for copious, foul-smelling discharge for 3 days. Her last menstrual period was 10 days ago and she is sexually

active. She reports that she does not have a primary care provider. Medical record review reveals multiple ED visits for sexually transmitted infections and emergency birth control. Vital signs include the following: temperature 37.8 °C, heart rate 87 beats/minute, respiratory rate 18 per minute, and blood pressure 111/76 mm Hg. Examination reveals several tattoos, scars that appear to be cigarette burns, and bruises on her thighs. Speculum vaginal examination reveals copious, purulent, foul-smelling discharge from a friable cervix. Chlamydia/gonorrhea testing is obtained. The uncle would not leave bedside except for the vaginal examination. The nurses report that he is lying in the bed with her and is acting "inappropriately." The mother is unable to come, but is able to provide consent for care over the phone. The patient is treated presumptively with antibiotics for sexually transmitted infection.

Which of the following is the most likely explanation for the constellation of findings?

A. Commercial sexual exploitation of children (CSEC)
B. Drug-facilitated sexual assault
C. Normal teenage consensual sexual relations
D. Emotional abuse
E. Physical abuse

Correct Answer: A

Discussion

This patient has a cervicitis likely caused by a sexually transmitted infection (STI). The social situation is concerning for commercial sexual exploitation of a child (CSEC), also known as "sex-trafficking." One international study showed that 33% of victims of commercial exploitation were children. Victims are at increased risk for injury, infectious diseases, malnutrition, mental health disorders such as depression or suicide, chronic medical conditions, substance abuse, neglect, emotional abuse, physical abuse, and more. While the patient is at risk for all of these forms of abuse, the diagnosis that encompasses all of her findings is most likely CSEC.

Studies show that the age of entrance into sex trafficking is approximately 12–16 years. This age group is particularly vulnerable, but other risk factors are being homeless, a history of sexual or physical abuse or neglect, having a dysfunctional family (i.e., caregiver substance abuse), a history of juvenile justice or CPS involvement, exposure to violence, and those who are lesbian/gay/bisexual/transgender. The fact that the teenager is presenting with a domineering adult who does not allow the child to answer questions, and has evidence of inflicted injury, previous STI, and visits for emergency contraception are all concerning factors for CSEC. Patients seldom self-identify as victims of CSEC. When the provider has concerns for CSEC, they can consider asking the patient alone:

- Is there a previous history of drug and/or alcohol use?
- Has the youth ever run away from home?
- Has the youth ever been involved with law enforcement?
- Has the youth ever broken a bone, had traumatic loss of consciousness, or sustained a significant wound?
- Has the youth ever had a sexually transmitted infection?
- Does the youth have a history of sexual activity with more than 5 partners?

Answering yes to four or more questions has an 88% positive predictive value. When there is concern for CSEC, the provider should focus on treating acute medical conditions, consider referral to the sexual response team, document acute/remote injuries, assess for mental health issues, test for pregnancy/STIs and HIV infection, offer contraceptive options, and treat presumptively for STIs. This can be time consuming and should be multidisciplinary. Providers should know local policies for notification of law enforcement and resources for victims of CSEC.

Take-Home Message

Commercial sexual exploitation of a child should be suspected in a child with risk factors such as

multiple STIs, more than five sexual partners, substance abuse, and runaway/homelessness. These patients should be provided resources and treated presumptively for STIs.

ABP Content Specification

- Recognize the signs and symptoms of sexual abuse in children.

Question 13

A 20-month-old girl presents with "bumps on her vagina." She is well appearing and able to put together two-word sentences, and has normal vital signs. On examination, she has multiple, soft, fleshy, cauliflower-like colored papules on her labia, perineum, and perianal skin. The hymen is crescentic and grossly appears normal. Her skin is otherwise normal. The mother has never seen these before. She lives with mother and mother's boyfriend and is in a home daycare while mother works. The mother does not have any concern for abuse. There are no other medical or behavioral changes. The mother was diagnosed with human papilloma virus (HPV) infection 5 years ago but does not have active lesions.

Which of the following is the most likely explanation for these findings?

A. Molluscum contagiosum from sexual transmission
B. Condyloma acuminata from perinatal transmission
C. Molluscum contagiosum from fomite transmission
D. Condyloma acuminate from self-inoculation
E. Human papilloma virus (HPV) infection from sexual transmission

Correct Answer: B

Discussion

Human papillomavirus (HPV) is a very common virus that causes many forms of warts on all portions of the body, including anogenital warts (condyloma acuminate). HPV infection can be transmitted by fomites, autoinoculation (hands, feet), perinatal (vertical), or hetero-inoculation (including sexual and nonsexual contact). Because it can be transmitted in various innocuous manners, it is NOT specific to abuse, particularly in a child under 5 years of age. The virus may remain latent in the child or dormant for several months or possibly years after birth. Most experts suggest 24 months as the upper age limit for warts attributable to vertical transmission, but it may even be possible up to 5 years of age. The lesions are often asymptomatic but can be associated with itching, bleeding, or pain with bowel movements or urination. Because this case is most consistent with vertical inoculation, referral to a pediatric gynecologist or dermatologist should be considered. If the child was >5 years old, there is no expert consensus, but even without other indicators of abuse an evaluation by local specialists is warranted and may include further interviews, colposcopy, or sexually transmitted infection (STI) testing. There is no "expert consensus" on approach to herpes type 1 or 2 confirmed by culture or PCR testing in the genital or anal area of a child without other indicators of sexual abuse, but probably warrants referral to a specialist for further investigation.

Molluscum contagiosum typically presents as a smooth, flesh-colored, umbilicated papule on the skin. This common poxvirus is spread from direct person-to-person contact and through contaminated fomites. Even anogenital lesions are not specific or concerning for sexual abuse.

The latest guidelines by Adams suggest that the following STIs found in children are caused by sexual contact, unless there is evidence of perinatal transmission or clearly, reasonably, and independently documented but rare nonsexual transmission:

- Genital, rectal, or pharyngeal *Neisseria gonorrhoeae* infection
- Syphilis
- Genital or rectal *Chlamydia trachomatis* infection
- *Trichomonas vaginalis* infection
- HIV infection, if transmission by blood transfusion has been ruled out

Diagnostic of sexual contact

- Pregnancy
- Semen identified in forensic specimens taken directly from a child's body

Take-Home Message

STIs caused by *N. gonorrhea* chlamydia, syphilis, trichomonas, and HIV infection are highly concerning for CSA. Genital warts, in a young child, are often transmitted perinatally.

ABP Content Specification

- Know the relationship between sexually transmitted diseases and sexual abuse of children.

Question 14

A 2-year-old previously healthy girl is brought to the emergency department by her tearful mother after a planned visit with the father this afternoon. The mother changed her diaper and noted that her "vagina and butt are tearing up and the holes are too big." A social worker speaks with the family and there is a history of interpersonal violence between the mother and father with a complicated custody battle in process. The mother has no specific details concerning for abuse other than mild anogenital erythema. On examination, the patient has vulvar and perianal erythema extending into the creases with satellite lesions, no lacerations or bleeding, or discharge. While examining the child, the external anal sphincter relaxes and mom yells out "there, that is it!"

Chart review reveals that child has been brought by the mother several times for similar complaints and has had multiple evaluations in a local center for child abuse that were normal.

What is the best next step in evaluation?

A. Order chlamydia and gonorrhea urine Nucleic Acid Amplication Testing (NAAT), sympathize with the complicated social situation, reassure the mother that the findings are nonspecific, remind her that there have been multiple normal investigations, and give her local resources (CPS, law enforcement, local child abuse specialists) that she can contact with further concerns.
B. Call Child Protective Services (CPS) and report that the mother is endangering the child by bringing her to the emergency department for evaluation yet again.
C. Call law enforcement in the city where the father lives.
D. Sympathize with the complicated social situation, reassure the mother that the findings are nonspecific, remind her that there have been multiple normal investigations, and provide her local resources (CPS, law enforcement, local child abuse specialists) that she can contact with further concerns.
E. Call law enforcement and CPS to request an acute sexual assault examination.

Correct Answer: D

Discussion

Relationship issues between caregivers and custody disputes may give rise to heightened concerns for sexual abuse. These children may be brought by the parents seeking a "sexual abuse evaluation." In the United States, all providers are mandated reporters of *suspected* abuse. Each provider needs to consider the facts of each case when making the decision to report while keeping in mind the local statutory reporting requirements (CPS vs. law enforcement vs. both). Law enforcement will decide if an acute evidentiary examination is warranted but the physician's findings, parental concerns, and timing of the event will influence the need for an acute evidentiary examination. This child most likely has a fungal diaper rash. Parents can perceive normal anatomy as abnormal or injury.

Current guidelines indicate that there are some findings that are more specific to trauma and/or sexual contact:

Acute trauma to external genital/anal tissues, which could be accidental or inflicted:

- Acute lacerations or bruising of labia, penis, scrotum, perianal tissues, or perineum.

- Acute laceration of the posterior fourchette or vestibule, not involving the hymen.
- Residual (healing) injuries to external genital/anal tissues. These rare findings are difficult to diagnose unless an acute injury was previously documented at the same location.
- Perianal scar.
- Scar of posterior fourchette or fossa.

Injuries indicative of acute or healed trauma to the genital/anal tissues:

- Bruising, petechiae, or abrasions on the hymen
- Acute laceration of the hymen, of any depth; partial or complete
- Vaginal laceration
- Perianal laceration with exposure of tissues below the dermis
- Healed hymenal transection/complete hymenal cleft—a defect in the hymen between 4 o'clock and 8 o'clock that extends to the base of the hymen, with no hymenal tissue discernible at that location.
- A defect in the posterior (inferior) half of the hymen wider than a transection
- An absence of hymenal tissue extending to the base of the hymen

Diagnostic of sexual contact

- Pregnancy
- Semen identified in forensic specimens taken directly from a child's body

Take-Home Message

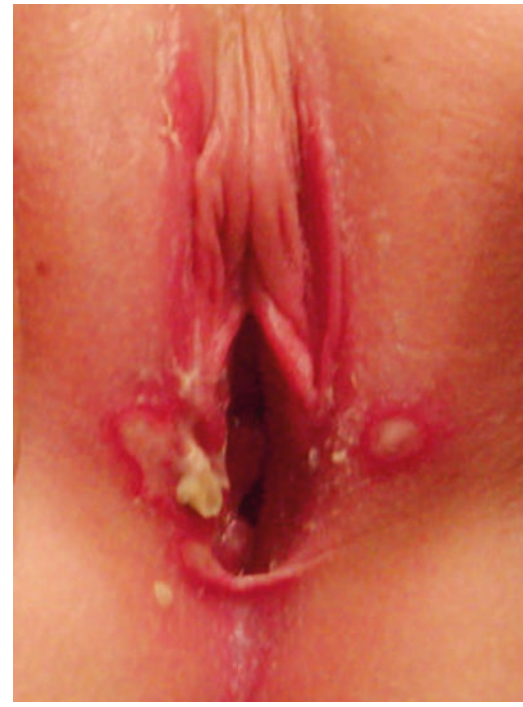
Examination findings consistent with trauma are as follows: bruising, petechiae, or abrasions of the hymen, acute hymenal laceration, vaginal laceration, or perianal laceration below the dermis. CSA should be considered in these findings without a witnessed injury/trauma. Other less-specific findings (i.e., erythema, dilation) need to be evaluated for medical causes.

ABP Content Specification

- Know the significance of specific findings on physical examination and evaluation of a sexually abused child.

Question 15

A 10-year-old girl presents with history of myalgias, a low-grade fever, vulvar pain, and dysuria, worsening during the last 4 days. Her primary care provider started her on antibiotics yesterday. There is no change in urine output. Vital signs are stable, but the child appears uncomfortable. On examination, her abdomen is soft and nontender. Her vulva has several exquisitely painful, circular, shallow ulcerations with an erythematous halo, and a yellow, fibrinous center. The skin and mucosa surrounding the ulcerations are erythematous, edematous, and friable (see image). There is no inguinal lymphadenopathy and no oral lesions are noted. There is no pallor or petechial rash. She reports no sexual activity, feels safe at home, and her mother has no concern for child sexual abuse (CSA).



What is the most likely cause of these findings?

A. Sexually transmitted herpes simplex virus type 2 anogenital ulcers
B. Idiopathic aphthous genital ulcers

C. Sexually transmitted herpes simplex virus type 1 anogenital ulcers
D. Vulvovaginal candidiasis from antibiotics
E. Urethritis from chlamydia

Correct Answer: B

Discussion

When HSV anogenital ulcers are found in a child, abuse must be considered. But there are other conditions that can cause these symptoms in preteens such as aphthous genital ulcers (AGU) from epstien barr virus (EBV), cytomegalovirus (CMV), varicella-zoster, nonspecific viral infections, or mycoplasma, contact or irritant dermatitis, impetigo, blister beetle bites, group A beta-hemolytic streptococci vulvitis, and Bechet syndrome and Lipschutz ulcer.

Aphthous genital ulcers (AGUs) are seen in preteens and adolescents often preceded by fever and myalgias followed by multiple shallow painful anogenital and occasionally oral ulcers that self-resolve. Approximately 70% of cases are idiopathic. It is a diagnosis of exclusion. Because HSV is the most common cause of genital ulcers, and concerning for CSA in a child, a PCR is helpful. Most children will benefit from further evaluation with a specialist and serial examination. Providers should have a low threshold to consult Child Protective Services if there is *any* concern for abuse or if HSV PCR is positive. Treat the patient with supportive care such as nonsteroidal anti-inflammatory drugs (NSAIDs) or topical lidocaine and perform serial examination for urinary retention.

Other conditions and normal variants can mimic CSA. Some of the more common mimics are described below:

- *Anal venous pooling*: Occurs when a child is supine. The anal opening may enlarge and become purple/blue. This resolves with change in position.
- *Generalized erythema, fissures, and inflammation of the vulva*: Erythema is common in young children and signifies irritation of the tissues due to moisture, bacteria, fungus, parasites, or other infections that are not transmitted sexually.
- *Lichen sclerosus et atrophicus*: A chronic inflammatory disease most commonly in the anogenital area. Symptoms include pruritus, soreness, and hypopigmentation in classic figure 8 pattern with fragile skin (can have petechiae, bruises, skin breakdown with minor trauma). This is not from CSA and is treated with topical steroids.
- *Urethral prolapse*: This occurs when a portion of the urethra extrudes out of the urethral meatus and typically forms a doughnut-shaped mass at the urethral meatus in young girls. It is associated with minor bleeding and can be mistaken for trauma.
- *Rectal prolapse*: This is a relatively common benign, self-limited condition of mucosal anal/rectal protrusion not typically associated with trauma.
- *Partial dilation of the external anal sphincter*: When the external anal sphincter opens; typically <3 cm, when supine, and often when there is stool in the rectal vault. There is no expert consensus on this, but it is thought to be a normal variant or worse with constipation.

Take-Home Message

There are many nonspecific genital findings and disorders that can mimic child sexual abuse. History, age, disclosures, and provider and parental concern may help determine evaluation of nonspecific findings.

ABP Content Specification

- Recognize the findings that may mimic sexual abuse of a child.

Question 16

A 7-year-old boy presents to the emergency department with his mother. At a local grocery store this morning the patient had to go to the bathroom. The mother had a full cart and a younger sibling, so a grocery employee offered to take the patient to the bathroom. Although the mother felt uncomfortable, she was too embarrassed to turn down the help and they were in the bathroom for about 5 minutes. After shopping, the child had repeated emotional outbursts and

during his evening bath disclosed to mom that the "grocery guy touched my pee pee and showed me his pee pee." He denies anal bleeding.

What is the best next step in evaluation?

A. Examine for external trauma as tolerated by the child and report the history and examination findings to law enforcement where the incidence occurred.
B. Ask the child "Did it hurt when the grocery guy put his penis in your bottom?"
C. Examine the child for anogenital trauma including anoscopy.
D. Stop any further evaluation and document findings in broad terms.
E. Collect DNA swabs from the penis and mouth and then call law enforcement for collection.

Correct Answer: A

Discussion

This child already has made a disclosure and the emergency department (ED) is not the best place for further forensic interviews. The medical provider should document the mother's history in unambiguous language and quotations when possible. A medical history should be taken, which includes pain, bleeding, or discharge. These questions should be asked to the patient in developmentally appropriate language. No leading questions should be asked and parents should be discouraged from further questioning.

The initial examination is to evaluate for trauma and medical emergencies such as bleeding that require immediate treatment. The ED provider should document the patient's general demeanor and any findings. Anoscopy is invasive and low yield without active anal bleeding or signs of trauma. Regional protocols determine who, when, where, and what evidence is collected. Law enforcement should be contacted immediately in the area where the incident occurred.

The forensic examination and evidence collection should be performed as soon as practically possible. The chain of evidence is important and should follow local protocols. It is possible that the provider will be subpoenaed to testify either as a fact witness or as an expert witness in court. Thorough documentation, collection per protocols, and timely evaluation will help the case in court. Because examination findings are frequently normal, court testimony often centers on explanation of the findings and the physical examination alone does not prove or disprove sexual abuse.

Take-Home Message

The ED provider should document sexual abuse disclosures using the patient's own words when possible, treat any emergent medical condition, report to local authorities, and follow local protocol for evidence collection.

ABP Content Specification

- Know the principles of forensic medicine in victims of sexual abuse (e.g., documentation, chain of evidence, court testimony).

Question 17

A 4-year-old previously healthy girl presents with bloody stools this evening. The mother's live-in boyfriend, who is the primary caregiver when the mother is at work, reports that she was playing outside and fell on a toy 3 days prior. The mother does not remember any trauma or bleeding when she bathed the patient the night before. On examination, she has an anal laceration at the 6 o'clock position that extends to the muscle, but you are unable to see where the laceration extends internally and there is also fecal incontinence. There are no other injuries. The child is shy and does not disclose any details.

Which of the following is the most appropriate next step in patient care?

A. Consult pediatric surgery for examination under anesthesia and possible repair, report to child protective services (CPS), and admit to the hospital.
B. Consult pediatric surgery for examination under anesthesia and possible repair, report to CPS, and discharge if cleared by pediatric surgery.
C. Consult pediatric surgery, ask the mother to bring in the shovel, if there is blood on the

shovel discharge when cleared by pediatric surgery.

D. Give a stool softener and oral pain medications. Report the incident to CPS.

E. Perform a digital rectal examination in the ED to determine the extent of the trauma and consult surgery as needed. Report the incident to CPS.

Correct Answer: A

Discussion

Anal lacerations are rare in children, but ambulatory children can sustain unintentional anogenital impalement injuries. The provider should determine whether the history is compatible with the examination findings, and may need to confirm the history with corroborating evidence from CPS. In this case the caregiver did not seek medical care acutely if the history is accurate, there is penetrating trauma, and the mother did not see trauma when she bathed the child the night before. This child deserves a sexual assault evaluation and CPS report to investigate the scene where the incident allegedly occurred. It is not the provider's job to investigate the scene or the family. Internal trauma may be more severe than initially apparent and surgical repair may be required. But further evaluation while conscious would likely be stressful to the child. Like a speculum examination of a prepubertal child, anoscopy with possible sigmoidoscopy should be done under sedation or anesthesia when necessary.

Admission may be warranted for further evaluation and medical care if there is concern for patient safety; such as exposure to the perpetrator or concern for commercial sexual exploitation of children or if there is severe mental or emotional trauma that necessitates inpatient stabilization.

Take-Home Message

If invasive but necessary examination is warranted, for example, speculum examination or anoscopy, it may need to be performed under sedation/anesthesia to reduce further trauma to the child. Patients should be admitted for severe injury requiring treatment or if there is concern for patient safety.

ABP Content Specification

- Know the indications for hospitalization of a sexually abused child and describe indications for examination of such a patient under anesthesia.

Question 18

A 7-year-old previously healthy girl is brought to the emergency department by the biological father after she disclosed that her mother's live-in boyfriend had been "touching my pee pee." He has been suspected of abuse in the past.

Of the following physical and laboratory findings, which is the *most concerning* for the diagnosis of sexual abuse?

A. A perianal wart

B. Herpetic lesion on her lower lip

C. Vulvar molluscum contagiosum

D. *Neisseria gonorrhoeae*

E. Anal dilation

Correct Answer: D

Discussion

A perianal wart or condyloma accuminata is suspicious for abuse in a child older than 5 years, but is not specific. A wart in addition to disclosure in an older child deserves sexually transmitted infection (STI) evaluation, referral to a specialist, and child protective services (CPS) referral. Oral herpes is very common and is not specific to abuse. Anogenital herpes type 1 or 2 confirmed by culture or PCR testing without other concerns for abuse is difficult to interpret and there is no expert consensus. Similar to condyloma accuminata in older children, HSV warrants a full evaluation. Molluscum contagiosum is commonly seen in non-abused children, and while it can be transmitted sexually, it is neither specific nor in itself concerning for sexual abuse. Anal dilation specificity is also highly contested as stool in the rectal vault, medications, and other confounders can cause dilation. Genital or rectal isolation of *Neisseria gonorrhoeae* or *Chlamydia trachomatis* is specific to

sexual contact without a clearly, reasonably, and independently documented source for nonsexual transmission.

Take-Home Message
Condyloma accuminata can be transmitted nonsexually especially in children younger than 5 years. Older children should be evaluated for sexual contact. Genital herpes type 1 and 2 can be transmitted nonsexually and are not specific to abuse but need evaluation for sexual contact.

ABP Content Specification
- Recognize and interpret relevant laboratory studies for the evaluation of victims of sexual abuse.

Question 19

A 15-year-old girl with a history of depression presents to the emergency department with her mother. The mother found concerning text messages on the patient's phone from a male, not known to her. The girl had secretly gone out of the house the night before and returned in the morning disheveled and tearful. The text messages expressed the girl had "wanted it…" and "don't tell anyone about last night." The child did not provide the mother any details.

When her mother steps out of the room, the patient discloses she met a man online and has been texting him. She met him last night in a local park and he turned out to be "old like my dad," but he gave her beer so she stayed. He took her into the bathroom and took off her pants. He "put it in me," but then she became tearful and was unable to explain further. She had some scant bright red blood in her underwear. Previously, she has had consensual sex with two other boys in her class.

Which of the following is *not* an appropriate next step in patient care?

A. Call local law enforcement to report a sexual assault.
B. Document the patient's disclosure using the patient's own words and the specific questions asked.
C. Examine the child for further injuries including an external genital examination for ongoing hemorrhage.
D. Collect evidence such as urine and clothing per local protocols.
E. Allow the patient to "clean up" with wipes prior to being examined.

Correct Answer: E

Discussion
The patient disclosed a clear history of sexual assault. Per local protocols, the provider should call law enforcement where the incident occurred. The emergency provider should clearly document the patient's disclosure using the patient's own words as much as possible. Before the sexual assault forensic examination, the child should be medically cleared by a thorough trauma evaluation and receive any needed emergency treatment. The child should not clean up until evidence is collected and local evidence collection protocols followed.

Regional protocols dictate timing and who does the forensic examination. Most regions authorize an acute examination if presentation is within 72–96 hours. Older adolescents have the right to consent or refuse evaluation for issues relating to their reproductive healthcare.

Take-Home Message
Providers should document the history in the patient's own words when possible, as well as genital and nongenital findings. Law enforcement involvement and evidence collection should be according to local protocols.

ABP Content Specification
- Plan the evaluation of a sexually assaulted child.

Question 20

A previously healthy 15-year-old girl presents to the emergency department approximately 12 hours after waking up from "passing out at a party." She remembers drinking a sweet drink given to her by some classmates and woke up outside of the house with her pants off, minor vaginal bleeding, and no memory of the event. Her friend said she went out-

side with several seniors and later the friend heard them laughing about "everyone having sex with the patient." On examination, she has normal vital signs and normal pupils, appears scared and exhausted, and has a normal neurological examination. She has debris all over her and an external vaginal examination shows multiple shallow abrasions and debris. The anal examination shows multiple shallow abrasions. There are no other injuries. Social work calls local law enforcement who interviewed the child, but after discussion with the patient, she refuses an evidentiary examination. The patient and parents want appropriate prophylaxis.

Which of the following is the most appropriate next step in management?

A. Offer ceftriaxone 250 mg IM (intramuscularly), azithromycin 1 g PO (by mouth), metronidazole 2 g PO, Plan B.
B. Refer her to a local gynecologist for the following day.
C. Refer to a local child abuse pediatrician, next available appointment.
D. Offer ceftriaxone 250 mg IM, azithromycin 1 g PO, metronidazole 2 g PO, emergency contraception, discuss risks and benefits of nonoccupational postexposure prophylaxis (nPEP) for HIV infection.
E. Offer ceftriaxone 1000 mg IM, azithromycin 1 g PO, emergency contraception, discuss risks and benefits of nPEP.

Correct Answer: D

Discussion

Emergency contraception and nonoccupational HIV postexposure prophylaxis (nPEP) is recommended within time limits as defined by state guidelines and varies from 36 to 120 hours. The history can be highly concerning for a drug-facilitated sexual assault, but often the teen, parents, and even law enforcement are wary to proceed with an investigation and/or collect evidence.

The Centers for Disease Control and Prevention (CDC) recommends empiric prophylactic antimicrobial therapy for *adolescent* sexual assault, survivors due to the rate of prevalent STIs and low follow-up rate. Empiric treatment for adolescents is ceftriaxone 250 mg IM, azithromycin 1 g orally, *plus* a single dose of metronidazole or tinidazole 2 g orally.

Baseline testing for HIV infection and hepatitis C is recommended and hepatitis B testing to verify immunity status should be obtained. A 28-day course of PEP for HIV infection should be offered within 72 hours of exposure to patients with *substantial risk*, ie. exposure of mucous membranes such as vagina, rectum, mouth, or nonintact skin contact with blood or semen. Receptive anal sex is the highest risk exposure.

Postpubertal children should be tested for pregnancy and, if negative, offered emergency contraception. It can be given up to 120 hours post assault.

Take-Home Message

Baseline testing for HIV/hepatitis B and C and pregnancy should be obtained and postexposure prophylaxis (HIV infection/STD/pregnancy) offered when applicable.

ABP Content Specification

- Plan the management of victims, of sexual assault including the indications for postexposure prophylaxis and emergency contraception.

Question 21

A 14-year-old girl with a history of bipolar disorder presents to the emergency department with her mother. The mother reports her daughter "snuck out of the house" the night before and the mother believes the child had sex. The child did not provide her mother any details. Her mother is here to "check if she is still a virgin."

Which of the following is the best next step in the evaluation?

A. Examine the child in the frog leg position.
B. Call law enforcement to interview her and authorize an acute sexual assault examination.
C. Refer her to the nearest specialist in child sexual assault.
D. Ask mother to step out of the room and interview the child.
E. Administer ceftriaxone 250 mg IM, azithromycin 1 g PO, metronidazole 2 g PO, and

emergency contraception, obtain urine gonorrhea and chlamydia NAATs, and obtain a urine pregnancy test.

Correct Answer: D

Discussion
Further evaluation will be guided by private interview with the patient—is there a disclosure of sexual contact, was it consensual involving a peer, or is there concern for nonconsensual sexual assault? The parent should be interviewed about concerns separately from the child to avoid leading the child. Create a comfortable environment by telling the child that it is a doctor's job to keep children healthy and it is OK to talk about difficult or uncomfortable topics with his or her doctor. Use open-ended questions/statements such as "Tell me why you are here today" or "Why do you think your mom is worried?" Adolescents have the right to consent or refuse evaluation for issues relating to their reproductive healthcare, and an examination to "check if she is still a virgin" is not appropriate.

Take-Home Message
Most children older than 12 years can be asked with nonleading questions about the events to clarify trauma, safety, exposure, and treatment needs.

ABP Content Specification
- Know the principles of interviewing victims of sexual abuse (e.g., avoiding repeated interviews, interviewing family and children separately).

Question 22

What is most common form of abuse reported to Child Protective Services?

A. Neglect
B. Physical abuse
C. Sexual abuse
D. Caregiver-fabricated illness
E. Emotional abuse

Correct Answer: A

Discussion
Neglect is the most commonly reported form of child abuse accounting for 75% of all reports. There are many parenteral, societal, and child risk factors for neglect. Some parent risk factors include poverty, substance abuse, unplanned pregnancy (especially among teens), a poor social support system, mental health issues, intellectual deficits, inappropriate expectations, and intimate partner violence. Child risk factors include chronic illness, behavioral and emotional problems, and developmental delay. Societal risk factors include isolation and a negative or dismissive view of children with poor resource allocation. It is important to note that while poverty is an established risk factor, most impoverished families are able to supply or get resources for the child's basic physical and emotional needs. One should report high-risk situations of interpersonal violence in which children are considered at risk of injuries.

Take-Home Message
Neglect is common and etiology is multifactorial. Key risk factors include poor support for parents, and substance abuse, chronic medical problems, child behavioral/emotional problems, and social isolation.

ABP Content Specification
- Know the factors that contribute to the neglect of children.

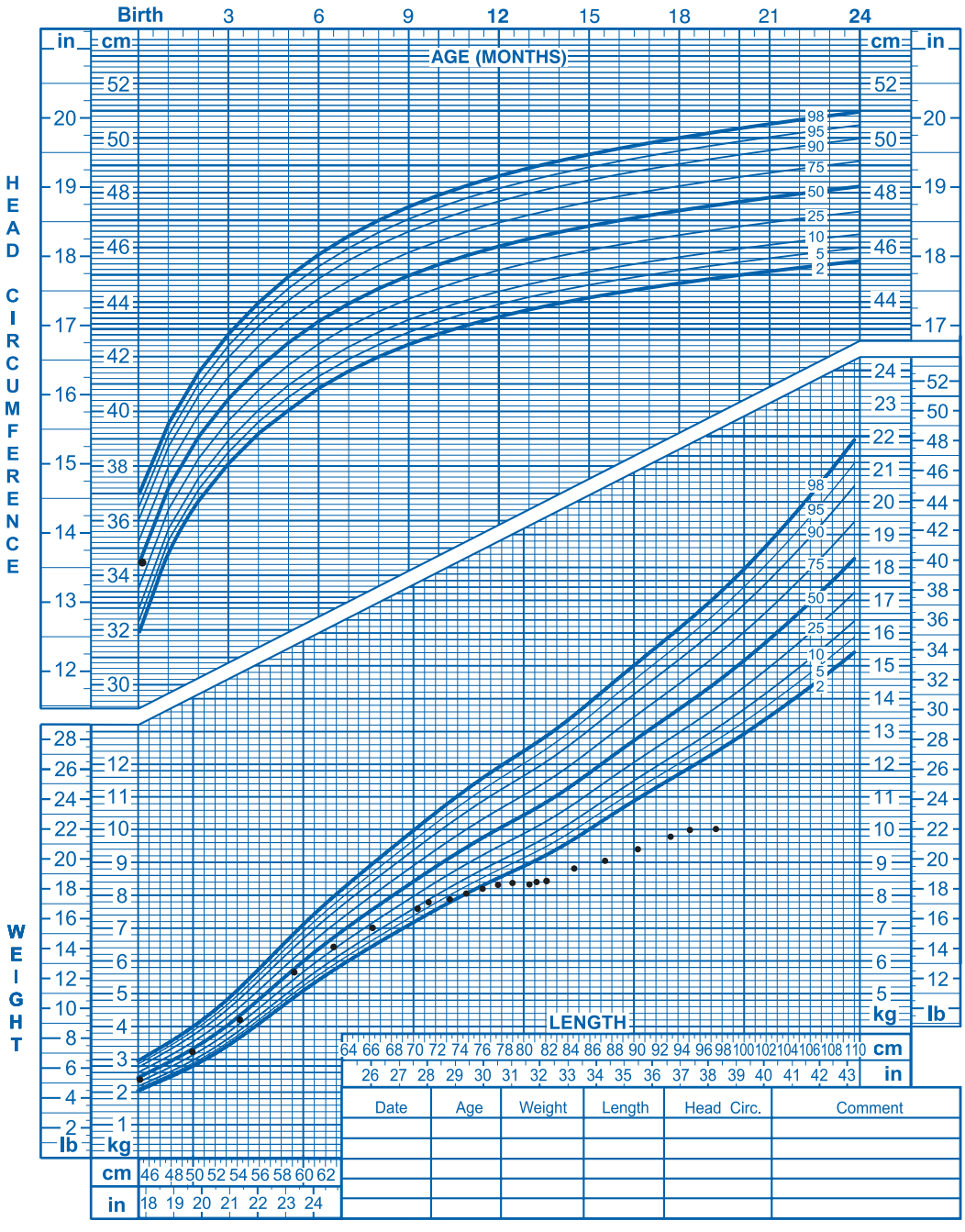
Question 23

A 20-month-old boy presents to the emergency department with chronic, nonbloody, diarrhea since 9 months of age, occasional nonbilious emesis, and poor appetite. He has had multiple negative stool cultures and ova and parasite stool antigen tests. Diet history revealed that he was breastfed for 2 months, and then formula fed until 12 months of age. He ate cereal at 4 months of age and was gradually introduced to table foods. The family moved here from China when he was 2 months old. The mother feels socially isolated and is depressed. Family history is unremarkable. The patient's pediatrician follows him closely and he has not missed any appointments (see growth chart question 23). He has a normal examination.

Birth to 24 months: Boys
Head circumference-for-age and Weight-for-length percentiles

NAME _____

RECORD # _____



Date	Age	Weight	Length	Head Circ.	Comment

Published by the Centers for Disease Control and Prevention, November 1, 2009
SOURCE: WHO Child Growth Standards (http://www.who.int/childgrowth/en)

Which of the following is most likely to confirm the diagnosis?

A. Obtain serum immunoglobulin A (IgA), anti-tissue transglutaminase (TTG)
B. Thyroid-stimulating hormone (TSH)
C. Admit to feed him in a protected environment
D. Obtain stool phenolphthalein
E. Place a purified protein derivative (PPD) skin test

Correct Answer: A

Discussion

Failure to thrive (FTT) is defined by the 2005 AAP clinical report as "significantly prolonged cessation of appropriate weight gain compared with recognized norms for age and gender after having achieved a stable pattern (e.g., weight-for-age decreasing across 2 major percentile channels from a previously established growth pattern; weight-for-length <80% of ideal weight)." FTT can be caused by organic or nonorganic factors or a combination of both. Nonorganic FTT is based on a thorough medical history, social history, and physical examination. Risk factors for FTT from neglect include parental stressors (depression, marital strife, divorce, history of child abuse, mental retardation, psychological abnormalities, young age, substance abuse, domestic violence, social isolation or poverty, inadequate adaptive/social skills, focus outside of home, and failure to adhere to medical regimens) low birth weight, or history of prolonged hospitalization. Children with medical causes for FTT can be victims of neglect as well, and many patients exhibit components of both organic and nonorganic FTT.

In this scenario the patient has a classic presentation of celiac disease: normal growth pattern until introduction of table foods (9–24 months old) that contain gluten (wheat, rye, and barley), weight plateau followed by height plateau, diarrhea, anorexia, and vomiting. Patients can also have abdominal pain, distention, constipation, dermatitis, anemia, or even be asymptomatic. North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) suggests screening for celiac disease with IgA and TTG.

The patient has objective gastrointestinal symptoms and close follow-up with the pediatrician and a responsive and concerned parent, so nonorganic FTT is less likely to be the primary diagnosis. This child does have risk factors (socially isolated parent and parental depression) for nonorganic failure to thrive and further home evaluation is warranted as part of evaluation. Admission may be argued for, in order to facilitate an immediate multidisciplinary evaluation. But feeding him in a protected environment will not help him gain weight or confirm the diagnosis.

Medical child abuse is when a caregiver fabricates or induces medical signs and symptoms. Laxative-induced diarrhea has been described and can be diagnosed endoscopically, or by the presence of medication derivatives in the stool such as stool phenolphthalein. This is possible in this child, but celiac disease is more common and explains the anorexia and vomiting as well. Hypothyroidism presents early and with other symptoms. Tuberculosis is common in China but less likely to present with the symptoms provided.

Take-Home Message

Nonorganic failure to thrive occurs when a child does not receive adequate calories due to psychosocial reasons such as neglect versus presence of a medical etiology. Neglect can occur concomitantly with medical causes of failure to thrive.

ABP Content Specification

- Recognize the signs and symptoms of nonorganic failure to thrive as a manifestation of neglect.

Question 24

A 7-year-old girl has several unexplained absences from school. A home visit by a school district social worker finds the 7-year-old unsu-

pervised in the home and caring for two younger siblings. The girl reports when her mother "goes out" she has to stay home to mind the other children. She does not know where her mother went or when she is expected to return home. There is little food. The children appear unharmed and is in no distress. They are placed in protective custody and brought to the ED for evaluation.

In the ED, the children are dirty, underweight, and hungry. Their examinations are otherwise normal with no evidence of bruising or injuries.

Which of the following statements are true?

A. The children are unharmed and although there was inadequate supervision, this picture amounts to neglect but does not amount to child abuse.
B. Neglect accounts for 10–20% of cases of child abuse in the emergency department.
C. Neglect accounts for approximately 30% of child abuse fatalities.
D. Once she is located, education of the mother and provision of food stamps will likely suffice in preventing future morbidity.
E. If the mother is found to be mentally ill and unable to care for the children, this will not be considered abuse.

Correct Answer: C

Discussion

Neglect is said to exist when a caregiver fails to provide for the basic needs of the child, including food, shelter, safety, and medical care. Neglect can be physical, medical, dental, lack of supervision, emotional, and educational, and can occur in combination (see Table 17.2). All forms interfere with normal childhood development and health and safety because a child's needs are not sufficiently met. It may not be as apparent on casual observation, as often a host of psychological, behavioral, and developmental issues are present. Neglect is by far the most common form of child abuse accounting for >75% of all cases and should be taken seriously. According to the US Department of Health and Human Services (USDHHA), neglect accounts for approximately 30% of child abuse fatalities. A 2015 study using the Nationwide Emergency Department Sample found that physical abuse was the most common explicit maltreatment diagnosis (33 ED visits per 100,000 children ≤3 years old) and neglect was the most common likely maltreatment diagnosis (436 ED visits per 100,000 children ≤3 years old). Mandated reporting laws apply to child neglect.

Table 17.2 Definitions of types of neglect

Types of neglect	Definition
Physical	Inadequate food, clothing, shelter, hygiene
Medical	Failure to provide prescribed medical care or treatment or failure to seek appropriate medical care in a timely manner
Dental	Failure to provide adequate dental care or treatment
Supervisional	Failure to provide age-appropriate supervision
Emotional	Failure to provide adequate nutrition or affection, failure to provide necessary psychological support, or allowing children to use drugs and/or alcohol
Educational	Failure to enroll a child in school or failure to provide adequate home schooling, failure to comply with recommended special education, allowing chronic truancy
Other	Includes exposing children to domestic violence, or engaging or encouraging children to participate in illegal activities such as shoplifting or drug dealing

The risk factors for neglect are chronic in nature and a single intervention is unlikely to prevent future episodes. Community-based programs aimed at prevention, early detection, and intervention aim to reduce ongoing harm to these at-risk children. They offer the best hope of keeping them safely within their family unit. At times, removal for short-term or long-term care may be the only safe option.

Take-Home Message

Types of neglect include physical, medical, dental, supervisional, emotional, educational, and exposing children to danger (illegal activities or domestic violence). Neglect is a component of one-third of fatal child abuse cases.

ABP Content Specification

- Recognize signs of neglect other than nonorganic failure to thrive.

Question 25

A previously healthy 5-month-old, unimmunized, male infant was seen in the ED for fever and fussiness. A lumbar puncture was performed, which shows CSF WBC 1450 per mm^3, protein 3 mg/dL, glucose 25 mg/dL, and Gram stain positive for gram-negative coccobacilli. You explain the need for immediate and continued antibiotics to the family who say they do not believe in antibiotics and want to take the child to the family's naturopathic doctor for treatment.

The best next step in management is:

A. Call security to escort the parents away from the baby due to medical neglect.
B. Call local child welfare to report medical neglect because immunization would have prevented this disease.
C. Discuss parental concerns about treatment and review risks and benefits of treatment, but since this constitutes medical neglect, child protective services will be involved and antibiotics should be administered.
D. Ask a colleague to talk the family into staying because you do not agree with parents withholding immunizations.
E. Hold off giving the antibiotics until you can get administrative consent.

Correct Answer: C

Discussion

Medical neglect is defined as failure to provide prescribed medical care or treatment or failure to seek appropriate medical care in a timely manner. There are many aspects that contribute to neglect and it is important to identify how best to make sure the child's needs are met and what is the potential for harm such as the likelihood and severity of harm. A problem with highly predictable and potentially severe outcomes is clearly medical neglect. Refusal of treatment for bacterial meningitis with severe and predictable outcomes constitutes medical neglect. Medical neglect and its consequences are often identified in the emergency department.

When addressing concerns for neglect with the family, it is important to discover the circumstances around possible neglect. The provider should try to maintain alliance with the family, be forthright with the family regarding the concerns and consequences of neglect, monitor the patient closely and report cases of moderate or severe neglect to child welfare. In this case it is important to start by having an open discussion with the family about their concerns for treatment, the risks and benefits of treatment, and likely consequences of withholding treatment. This is a complicated scenario for the medical provider, and when this scenario presents itself, it is best to have a multidisciplinary approach enlisting the help of the bedside nurse, social work, and security and risk management if needed.

Take-Home Message

Medical neglect is complicated. The first step is taking time to partner with the family and make sure the parent understands the risks and benefits of treatment. If that fails and there is likelihood for direct harm, use a multidisciplinary approach (social workers, CPS, law enforcement, hospital attorneys, and security) to protect the child.

ABP Content Specification

- Know principles of a general management plan for medical neglect in children.

Question 26

A 13-month-old previously healthy boy presents to the emergency department with multiple bruises and abrasions. On examination, there are 24 bruises on his shins, forearms, and forehead, several abrasions are on his elbows and knees, and he appears very thin. His weight is below 3rd percentile for age on the World Health Organization's growth chart, and his growth velocity has diminished since he was 4 months

old. He is voraciously eating the graham crackers you give him. Mom does not know how he obtained the injuries. She reports he has had a poor appetite since he was ill 6 weeks ago and has seen the pediatrician who drew labs, including a CBC and electrolytes, which were normal. She was told to feed him more calorie-rich foods but this is difficult since she works long hours and has to depend on extended family (total of eight different providers) to give him most of his meals. They have missed four appointments with the pediatrician.

Which of the following is the most appropriate next step in management?

A. Obtain a CBC, uric acid, lactate dehydrogenase, comprehensive metabolic panel, thyroid-stimulating hormone, prealbumin, urine organic acids and serum amino acids, INR, and PTT.
B. Call Child Protective Services (CPS) to report neglect and discharge to follow up with his pediatrician.
C. Admit for multidisciplinary evaluation of failure to thrive and notify CPS to evaluate for abuse.
D. Instruct mother to keep a diary of his intake and follow up with gastroenterology.
E. Perform a head CT scan, skeletal survey, and notify CPS.

Correct Answer: C

Discussion

While failure to thrive (FTT) is a chronic process, hospitalization has been shown to improve sustained catch-up physical growth among nonorganic FTT patients. The 2005 AAP clinical report on FTT suggests hospitalization of children with severe FTT and/or if abuse or neglect is suspected. The American Family Physician (AFP) update on FTT recommends hospitalization if the child is <70% of predicted weight for length, a child fails to improve with outpatient management, suspicion for abuse or neglect exists, signs of traumatic injury are present, or severe impairment of the caregiver is evident.

While the quantity of bruises is high, the locations are consistent with accidents. It is possible that he is not supervised rigorously with the quantity of injuries that are noted, but that is difficult to determine in the emergency department. With so many caregivers, missed appointments, prior normal labs, and weight loss even before the recent illness, nonorganic failure to thrive from neglect is likely. Children with neglect may eat well in the protected hospital environment and good weight gain in the hospital supports the diagnosis of FTT from neglect. Routine laboratory testing identifies an etiology in <1% of children and is not generally recommended. A more thorough history and evaluation by a multidisciplinary team may generate other differential diagnoses.

Take-Home Message

Admit children with severe FTT and/or if abuse or neglect is suspected.

ABP Content Specification

- Know the indications for hospitalizing a child who has failed to thrive.

Question 27

A 9-year-old boy with a history of a forearm fracture that was reduced and casted 4 weeks ago presents to the ED with arm pain under the cast for 3 days. The child reports getting the cast wet in the shower 4 days ago and that he told his parents. They are here today because the school said he needed attention due to the smell coming from the cast. The cast is removed and there is extensive skin breakdown and a foul odor fills the room. Review of the chart shows that the family was given instructions on cast care and an appointment 1 week after the reduction. The family members state that they were unable to make the appointment. He was also seen in the ED 1 week prior with similar complaints of a wet cast and was re-cast. The boy is otherwise healthy, up-to-date on vaccines, and has no other injuries or history of injuries.

Which of the following is the most appropriate next step in patient care?

A. Arrange another orthopedics appointment and impress upon the child and the family the need to keep the cast dry and the importance of follow-up using the teach-back method.
B. Tell the child that it is partly his responsibility to keep the cast dry and he is not to take any more showers.
C. Consult orthopedics and let them know about the history. Inform them that it is orthopedic responsibility to call CPS if the family does not make their next appointment.
D. Call CPS for medical neglect due to a delay in seeking care.
E. Consult the hospital's attorney regarding next appropriate legal steps.

Correct Answer: D

Discussion

This is a case of medical neglect and all nurses and physicians are mandated reporters of all forms of abuse including neglect. This scenario constitutes medical neglect because the harm is moderate to severe and predictable. An average reasonable person would have responded to the verbal child with 3 days of pain and the smell emanating from the cast.

It is important to talk with the family about barriers to seeking care such as transportation, their understanding of the severity of the problem, their understanding of discharge instructions, and any contributing cultural expectations/practices. If the diagnosis of medical neglect is made, the provider should follow local practices, but most states require the provider to report to child protective services (CPS) per local policies (telephone, online, faxed report, or combination of these) outlining the diagnosis, findings, and reasons for making the diagnosis. Most of the time the family should be made aware that a report has been made unless there is concern for the safety of the child. It is important to encourage the 9-year-old to take care of his cast, but these complications are not his responsibility. A hospital attorney is often a good resource for legal questions and always an option but there is no need to call for each child welfare report made.

Take-Home Message

When medical neglect is suspected, the provider should report to CPS according to the local policy. The provider should document/report the harm or potential harm to the child, and that the parent knew or a reasonable person would have known the child needed medical attention.

ABP Content Specification

- Know the physician's role in reporting cases of child neglect.

Question 28

A 15-year-old previously healthy girl presents to the emergency department with a frontal headache for 2 weeks. She is here with her mother because she is missing school because of the headaches. She did not receive any immunizations after 4 years of age. She has no fever, vomiting, neck stiffness, weakness, or vision changes. She does not wake up with the headaches and has not traveled. There is a family history of migraines. On examination, her vitals are normal, and she has a normal neurological examination, but she is very quiet and her mother answers all the questions for her. Her head is shaved roughly and she does not want to look in your eyes. She finally mentions that her stepfather made her shave her own hair because she went on a date with a girl from her class. She does not want to go back to school because she is embarrassed by her hair and does not want to see the girl. She begs you not to tell anyone and denies any physical or sexual abuse.

Which of the following is the most likely diagnosis?

A. Physical abuse because he made her cut her hair.
B. Sexual abuse because the reason the step father lashed out at her for dating someone else is he was jealous and is likely sexually abusing her.

C. Educational neglect because she has been missing school for 2 weeks.
D. Medical neglect because she is missing vaccinations.
E. Emotional abuse because the extreme acts by her caregivers that caused affective, and other behavioral problems.

Correct Answer: E

Discussion

Emotional abuse or psychological maltreatment is defined as acts or omissions, other than physical abuse or sexual abuse that caused or could have caused conduct, cognitive, affective, or other behavioral or mental disorders. It frequently occurs as verbal abuse or excessive demands on a child's performance. This is likely the most prevalent type of abuse since it accompanies the other forms of abuse, but is underreported. The negative psychological message is "you are bad" and/or "you are not valuable," and this has long-term health consequences. That said, emotional abuse is often overlooked, difficult to prove, and most of the time requires more information than available in the ED.

Children with emotional abuse can present to the ED with a myriad of symptoms from behavioral problems to medical problems that have no clear organic cause. Emotional abuse is often seen in children with substance abuse problems, runaway teens, and children used as a pawn between estranged parents.

Most reports of emotional abuse are reported along with other forms of abuse and in this scenario, it is very likely that there are other forms of maltreatment in the home that will be uncovered with investigation.

Take-Home Message

Emotional abuse is prevalent and should be considered when a child presents with psychosomatic symptoms, behavioral problems, substance abuse, running away from home, or in a divorce dispute.

ABP Content Specification

- Recognize the signs and symptoms of emotional abuse.

Question 29

A 9-month-old boy with a history of idiopathic epilepsy taking levetiracetam presents with another episode of apnea with cyanosis and loss of tone. Chart review reveals multiple admissions and extensive evaluation for similar symptoms, but the events have never been documented in the hospital. He has stable vital signs, is well appearing, and has no signs or symptoms of current illness. He is asymptomatic in the ED. His primary neurologist is not available, but the evaluating neurologist does not think this was a seizure; in fact, the neurologist questions whether he actually has epilepsy based on the prior admissions. You discuss with mother the extensive work-up, reassuring symptoms, and suggest observation at home with strict return precautions. Mother, previously very helpful, becomes upset and accuses you of malpractice. You leave the room and soon after central monitoring shows saturation of 75% with a good waveform. You return to the room and the patient is gasping for air and appears pale, but saturations rapidly increase to normal. You start oxygen and get more history. The mother is tearful and explains this is exactly what she is worried about.

Which of the following is the most appropriate intervention?

A. Document your findings and suspicion thoroughly and start video surveillance immediately to catch any further episodes.
B. Call Child Protective Services (CPS) and discharge him to follow up with CPS and his pediatrician the following day.
C. Document your findings and suspicion thoroughly and call the child's pediatrician to discuss concerns for caregiver-fabricated illness.
D. Document your findings and concerns thoroughly, contact the local child abuse pediatrician to discuss hospital surveillance, admit to an area of the hospital with central monitoring.
E. Confront the mother and then ask her to leave the hospital, but leave the baby for further evaluation of apparent life-threatening events.

Correct Answer: D

Discussion

This scenario is concerning for caregiver-fabricated illness defined as maltreatment that occurs when a child has received unnecessary and harmful or potentially harmful medical care because of the caregiver's fabricated claims or signs and symptoms induced by the caregiver. The scenario is escalating and this child is at increased risk of further abuse. At this point the child's safety is paramount and he needs admission for central monitoring, thorough documentation, a child abuse evaluation, and possible covert surveillance. Covert surveillance is complicated with many legal requirements and is not practical to start in the ED. It is not safe to discharge him to home with future follow-up even if social services have been contacted. Confrontation is unlikely to be helpful in the acute setting but the ED provider can ask open-ended nonaccusatory questions with thorough documentation. Legal authorities best conduct investigation and interviews.

Take-Home Message

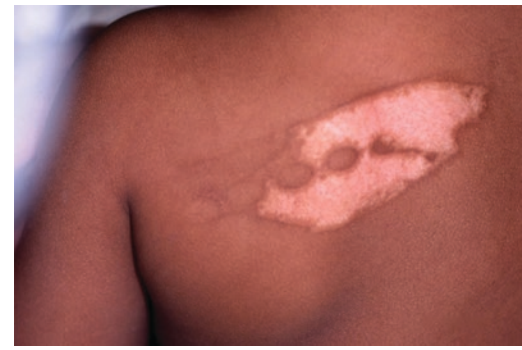
Emergency department priorities for caregiver-fabricated illness evaluation and treatment include patient safety, thorough documentation, and consulting a child abuse pediatrician.

ABP Content Specification

- Plan the management of Munchausen syndrome by proxy.

Question 30

This 4-year-old boy was having his T-shirt changed at a daycare center when a worker noted this finding on his back (image question 30) that was not present prior to the weekend break. To her knowledge, it was not there the week before when the child was last at the center. The child denies anyone "hurt him" and would not answer any other questions when asked what had happened. She called the mother who reported he "scraped himself when he fell against a wall" over the weekend. The worker was concerned and made a report to a local child abuse hotline.



Which of the following best describes this injury?

A. It is nonspecific in appearance and may be explained by the history of falling against a wall.
B. It appears almost healed now and is not infected and the mother should be advised to use topical bacitracin and follow up with her pediatrician.
C. Although the appearance of the injury is unusual, the child denies anyone hurt him so no additional intervention is needed.
D. The injury is a specific pattern injury, is not explained by the history provided, and warrants further investigation.
E. Refer to a dermatologist.

Correct Answer: D

Discussion

The image shows a healing pattern burn injury (image question 30). The injury pattern is suggestive of a clothing iron burn with tapered front and skin sparing from the circular vent holes.

It is not the role of a physician to directly investigate child abuse, but physicians play a key role in recognizing child abuse and working as part of a multidisciplinary team concerned with the care of a physically abused child. Pediatricians and pediatric emergency physicians should be familiar with common pattern injuries occurring

from household items such as clothing irons, curling irons, space heater grids, and loop-shaped contusions from electric cords and belts.

The inconsistency of the history from the mother in this case is a red flag and warrants reporting to local child protection agency and further evaluation for other potential injuries. All states have mandatory reporting laws and physicians are mandated reporters.

It is not unusual for children who are being abused to refuse to disclose what happened or may deny what happened. If the child cannot be safely discharged into the care of a reliable caregiver, admission is indicated.

Take-Home Message

Failure to seek medical care for the injury, which is already in the healing stages, is a red flag in this case. Failure of the explanation offered to explain the injury should further alert the physician to suspect nonaccidental injury. The physician should be aware that failure to disclose the details of the injury by a verbal child is not unusual, and should not change the provider's decision to consider child abuse and proceed accordingly.

ABP Content Specification

- Recognition of common pattern injuries seen in child abuse.

Suggested Reading

Question 1

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Question 9

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Question 10

Adams JA, Kellog ND, et al. Updated guidelines for the medical assessment and care of children who may have been sexually abused. J Pediatr Adolesc Gynecol. 2016;29(2):81–7.

Question 11

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Question 12

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Question 15

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ENT

18

David Zodda

Question 1

A concerned parent brings his 3-month-old son to the emergency department for a fever and runny nose that has been present for 2 days. The child has a temperature of 38.0 °C (100.4 °F). All other vital signs are within normal limits. Physical examination reveals an active child without any abnormal physical examination findings. What is the most appropriate next step?

A. Obtain CBC, chemistry, and urinalysis
B. Obtain CBC, chemistry, urinalysis, and lumbar puncture
C. Obtain chest x-ray
D. Provide nasal decongestants and recheck temperature
E. Provide oral hydration and antipyretics

Correct Answer: E. Provide oral hydration and antipyretics

Critique

Nasopharyngitis, or the common cold, is caused by a viral illness of the upper respiratory tract. Rhinovirus and corona virus are the most commonly isolated organisms; however, multiple viral etiologies exist. Mild conjunctivitis, coryza, fever, and pharyngitis may be present. Recommendations for therapy include rest, adequate hydration, and antipyretic agents. Antibiotics, antivirals, nasal decongestants, immunomodulatory therapy are not recommended treatments for nasopharyngitis. A septic workup is not indicated as the risk of serious bacterial infection is low among infants greater than 90 days old unlike infants 0–28 days (20%) and infants 29–56 days (9%). Decongestant and cough preparations should be avoided in young children due to the concerns of side effects. Many cough and cold products for children have more than one ingredient, and may increase the risk of accidental overdose if combined with another product.

Take-Home Message

Treatment of nasopharyngitis is supportive that includes rest, hydration, and antipyretic agents.

ABP Content Specification

- Plan the management of acute nasopharyngitis.

Question 2

A 5-year-old child presents to your emergency department complaining of sore throat. He has a low-grade fever, cough, and rhinorrhea. Physical examination demonstrates the pharyngeal erythema, tonsillar enlargement, oral ulcers and no

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_18

cervical lymphadenopathy. The next best step for this patient includes which of the following?

A. Antibiotics
B. Corticosteroids
C. Decongestants
D. NSAIDs
E. Rapid antigen detection test

Correct Answer: D. NSAIDs

Critique
Pharyngitis is a common infection in the pediatric population. The predominant etiology of acute pharyngitis is viral, approximately 80–90%. Patients often present with sore throat, cough, low-grade fever, and runny nose. This child likely has viral pharyngitis. Treatment with antibiotics should be reserved for those with clear group A streptococcal infections. This patient's presentation strongly suggests viral etiology (rhinorrhea, oral ulcers, cough, and no exudates) and thus does not warrant the use of antibiotics. Several studies have demonstrated the efficacy of corticosteroids for the treatment of moderate to severe pharyngitis. Steroids have been found to provide earlier onset of pain relief as well as shorter duration of symptoms. However, current Infectious Diseases Society of America (IDSA) guidelines do not advocate for their routine use in the treatment of acute pharyngitis. IDSA guidelines do recommend NSAIDs (strong, high recommendation) as an adjunctive therapy. Rapid antigen detection test should be reserved for patients presenting with clinical features that suggest bacterial group A streptococcal infection. These include high fever, exudates, and absence of cough.

Take-Home Message
Treatment of viral pharyngitis includes NSAIDs. Antibiotics should be reserved for those with clear clinical evidence of group A streptococcal infections.

ABP Content Specification
- Plan the management of acute pharyngitis.

Question 3

Which of the following clinical examination findings is most indicative of a bacterial cause of pharyngitis?

A. Abrupt Onset
B. Cough
C. Coryza
D. Conjunctivitis
E. Lymphadenopathy

Correct Answer: A. Abrupt Onset

Critique
Acute pharyngitis is most commonly caused by a virus such as adenovirus, influenza virus, and enteroviruses. Approximately 10–20% of pharyngitis is caused by group A β-hemolytic streptococcus (GABHS). Certain clinical features favor a bacterial cause. An abrupt onset is consistent with GABHS pharyngitis. The typical presentation is sore throat, fever, tonsillar exudates, tender anterior cervical adenopathy, and absence of cough (Centor criteria). It is rare in children <2 years of age and primarily affects children age 5–15 years old. It usually occurs in winter and early spring. Comparatively, cough, coryza, conjunctivitis, and hoarseness are associated with a viral etiology. Lymphadenopathy may be seen in both viral and bacterial pharyngitis. A severe sore throat with minimal physical findings on examination of oropharynx may suggest a serious soft tissue infection such as epiglottitis or retropharyngeal infection.

Rapid streptococcal tests (RSTs) have a reported specificity and sensitivity of up to 95%.

Antibiotics should be reserved for patients with a positive antigen test or culture, or those meeting clinical criteria for diagnosis. Penicillin remains the treatment of choice and is effective in reducing the rheumatic fever. For those with penicillin allergy clindamycin is preferred over macrolides.

Take-Home Message
An abrupt onset, fever, and tonsillar exudates favor a bacterial cause of acute pharyngitis.

ABP Content Specification
- Know the etiology of acute pharyngitis.

Question 4

A 4-year-old child presents to the emergency department with fever and pulling on his left ear. When you examine the tympanic membrane, you find it to be erythematous, bulging, and with purulent fluid behind it. What is the most common causative bacterial organism?

A. *Haemophilus influenzae*
B. *Moraxella catarrhalis*
C. Parainfluenza virus
D. *Staphylococcus aureus*
E. *Streptococcus pneumoniae*

Correct Answer: E. *Streptococcus pneumoniae*

Critique
Overall, viruses are responsible for a majority of acute otitis media in children. *Streptococcus pneumoniae* is the most common bacterial cause of acute otitis media for all ages. The other organisms include nontypeable *Haemophilus influenzae* and *Moraxella catarrhalis*. *S. aureus* and Gram-negative organisms are found commonly in neonates and very young infants who are hospitalized.

Take-Home Message
Streptococcus pneumoniae is the most common bacterial cause of acute otitis media for all ages.

ABP Content Specification
- Differentiate the etiology and pathophysiology of otitis media.

Question 5

A 3-year-old child presents to the emergency department complaining of 1 day of pain in her right ear. She is afebrile, well appearing, and acting appropriately. The pinna, lobule, and external auditory canal are normal. However, the tympanic membrane is erythematous and bulging and does not move when pneumatic otoscopy is utilized. What is the appropriate treatment?

A. Oral antibiotics and antihistamines
B. Broad-spectrum IV antibiotics and hospital admission
C. Oral and topical antibiotics and follow up with pediatrician
D. Oral antibiotics and follow up with pediatrician
E. Oral antibiotics only if the child does not improve with analgesics or is worse in 48 hours

Correct Answer: E. Oral antibiotics only if the child does not improve with analgesics or is worse in 48 hours

Critique
Acute otitis media (AOM) is the most common diagnosis associated with antibiotic prescriptions in children. Concern about increasing bacterial resistance has prompted this recommendation to withhold antimicrobial treatment in some cases unless symptoms persist for 2 or 3 days, or worsen. Watchful waiting or "wait-and-see" for 48 hours has been found to substantially reduce the unnecessary use of antibiotics in children with acute otitis media and may offer an alternative to the routine use of antimicrobials. Patients suspected of having acute otitis media are provided a prescription for oral antibiotics and encouraged to only fill the prescription if the child is not better or becomes worse within 48 hours. The decision to choose observation in lieu of antibiotics should be based upon the age of the patient (typically >2 years), severity of the illness, reliability of caregivers, and the ability for close follow-up. However, antibiotics continue to be recommended in the following:

- Children aged 6 months and younger
- Severe signs or symptoms, such as moderate or severe otalgia, or otalgia for at least 48 hours and fever of 102.2 °F or higher
- Ruptured tympanic membrane

Take-Home Message
Watchful waiting for 48 hours has been found to substantially reduce the unnecessary use of antibiotics in children with acute otitis media and may offer an alternative to the routine use of antimicrobials.

ABP Content Specification
- Recognize signs and symptoms and management of otitis media.

Question 6

A 16-year-old child presents with sore throat, muffled voice, and an inability to completely open his mouth. Examination reveals erythema and fullness of the posterior lateral left soft palate. The child is cooperative and appropriately protecting his airway. What is your initial approach for needle aspiration of the suspected abscess?

A. Anterior pole of the tonsil
B. Inferior pole of the tonsil
C. Lateral pole of the tonsil
D. Middle pole of the tonsil
E. Superior pole of the tonsil

Correct Answer: E. Superior pole of the tonsil

Critique
Peritonsillar abscess (PTA) is a deep oropharyngeal infection which is more common in teenagers. It commonly presents with sore throat, fever, trismus, muffled or hot potato voice, drooling, and odynophagia. Patients may report this as the worst sore throat of their life. Physical findings include limited opening of the mouth, erythematous tonsil which may appear full, asymmetry of the soft palate, tonsillar exudates, and contralateral deviation of the uvula. Peritonsillar cellulitis is an inflammatory reaction but without localized abscess formation. This often precedes formation of abscess.

Although most are polymicrobial, the predominant organisms include group A hemolytic streptococcus (*S. pyogenes*) S. aureus, and *H. influenzae*. Other organisms include anaerobes such as *Bacteroides*, and aerobes, including Gram-positive cocci and Gram-negative rods. Diagnosis is clinical and based upon history and physical examination findings. Intraoral or transcutaneous ultrasound scan of the neck will be helpful in establishing the diagnosis. Plain radiographs may not be able to identify a peritonsillar abscess.

A CT scan of the neck with IV contrast may be obtained if the diagnosis is not certain but it is not required in uncomplicated cases. Ultrasound may be helpful in verifying landmarks before aspiration.

Needle aspiration followed by antibiotics is the treatment of choice. Needle aspiration has been found to be superior to incision and drainage. Several studies have demonstrated that needle aspiration causes less trauma and pain than incision with an applicable cure rate. The technique involves using a long 18–20-gauge needle on a 10–20-mL syringe. A needle guard should be modified so that only 1 cm of the needle is exposed. After anesthetizing the area with topical lidocaine spray, the needle is advanced into the superior pole in a sagittal plane to avoid the carotid artery. If pus is not obtained at a 1-cm depth, deeper penetration is not recommended.

It is important to advance the needle in the sagittal plane only and not to angle to the side toward the carotid artery. One should not penetrate deeper than 1 cm and stay medial to avoid the more lateral-positioned carotid artery. Also, not to aspirate the tonsil itself because the abscess develops in the peritonsillar space surrounding the tonsil. If no pus is aspirated, the middle pole, followed by the inferior pole may be attempted. Beware that a negative aspirate does not exclude a PTA. Initial IV antibiotic therapy should include ampicillin/sulbactam or clindamycin. The recurrence rate is up to 10% after drainage. The potential complications include airway obstruction, extension to the retropharyngeal space, and spontaneous rupture and aspiration of pus.

Take-Home Message
The appropriate location for draining a PTA is to slowly advance the needle into the superior pole of the tonsil to avoid injury of the carotid artery.

ABP Content Specification

- Know the etiology pathophysiology, signs, symptoms, and management of peritonsillar abscesses.

Question 7

A previously healthy 7-year-old girl presents with painful and itchy left ear. She recently returned from a weeklong swimming camp. Inspection of the ear reveals pain with palpation of the pinna, purulent material adhering to an edematous external auditory canal, you cannot visualize the tympanic membrane. What is best treatment for this condition?

A. Acetic acid solution alone
B. Topical antibiotic and steroid drops
C. Oral antibiotics and topical antibiotic solution
D. Oral antibiotics and topical antibiotic suspension
E. Acetic acid solution and ear wick

Correct Answer: B. Topical antibiotic and steroid drops

Critique

Otitis externa, also known as swimmer's ear, is an infection of the external ear canal. The diagnosis is based on the clinical findings. The presentation includes pruritus, ear pain, and ear discharge. There may be foul-smelling discharge, and reduced hearing. Physical findings include tenderness over the tragus or pinna and diffuse ear canal edema or erythema. Beware that it can be very painful and adequate analgesia is required.

The common organisms are *Pseudomonas aeruginosa* and *Staphylococcus aureus* but can also be polymicrobial. Beware that *Pseudomonas* can be severely virulent in immunocompromised individuals, particularly those with diabetes or HIV infection.

Treatment includes removing the inflammatory debris and a topical antibiotic drop with or without steroid, although the addition of a steroid appears to increase cure rates. Traditionally, the combination of polymyxin B, neomycin, and hydrocortisone has been used. Topical fluoroquinolone drops, such as ofloxacin or ciprofloxacin, are preferred as they have a better safety profile than neomycin-containing drops. Also, neomycin should not be used if there is concern of tympanic membrane perforation. There is no evidence that systemic antibiotics alone or in combination with topical antibiotics improve outcomes but systemic medications may be indicated in immunocompromised patients. Beware that acidifying agents, such as 2% acetic acid drops should be avoided if there is a suspicion of tympanic membrane perforation, if the tympanic membrane cannot be visualized or if there are tympanostomy tubes. Acetic acid alone may be used for fungal otitis externa or in mild cases. Although ear wick is often placed by ENT, it may not be required in the ED. The wick usually falls out, or if left in place, may become a foreign body in the ear. If an ear wick is placed, follow-up should be arranged with a pediatrician within 48 hours for reevaluation and possible removal.

Take-Home Message

Treatment of acute otitis externa includes removing the inflammatory debris and topical antibiotics and steroid drops.

ABP Content Specification

- Plan the evaluation and management of acute otitis externa.

Question 8

A 12-year-old boy presents to the emergency department complaining of a frontal headache with associated mucopurulent discharge that has worsened over the course of 8 days. Examination reveals tenderness to the frontal sinuses and nasal discharge. Vital signs are normal except for a temperature of 38 °C (100.4 °F). What features make you suspect a bacterial as opposed to viral etiology?

A. Age of the patient
B. Progression of symptoms
C. Fever <39 °C (102.2 °F)
D. Frontal headache
E. Duration of his symptoms

Correct Answer: B. Progression of symptoms

Critique

Sinusitis is the inflammation of the paranasal sinuses (frontal, maxillary, ethmoid, and sphenoid). Sinusitis can be classified as acute (<4 weeks), subacute (4–12 weeks), or chronic (>12 weeks).

The diagnosis of sinusitis is clinical and is made when a child with an acute upper respiratory tract infection (URI) presents with:

1. Persistent illness (nasal discharge [of any quality] or daytime cough or both lasting more than 10 days without improvement).
2. A worsening course (worsening or new onset of nasal discharge, daytime cough, or fever after initial improvement).
3. Severe symptoms (concurrent fever [temperature ≥ 39 °C/102.2 °F] and purulent nasal discharge for at least 3 consecutive days is also suggestive of bacterial component.

Physicians should not obtain imaging studies to distinguish acute bacterial sinusitis from upper respiratory tract infection, because they do not contribute to the diagnosis. However, imaging studies may be obtained if orbital and intracranial complications are suspected. In such situations, contrast-enhanced computed tomography (CT) imaging of the orbits, sinuses, and brain should be performed.

Acute sinusitis signs and symptoms most often resolve without antibiotic treatment and can be treated with analgesics, antipyretics, and decongestants. Patients with a persistent illness (>10 days), worsening course, or with severe symptoms (described above) should be treated with antibiotics. First-line therapy is amoxicillin. Amoxicillin–clavulanic acid may be preferred. Beware that high rates of resistance among *Streptococcus pneumoniae* are reported with macrolides such as clarithromycin or azithromycin and trimethoprim-sulfamethoxazole.

Patients should be advised to return to their pediatrician if there is:

- Failure of symptoms to resolve after 3–5 days of antibiotic therapy
- Worsening of symptoms after 48–72 hours of antibiotics

Take-Home Message

Symptoms of acute bacterial sinusitis include persistent nasal discharge lasting more than 10 days without improvement, a worsening clinical course, and fever [temperature ≥ 39 °C/102.2 °F].

ABP Content Specification

- Differentiate the etiology and understand the pathophysiology of sinusitis.

Question 9

A 4-year-old child presents complaining of a sore throat, fever, and chills that have been developing over 1 week. Physical examination reveals, cervical lymphadenopathy, and pain with extension of the neck. The oral cavity and posterior pharynx are normal in appearance. What imaging could you obtain to better aid in your diagnosis?

A. Anteroposterior chest radiograph
B. Anteroposterior neck radiograph
C. Expiratory lateral neck radiograph, head in extension
D. Inspiratory lateral neck radiograph, head in extension
E. Inspiratory lateral neck radiograph, head in flexion

Correct Answer: D. Inspiratory lateral neck radiograph, head in extension

Critique

Retropharyngeal abscess (RPA) is an infection and subsequent inflammation of the space between the anterior border for the cervical vertebrae and the posterior wall of the epiglottis. It is predominately a disease of childhood with most occurs in children under 4 years. Usually after this age, the retropharyngeal nodes atrophy.

The retropharyngeal space communicates with the lateral pharyngeal space, which contains the carotid artery and jugular vein. A danger space is situated behind the retropharyngeal space, which extends from the base of the skull to the superior mediastinum at the level of T2. Once the retropharyngeal space is involved, the infection spreads rapidly and an abscess develops.

The predominant organisms are *Streptococcus pyogenes* (group A β-hemolytic streptococcus [GABHS]), *Staphylococcus aureus* (such as methicillin-resistant *S. aureus* [MRSA]), and anaerobes.

Children with retropharyngeal abscess are ill appearing. The clinical presentation of high fever, drooling, and stridor is similar to that of epiglottitis, with the exception that symptoms develop gradually in retropharyngeal abscess. These children often present with neck pain and/or refusal to extend the neck due to compression of the prevertebral space with this maneuver.

If the diagnosis of RPA is suspected and the airway is stable, the provider may choose to obtain an inspiratory lateral x-ray of the neck. A pathologic process is suggestive if the retropharyngeal space at C2 is greater than 7 mm and at C6 is greater than 14 mm in children. A lateral inspiratory view obtained when the neck held in normal extension may be helpful to avoid a false thickening of the retropharyngeal space. This is not a definitive study for the diagnosis of retropharyngeal abscess; computed tomography (CT) of the neck with intravenous contrast is the modality of choice for the diagnosis.

All children with suspected retropharyngeal infection should be hospitalized. The management plan should be developed in consultation with pediatric otolaryngologist.

Antibiotic coverage should include group A *Streptococcus*, *S. aureus*, and anaerobes. The initial antibiotics such as Ampicillin-sulbactam or clindamycin should be given. Surgical drainage should be considered if the following occurs:

- Airway compromise
- Large abscess ≥2.5 cm
- Failure to improve with parenteral antibiotic treatment

Take-Home Message

If the diagnosis of retropharyngeal abscess is suspected and the patient's airway is stable an inspiratory lateral x-ray of the neck with the head in extension may assist in diagnosis.

ABP Content Specification

- Recognize and interpret relevant imaging studies.

Question 10

A father brings his 6-month-old son to the emergency department for evaluation. He states that the child has not been eating and has become increasingly fussy. Inspection of the oral cavity reveals several small mucosal ulcers on the soft palate of 2–3 mm in size with a white center. The lesions do not involve the gingiva, tongue, or buccal mucosa. Several additional vesicles are found on the dorsal surface of the child's hands and lateral borders of the feet. What is the appropriate treatment?

A. Acyclovir
B. Amoxicillin
C. Ceftriaxone
D. Nystatin
E. Oral analgesics

Correct Answer: E. Oral analgesics

Critique

Hand, foot, and mouth disease (HFMD) is characterized by an oral enanthem and vesicular rash of the hands and feet. Two of the most common viral pathogens causing stomatitis in children are Coxsackievirus A16 and enterovirus A71. Usually the disease due to enterovirus 71 is more severe than Coxsackievirus A16 disease, with high risk of neurologic and cardiopulmonary involvement.

This primarily occurs in the spring and summer season. It is highly contagious and spreads by the oral-oral or fecal–oral route. In this, vesicles or red papules are found on the tongue, oral mucosa, hands, and feet. The lesions may resemble those caused by herpes simplex or varicella-zoster virus. Usually the associated fever, sore throat, and malaise are mild.

Treatment is symptomatic with topical analgesic medications such as 2% viscous xylocaine for children older than 2 years and analgesia. However, this should be avoided in young children. Thus, oral analgesics are the mainstay of treatment in younger children.

Take-Home Message

Management of acute stomatitis is mainly supportive care with analgesics for pain and fever,

fluid intake to ensure adequate hydration, and vigilance to recognize cardiac or neurological complications.

ABP Content Specification
- Plan the management of acute stomatitis.

Question 11

A 2-year-old child presents with a barky cough, fever, and coryza that have developed over the past week. What is the most common cause of this illness?

A. Adenovirus
B. H. influenza
C. Parainfluenza
D. S. aureus
E. S. pneumoniae

Correct Answer: C. Parainfluenza

Critique
Croup or laryngotracheitis is the most common cause of upper airway obstruction. It is characterized by inspiratory stridor, barking cough, and hoarseness. It causes inflammation in the larynx and subglottic airway.

It is most common in winter season and typically affects children ages 6 months to 6 years old. Parainfluenza is the most common cause. Other viruses that can cause croup are respiratory syncytial virus, adenoviruses, and human coronavirus. *H. influenza* is most commonly associated with epiglottitis. *S. aureus* is commonly found in bacterial tracheitis.

Croup is a clinical diagnosis, and radiograph is not required but may be considered in the following circumstances:

- Uncertain diagnosis
- Atypical course
- Suspected foreign body

A posteroanterior view may show subglottic narrowing or steeple sign. However, this may be absent in children with croup, may be present in children without croup as a normal variant. Beware that radiographs do not correlate well with disease severity. The severity of croup is often determined by clinical scoring systems such as the Westley croup score. This includes the following variables:

- Stridor at rest
- Degree of chest wall retractions
- Air entry
- Cyanosis
- Mental status

Croup is a disease of the upper airway, and alveolar gas exchange is usually normal. Usually, these children do not require hospitalization. However, one should consider admission in the following conditions:

- Severe respiratory distress
- Persistence of stridor at rest after aerosolized epinephrine and steroids
- Significant medical history such as prematurity and pulmonary or cardiac disease

Take-Home Message
Parainfluenza is the most common cause of croup (laryngotracheobronchitis).

ABP Content Specification
- Understand the etiology, signs, symptoms, and pathophysiology of croup.

Question 12

A 4-year-old boy presents to the emergency department complaining of cough, coryza, and a hoarse voice that have developed over the past several days. Physical examination reveals an alert child with inspiratory stridor and intercostal retractions. Vital signs reveal low-grade fever, tachypnea, and tachycardia. What is the mainstay of treatment for this disease process?

A. Antibiotics
B. Antivirals
C. Emergent intubation

D. Glucocorticoids
E. Racemic epinephrine

Correct Answer: D. Glucocorticoids

Critique
Glucocorticoids are the mainstay of treatment for croup. Several studies have demonstrated glucocorticoids ability to reduce the need for aerosolized epinephrine, intubation, and readmission to the emergency department. Dexamethasone 0.6 mg/kg (maximum 10 mg) is one of the several options for glucocorticoid use. Since it is equally effective both parenterally or orally, oral route is preferred.

Racemic epinephrine can be used in moderate to severe croup, patients with stridor at rest, and especially in those for whom admission is being considered. Epinephrine reduces airway edema via its vasoconstrictive alpha effects. It decreases need for intubation and disease severity.

Side effects of aerosolized epinephrine are rare, most commonly tachycardia, but there may be a risk of cardiac arrhythmias. Since the action of nebulized epinephrine is short-lived, these children should be observed for at least 2 hours after aerosolized epinephrine is administered. Repeated doses may be warranted for persisting severe croup but may require admission. Patients can only be discharged home if there is resolution of stridor and respiratory distress in the ED. Parental antibiotics are not indicated in croup as the etiology is predominantly viral.

Take-Home Message
Glucocorticoids are the mainstay of treatment for croup.

ABP Content Specification
- Plan management of acute croup.

Question 13

A mother brings her 5-year-old child into the emergency department and states that today he developed a severe sore throat and high fever. The child appears anxious and is drooling and leaning forward in a tripod position. Examination reveals stridor and intercostal retractions. What is the next best step?

A. Direct visualization of the pharynx
B. Lateral radiograph of the neck
C. Prepare for intubation
D. Glucocorticoids
E. Racemic epinephrine

Correct Answer: C. Prepare for intubation

Critique
Epiglottitis is a life-threatening condition. The clinical features of epiglottitis such as acute onset, stridor, drooling, high fever, and toxic appearance are usually sufficient to make the diagnosis without the need for further imaging or laboratory analysis. It involves supraglottic region and can lead to rapid airway obstruction.

The classic triad includes three Ds drooling, dysphagia, and distress. Stridor is primarily inspiratory, and a late finding and its presence may suggest near-complete airway obstruction. In this condition, the child may assume the tripod position, sitting upright and leaning forward with the chin up and mouth open while bracing on the arms.

Classic radiograph may show the thumb sign; however, it requires adequate hyperextension of the head and neck. This is referred to the lateral view of the swollen epiglottis resembling a lateral view of one's thumb. The radiographs alone should not be used to diagnose epiglottitis. One should not obtain radiograph if the clinical suspicion is high. In such situation, direct visualization of the airway under controlled circumstances should be performed. This may reveal a large, cherry red, swollen epiglottis. However, this should occur in controlled environment such as an operating room or intensive care unit. A skilled physician who has expertise in advanced airway management should be available at all times.

Take-Home Message
A patient with suspected epiglottitis and in respiratory distress requires a definitive airway and the preferred setting for intubation is the operating room.

ABP Content Specification

- Plan management of acute epiglottitis.

Question 14

Although both croup and epiglottitis can manifest with stridor in a febrile child, what clinical feature can be used to make the diagnosis of croup more likely than epiglottitis?

A. Cough
B. Drooling
C. Leukocytosis
D. Lymphadenopathy
E. Odynophagia

Correct Answer: A. Cough

Critique

Clinical features can be helpful in distinguishing between the diagnosis of croup and epiglottitis. Both disease processes may cause stridor and fever. A subglottic narrowing of the upper airway leads to the stridor present in croup. In the case of epiglottitis, stridor is the result of supraglottic narrowing. Patients with epiglottitis are more likely to present ill appearing and with an acute onset of symptoms, drooling, and respiratory distress. Patients presenting with croup more often present with cough and a more insidious onset. A recent study demonstrated that the additional presence of drooling had a high sensitivity and specificity for epiglottitis while coughing had a high sensitivity and high specificity for croup.

Take-Home Message

Patients with both croup and epiglottis present with stridor, but croup is characterized by barking cough whereas patients with epiglottitis are toxic appearing, have drooling and have rapidly progressive respiratory distress.

ABP Content Specification

- Recognize the signs and symptoms for croup and epiglottitis.

Question 15

A 4-year-old child presents to your emergency department in obvious distress. He was diagnosed with viral croup 5 days ago. Since that time, he has developed a worsening fever and a brassy cough. Examination reveals a toxic appearing child with both inspiratory and expiratory stridor. What organism is most likely the cause of this patient's condition?

A. Group A streptococcus
B. Parainfluenza virus
C. *Mycoplasma pneumoniae*
D. *Staphylococcus aureus*
E. *Streptococcus pneumoniae*

Correct Answer: D. *Staphylococcus aureus*

Critique

Bacterial tracheitis is a rare but serious cause of stridor and airway obstruction in children. The typical presentation is a toxic child with high fever and rapidly worsening stridor that fails to improve with racemic epinephrine and glucocorticoids. Since the clinical presentation of bacterial tracheitis is nearly indistinguishable from that of severe croup, one should suspect bacterial tracheitis when URI symptoms progress to acute toxicity, respiratory distress, and stridor.

S. aureus is the organism primarily responsible for this disease. *Moraxella catarrhalis* infection is also prevalent and may potentially be more severe. Bacteria invade the tracheal epithelium producing inflammation and thick mucopurulent secretions. Patients presenting with symptoms suggestive of bacterial tracheitis require immediate airway assessment, supplemental oxygen, fluid resuscitation, broad-spectrum antibiotics, and hospital admission. Currently bacterial tracheitis might be more common than epiglottitis likely due to the impact of vaccination against *Haemophilus influenzae*.

Initial antibiotic coverage should include an anti-staphylococcal agent such as vancomycin or clindamycin plus a third-generation cephalosporin such as cefotaxime, or ceftriaxone.

Although neck radiographs are not needed to establish the diagnosis but when obtained it may show subglottic narrowing of the trachea and irregular tracheal margins. Bronchoscopy is both diagnostic and therapeutic. It allows visualization of the supraglottic structures and larynx, exclusion of other disease, suctioning of tracheal secretions and debris, and establishment of an airway.

Take-Home Message
Staphylococcus aureus is the most common cause of bacterial tracheitis, a rare but serious condition often presenting with fever, stridor, and airway obstruction in children.

ABP Content Specification
- Understand the etiology and pathophysiology of tracheitis.

Question 16

A father is concerned that his 3-year-old child may have swallowed a watch battery. An anteroposterior chest radiograph reveals a circular halo-like structure seen midway between the mouth and diaphragm. The child is well appearing, able to speak in full sentences, and showing no signs of respiratory distress. What is the next best step?

A. Attempt removal with forceps
B. Emergent bronchoscopy
C. Emergent endoscopy
D. Oral fluid challenge
E. Provide reassurance and follow up in 24 hours for repeat radiograph

Correct Answer: C. Emergency endoscopy

Critique
Foreign bodies may lodge in both the trachea and esophagus. In the esophagus, it occurs in areas of physiologic narrowing, such as at the level of the cricopharyngeus muscle, followed by the lower esophageal sphincter and the level of the aortic arch.

Button batteries can be differentiated from the coin by the presence of a bilaminar structure, making them appear as a double ring or halo on plain radiographs.

Radiographic imaging may be helpful in determining the location of radio-opaque foreign bodies, such as coins or metal objects. On an anteroposterior chest radiograph, a coin or button battery present in the esophagus appear as a round structure in the coronal plane. This circular structure is actually a battery since it has a double rim or halo. If the object has not passed into the stomach, as is the case with this patient, emergent endoscopy should be obtained for prompt removal as batteries can corrode adjacent tissues in as little as 2 hours. The battery causes damage by pressure necrosis, leakage of alkaline contents, and the generation of an electrical current. The flow of electric current causes hydrolysis and hydroxide buildup and subsequently local corrosive injury. Beware that discharged batteries may have enough voltage and storage capability to generate an external current.

Batteries lodged in the airway or esophagus require expeditious removal. However, Gastric or intestinal batteries may be treated with watchful waiting. Use of forceps and balloon catheters should be avoided as they can further impact the foreign body or potentially cause aspiration. The use of glucagon to facilitate esophageal motility may not be appropriate for a battery.

Take-Home Message
On an anteroposterior chest radiograph, a coin or button battery present in the esophagus will appear as a round structure in the coronal plane.

ABP Content Specification
- Know the indications and contraindications for acute upper airway foreign body removal.

Question 17

While performing a physical examination on a child you notice an object lodged in the patient's external auditory canal. The tympanic membrane

can be visualized and appears intact. Which of the following objects represent a contraindication to removal with irrigation?

A. Eraser
B. Marble
C. Metal ball
D. Plastic bead
E. Sponge

Correct Answer: E. Sponge

Critique

Foreign bodies in the external auditory canal are common in young children and should be removed as soon as safely possible. Many objects can be removed by gentle irrigation of the canal with room-temperature water or saline. The stream of water should be directed toward the side of the foreign body so that it accumulates behind it, therefore moving it out toward the external meatus. Materials such as food or sponges may expand when exposed to water and therefore irrigation should not be employed.

The patient may report feeling motion or hearing buzzing in the ear if the foreign body is an insect. A small amount of lidocaine or mineral oil instilled into the ear may be helpful in anesthetizing or immobilizing most insects. Disk batteries may corrode adjacent tissues and should generally not be removed via irrigation.

In order to have an adequate view, grasp the pinna of the ear and retract it in a posterosuperior direction to straighten the canal. A complete visualization of TM is required before irrigation. Irrigation should not be performed unless the TM is completely visualized and free of perforation. Document if the tympanic membrane has been ruptured by the foreign object or by prior removal attempts. Irrigation should not be attempted if the tympanic membrane perforation is suspected or if tympanostomy tubes are present. A complete examination of the canal should be performed to ensure the lack of retained material and to evaluate ear anatomy

Take-Home Message

Absorbent materials in the auditory canal such as food or sponges may expand when exposed to water and therefore irrigation should not be employed.

ABP Content Specification

- Foreign body removal from the external auditory canal: Know the indications and contraindications for foreign body removal.

Question 18

A 10-year-old presents to the emergency department after falling off his bike and striking his face on the pavement. He has mild bleeding coming from the left nostril that is controlled after 15 minutes of direct pressure. Upon closer inspection of the nasal passage, you identify a bluish discolored bulging adjacent to the nasal septum. What is the correct technique to manage this clinical finding?

A. Bilateral nasal packing and ENT follow-up
B. Chemical cautery and bilateral nasal packing
C. Horizontal incision, drainage, and nasal packing
D. Needle aspiration, drainage, and nasal packing
E. Vertical incision, drainage, and nasal packing

Correct Answer: C. Horizontal incision, drainage, and nasal packing

Critique

Trauma to the anterior part of the nasal septum may result in a hematoma formation. In this blood accumulates between the mucoperichondrium and the septal cartilage. Since vascular supply to the septal cartilage is provided through the perichondrium, septal hematoma potentially disrupts blood supply to the cartilage. This blood accumulation also serves as a medium for bacterial growth and the formation of an abscess. Common organisms include *S. aureus*, *Streptococcus pneumoniae*, and group A β-hemolytic streptococci.

They appear as a bulging or cherrylike swelling of the nasal septum on one or both sides of the nasal cavity. The presence of septal asymmetry with a bluish or reddish hue of the mucosa may suggest a septal hematoma. Since newly formed hematomas may not be ecchymotic, these may be missed on inspection, and direct palpation is required. Palpate the entire septum for swelling, fluctuance, or widening of the septal space.

Since no alternative blood supply is available, immediate drainage of the hematoma to restore blood flow from the perichondrium is necessary. This is best accomplished with a horizontal incision through the nasal mucosa and perichondrium covering the hematoma. Many perform L-shaped incision in the most inferior and dependent portion of the hematoma. This incision should be superficial through the mucosa, making sure not to incise the cartilaginous septum. This should be performed in consultation with otolaryngology service.

The nasal cavity should be packed to prevent reaccumulation of the hematoma, a broad-spectrum antibiotic should be provided, and the septum should be reevaluated in 24 hours with the ENT service. The most common complication is septal abscess. The other complications are due to spread and include meningitis, cavernous sinus thrombosis, intracranial abscess, and orbital cellulitis. Avascular necrosis of the septal cartilage may occur due to a large or rapidly expanding hematoma.

Needle aspiration may not be adequate and is less efficient in evacuating a nasal septal hematoma. There is a high risk of reaccumulation of blood in the septum.

Take-Home Message

Draining a septal hematoma is best accomplished with a horizontal incision through the nasal mucosa and perichondrium covering the hematoma.

ABP Content Specification

- Nasal septal hematoma: Know the indications and contraindications for drainage and packing of a nasal septal hematoma.

Question 19

A 12-year-old child presents with a laceration involving her upper lip. The laceration requires repair. What is the preferred nerve block for providing anesthesia to this region of the face?

A. Infraorbital nerve
B. Inferior alveolar nerve
C. Mental nerve
D. Supraorbital nerve
E. Superior alveolar nerve

Correct Answer: A. Infraorbital nerve

Critique

Regional nerve blocks of the face can be used to aid in repairing facial lacerations. It can provide anesthesia of a larger area with less discomfort and fewer needle sticks.

The *infraorbital nerve* exits the infraorbital foramen at a point that is medial of the mid-pupillary line and 6–10 mm below the inferior orbital rim. The infraorbital nerve block can be accomplished via an extraoral or an intraoral approach. Anesthetizing this nerve provides anesthesia to the lateral nose, upper lip, upper teeth, lower eyelid, most of medial cheek.

The inferior alveolar nerve block provides anesthesia to the ipsilateral mandibular teeth, lower lip, and chin. The *mental nerve* is a continuation of the inferior alveolar nerve with similar anesthetizing properties. It exits the mental foramen approximately 2 cm inferior to the alveolar ridge below the second premolar. This anesthetizes lower lip and chin. The mental foramen is located near the mid-point of a line from the oral commissure and the mandibular border.

The *superior alveolar nerve* has three branches, anterior, middle, and posterior.

- The anterior superior alveolar nerve supplies sensation to the ipsilateral central and lateral incisors, as well as the canine tooth and half the upper lip.
- The middle superior alveolar nerve provides sensation to the ipsilateral premolars and sometimes the first maxillary molars.

- The posterior superior alveolar nerve provides sensation to the ipsilateral maxillary molars.

The supraorbital nerve exits the supraorbital notch along the supraorbital rim. It supplies sensation to the forehead with the supratrochlear and infratrochlear nerves.

Also, remember not to exceed the maximum dose of the agent. The maximum dose of lidocaine is 4.5 mg/kg/dose (maximum dose 300 mg) and lidocaine with epinephrine 7 mg/kg/dose (maximum dose 500 mg).

Take-Home Message
- Supraorbital nerve = forehead
- Mental nerve = lower lip and chin
- Infraorbital nerve = upper lip, upper teeth, and lower eyelid

ABP Content Specification
- Regional local anesthesia of the head and neck.

Question 20

A 4-year-old child presents to your emergency department in severe respiratory distress. You make the decision to intubate the child via direct laryngoscopy. What size cuffed endotracheal tube should you use?

A. 2 mm
B. 3 mm
C. 4 mm
D. 5 mm
E. 6 mm

Correct Answer: C. 4 mm

Critique
The American Heart Association and the Pediatric Advanced Life Support course have endorsed the use of cuffed endotracheal tubes in children with the advent of high-volume, low-pressure cuffed endotracheal tubes.

Endotracheal tube size estimation in children is based on the age of the child.

The formula for cuffed tube is as follows:

$$\text{Cuffed tube} = \text{Diameter in mm} = \left(\left(\text{age in years}\right)/4\right)+3$$

A cuffed tube is preferred in children with decreased lung compliance and in those who may require prolonged mechanical ventilation. If an un-cuffed tube is to be used, you can add 0.5 to the above formula to adjust the diameter size. The internal diameter of the endotracheal tube for a child will roughly equal the size of that child's little finger, but this estimation is unreliable and should not be employed. A cuffed tube is not recommended for neonates. Beware that cuff inflation pressure should not exceed 20–25 cm H_2O.

The formula for uncuffed tube is as follows:

$$\text{Uncuffed tube : diameter in mm} = \left(\left(\text{age in years}\right)/4\right)+4$$

$$\text{Cuffed tube : diameter in mm} = \left(\left(\text{age in years}\right)/4\right)+3$$

Take-Home Message
Cuffed endotracheal tubes are preferred in children. The formula for estimating ETT size is diameter in mm = (age in years)/4) + 3

ABP Content Specification
- Direct and indirect diagnostic laryngoscopic procedures.

Question 21

You have successfully intubated an 8-year-old child with a cuffed endotracheal tube. What is the approximate proper depth of tube placement?

A. 10 cm
B. 12 cm
C. 15 cm
D. 18 cm
E. 20 cm

Correct Answer: C. 15 cm

Critique

The following formula can be used to estimate the proper depth of the endotracheal tube in children prior to radiographic confirmation. This is a two-step process. The first is used to determine the tube diameter. The second uses that value to estimate the tube depth.

Step 1

- **The internal diameter of the cuffed tube (mm) = (age/4) + 3**
- Internal diameter = (8/4) + 3
- Internal diameter = (2) + 3
- Internal diameter = 5 mm

Step 2

- **Pediatric endotracheal tube depth (cm) = (internal diameter of the tube) × 3**
- Pediatric endotracheal tube depth (cm) = (5) × 3
- Pediatric endotracheal tube depth (cm) = 15 cm

Keep in mind that the length represents the distance from the tube tip to the upper teeth incisors in children.

Take-Home Message

Pediatric endotracheal tube depth (cm) = internal diameter of the tube × 3

ABP Content Specification

- Direct and indirect diagnostic laryngoscopic procedures.

Question 22

A 5-year-old child presents with a nose bleed. The mother states that he is a constant nose picker and that their home has forced-air heat making the air in their apartment very dry. All of the following techniques for epistaxis management are appropriate with the *exception* of:

A. Direct pressure
B. Cautery
C. Oral nasal decongestant
D. Nasal packing
E. Topical nasal decongestant

Correct Answer: C. Oral nasal decongestant

Critique

The most common cause of epistaxis in children is digital trauma such as nose picking. The usual age is 2–10 years. The common site is the mucocutaneous junction on the septum. The anterior bleeding most commonly originates from Kiesselbach plexus, a venous vascular plexus on the anterior nasal septum.

Epistaxis in children can be managed in a similar fashion to the way it is managed in adults with a few exceptions. Direct pressure for 10–15 minutes is often the simplest and most effective way of controlling hemorrhage. The child should be sitting up with his or her head slightly forward. Cautery may be employed. However, it should be noted that cautery will not work on an actively bleeding source. A topical decongestant (vasoconstrictor) like neosynephrine or epinephrine may be used to control the bleeding. Packing may be used to tamponade the bleeding. However, packing poses the risk of toxic shock syndrome and necessitates careful patient follow-up. In dry environments placing petroleum jelly or Vaseline over the nasal mucosa helps prevent erosion and bleeding. Oral decongestants do are not recommended in children due to the side effects, and do not play a role in the acute management of epistaxis. Beware that up to 5–10% of children with recurrent nosebleeds may have von Willebrand disease.

Take-Home Message

Oral decongestants should not be used in children younger than 6 years of age due to their potential side effects.

ABP Content Specification

- Know the indications and contraindications for the management of epistaxis.

Question 23

A mother brings her 2-year-old child into the emergency department. She is concerned that her daughter may have put a plastic bead up her nose. The child is pleasant and exhibiting no signs of respiratory distress. You visualize a small plastic bead present in the middle third of the nose. All of the following techniques for removal are appropriate with the *exception* of:

A. Alligator forceps
B. Balloon catheter
C. Blowing air into the child's mouth
D. Plastic curette
E. Irrigation

Correct Answer: E. Irrigation

Critique
Nasal foreign bodies are a common presentation in children. It is not unusual for young children to put beads, paper, pieces of sponge, plastic toys, eraser, or other foreign objects into their nares. This should be considered in a young child if there is a unilateral nasal discharge and/or a foul smell. It is the most common cause of unilateral foul-smelling nasal discharge in children.

Several techniques can be employed to remove these items. Forceps, balloon catheters, and mouth-to-mouth air blowing, also known as a "mother's kiss" can be employed. In older and cooperative patients, "blow the nose" while blocking the opposite nostril is effective.

Irrigation is a good technique for removal of aural foreign bodies, but should be avoided for nasal foreign bodies due to risk of aspiration.

Possible concern during an attempted removal of a deeply situated foreign body is dislodgement into the nasopharynx and aspiration. Consider ENT consultation if the objects are located more posteriorly or could not be removed in the ED. Button batteries may cause liquefaction necrosis of surrounding tissue which may result in nasal septal perforation; therefore urgent consultation should be obtained.

Take-Home Message
Unilateral foul-smelling nasal discharge is strongly suggestive of nasal foreign body and should be carefully removed to avoid aspiration into the lungs.

ABP Content Specification
- Removal techniques and potential complications.

Question 24

A 2-year-old child presents with a chief complaint of right ear pain. A thorough history and physical examination is preformed that includes otoscopy. What is the most reliable clinical sign of acute otitis media?

A. Concave tympanic membrane
B. Convex tympanic membrane
C. Erythematous tympanic membrane
D. Loss of mobility of tympanic membrane on pneumatic otoscopy
E. Retracted and opaque tympanic membrane

Correct Answer: D. Loss of mobility of tympanic membrane on pneumatic otoscopy

Critique
Acute otitis media is primarily a disease of children. Young children are susceptible because

- the eustachian tubes are not angled downward and do not drain well
- relatively small tube size
- higher frequency of URI

The three criteria have been stipulated from the AAP guidelines

- Acute, abrupt onset of signs and symptoms such as otalgia, otorrhea, irritability, and fever
- Evidence of middle ear fluid such as bulging tympanic membrane (TM), an air-fluid level or air bubbles behind the TM, otorrhea, or limited TM mobility on tympanometry, pneumatic otoscopy, or acoustic reflectometry
- Signs or symptoms of inflammation in the ME, such as distinct erythema of the TM

Otoscopic examination is important for the diagnosis of otitis media. A bulging, nonmobile tympanic membrane on pneumatic otoscopy is characteristic for acute otitis media. Beware that crying and/or fever can both result in an erythematous TM and are therefore unreliable. A retracted and opaque tympanic membrane may represent an effusion.

Take-Home Message
A tympanic membrane with impaired mobility is diagnostic for acute otitis media.

ABP Content Specification
- Know the anatomy and pathophysiology relevant to otoscopic examination.

Question 25

A 7-year-old child is bitten by a dog and sustains a 1-cm laceration to the superior aspect of his right pinna. The wound includes the skin as well as the cartilage. After properly anesthetizing the area, what is the preferred method of closure for this laceration?

A. Approximate and suture skin only carefully avoiding manipulation of the cartilage
B. Approximate wound without sutures and employ a compressive dressing
C. Approximate cartilage and skin together at the same time with sutures
D. Approximate cartilage with sutures first, then approximate and suture skin
E. Animal bites to the face should be left to heal via secondary intention

Correct Answer: D. Approximate cartilage with sutures first, then approximate and suture skin.

Critique
The primary goals are coverage of exposed cartilage and prevention of wound hematoma. Ear laceration repair is accomplished by first approximating the exposed cartilage and suturing with 4-0 or 5-0 absorbable sutures. The anterior and posterior perichondrium should be included in the sutures. Next, the posterior skin surface should be approximated using 5-0 or 6-0 nonabsorbable sutures. Cartilage is an avascular tissue and receives nutrients via the skin. Therefore, all exposed cartilage should be covered. Finally, all ear lacerations should be enclosed with a compression dressing to prevent hematoma formation. Many recommend antibiotic prophylaxis including *Pseudomonas*. Beware that ear injuries are rare in children under 1 year of age and one should consider evaluation for nonaccidental trauma.

Take-Home Message
When suturing a laceration of the ear that involves the ear cartilage, approximate cartilage with sutures first, then approximate and suture skin.

ABP Content Specification
- Plan the key steps and know the potential pitfalls in performing external ear procedures.

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Pediatric Ophthalmology

19

Adetunbi T. Ayeni and Lucia J. Santiago

Question 1

An 18-year-old male presents to the emergency department complaining of right eye pain and redness. He thinks he might have gotten a piece of metal stuck in his eye while hammering metal. He felt a sharp pain and it has been difficult to open his right eye. In the ED, his vital signs are stable. On examination, you note an injected conjunctiva and epiphora. His pupil is round and there is no apparent hyphema or penetrating injury. He has a difficult time keeping his eye open and states that he has increased pain with blinking. What is the next best step to help in the examination and treatment of this patient's eye problem?

A. Fashion a device out of paper clips to prop his eye open for further examination
B. Flush with a copious amount of saline to remove the suspected foreign body from his eye
C. Examine his eye using a wood's lamp after fluorescein is applied
D. Apply tetracaine to his eye then apply dry fluorescein paper to his sclera for a better examination
E. Shield his eye and obtain an immediate ophthalmology consultation

Correct Answer: C

Explanation

This patient likely has a corneal abrasion and potentially a retained foreign body. Corneal abrasions are epithelial defects, which result from trauma to the surface of the eye. The presentation includes pain, excessive tearing from the involved eye, photophobia, foreign-body sensation such as sand in the eye, and blurry vision. These patients should be carefully examined to detect other eye injuries such as penetrating trauma and ruptured globe. This patient should be examined by first opening the eye using a gentle technique. A topical anesthetic such as tetracaine should be administered to make the patient comfortable during the examination. However, repeated doses are not recommended as it may delay healing of the corneal epithelium. While using a fluorescein strip, the strip should be wet first and then applied to the inner region of the inferior lid.

Corneal abrasions can be readily identified by staining the cornea with fluorescein and examining it under cobalt blue light. This allows abrasions

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_19

to appear green. The eye should also be examined carefully to evaluate for foreign bodies. This can be done by everting the upper eyelids.

An adequate examination is required without delay, and given this scenario without obvious penetrating injury, it is most appropriate to start with the fluorescein examination. A Seidel test showing leakage of aqueous humor through a damaged cornea and fluorescein streaming away from an abrasion, may indicate corneal perforation. This may demonstrate extrusion of intraocular contents. Further irrigation with saline is unlikely to help.

Urgent ophthalmologic consultation is required if there are signs of an active infection, such as a corneal infiltrate or ulceration. It is also recommended for deep and large corneal foreign bodies or if the central area of the visual axis is involved.

Patients with corneal abrasions should be reexamined in 24 hours. Most corneal abrasions will heal spontaneously because the corneal epithelium is one of the fastest-healing areas of the eye.

Take-Home Message

Examination with fluorescein stain and slit-lamp microscope is considered standard in patients with possible foreign bodies and corneal abrasion.

ABP Content Outline

- Recognize presentation of ocular foreign bodies and plan appropriate management

Question 2

A 19-year-old male presents to the Emergency Department via ambulance after being struck in the face by a group of teenagers attempting to mug him. He was hit in the eye with the butt of a gun and he fell on the ground. The patient states that he felt severe pain to the right eye but denies any loss of consciousness. On arrival in the ED, severe edema around the right eye was present and he was unable to open his eye. You were able to open his eye briefly and note that he has significant chemosis and impaired extraocular movements secondary to pain. You obtained a CT scan of the orbit and note a "blowout" fracture with entrapment. Which of the following is true about this type of fracture?

A. Step off signs and tenderness to palpation are common features and should be identified before making a clinical diagnosis
B. Facial numbness is not associated with this injury
C. There is always associated globe injury
D. It is difficult for a patient to look away from the fracture site because of tethering of the intraocular muscle to the fracture
E. The lateral wall is most commonly fractured

Correct Answer: D

Explanation

An orbital floor fracture is often known as a "blowout" fracture. This fracture may entrap the inferior rectus and inferior oblique muscles, which results in upward gaze restriction.

If asked to look up, the unaffected eye will look up, but the entrapped eye cannot. The common sites of orbital wall fracture are inferior wall and medial wall. Beware that a globe injury may be associated with this fracture. Physical examination may show point tenderness and "step off" but they are not required for clinical diagnosis. The bony rim of the orbit can be normal.

Clinical manifestations of blowout fractures include entrapment, or the inability to look away from the fracture site (because of the entrapped muscle), pain with extraocular movement, and inability to look toward the fracture site (due to an expanding hematoma). Infraorbital nerve injury may result in hypoesthesia of the ipsilateral cheek and upper lip.

Plain radiographs have low sensitivity in detecting orbital fractures. Indications to obtain a CT scan in a patient with orbital trauma includes

- Suspicion of a fracture on physical examination
- Limitation/or restricted extraocular movement
- Decreased vision
- Severe pain
- Inability to perform an adequate examination

CT scan of the orbits may reveal a defect in the orbital floor with possible entrapment of soft tissue and/or extraocular muscles. This may appear as a teardrop on facial CT scan. In such circumstances, evaluate the eye for visual acuity, hyphema, or retinal detachment, and the nose for septal hematoma. Periorbital subcutaneous emphysema may be present. Suspect an orbital floor fracture if an air-fluid level in the maxillary sinus is present on plain film. An ophthalmology consultation should be obtained in the presence of a true blowout fracture.

Fractures of the inferior wall with entrapment of the inferior rectus muscle can cause restriction of upward gaze and diplopia. Importantly, a fracture of the inferior wall may cause numbness of the ipsilateral malar region because of injury to the infraorbital nerve that travels on the floor of the orbit. For muscle entrapment, as a result of orbital floor or medial wall fractures, an ophthalmology or plastic surgery consultation should be obtained.

Take-Home Message
Fracture of the orbital floor should be suspected if there is diplopia, particularly with impaired upward gaze, and numbness below the eye is present.

ABP Content Outline
- Recognize orbital fracture and plan appropriate management

Question 3

You are evaluating a 10-year-old little league player presenting with a baseball injury to the left eye. Your student asks you to explain under what conditions should an eye shield be used. Your response should include

A. Hyphema
B. Ruptured globe
C. Corneal laceration
D. None of the above
E. All of the above

Correct Answer: E

Explanation
The eye should be protected with a rigid eye shield in patients with an obvious or suspected penetrating/ruptured globe injury. These patients can present with a hyphema, corneal laceration, 360° corneal swelling, bloody chemosis, irregularly shaped iris, and traumatic loss of visual acuity or positive Seidel test. In such situations, no further examination or manipulation of the eye should be performed and the patient should be referred for immediate evaluation by an ophthalmologist. In the ED, the bottom of a styrofoam or plastic cup may be used to craft an eye shield if a rigid shield such as a Fox metal eye shield is not readily available.

The shield should fit over the affected eye and contact the bony orbital prominences to ensure no pressure is placed on the actual eye. Any pressure placed on the eye after a penetrating trauma can potentially worsen the injury and may increase the intraocular pressure. Therefore, a pressure patch is not recommended. In situations such as ruptured globe, the ophthalmology service should be consulted immediately without further manipulation. Avoid succinylcholine in patents with suspected globe rupture as it may further increase intraocular pressure. Other attempts to decrease intraocular pressure such as elevating the head of the bed and the use of antiemetics should be utilized.

Take-Home Message
Eye shields should be used to protect eyes with suspected globe rupture and hyphema. Eye patches are not recommended.

ABP Content Outline
- Recognize ocular trauma and plan appropriate management

Question 4

A 19-year-old hospital volunteer complains of unilateral eye irritation and redness for 2 days. He wears contact lenses and has been using contact lens solution intermittently for dry eyes without improvement. He denies any eye discharge until this morning when he woke up with whitish discharge and crusting and difficulty opening it. He reports discomfort in the affected eye but denies photophobia, trauma, or increased pain with blinking. What is the *LEAST* acceptable management strategy for this patient?

A. Discharge home on topical polymyxin-trimethoprim drops
B. Apply tetracaine to the eye to help visualization of a retained foreign body
C. Evaluate the eye with fluorescein and/or slit-lamp microscope
D. Obtain a complete personal and family history of systemic disease
E. Evaluate the eye for iritis even if there was an injury 72 hours prior to presentation

Correct Answer: A

Explanation

Bacterial conjunctivitis is characterized by mucopurulent discharge, which involves one eye but may spread to the other. It is associated with injection of the bulbar conjunctiva. The most common organisms are *Haemophilus influenzae*, *Streptococcus pneumoniae*, and *Staphylococci*. The combination of trimethoprim sulfate and polymyxin B sulfate provides broad-spectrum coverage and is generally adequate for a superficial eye infection. However, in patients who are using contact lenses, the eyes may be colonized with *Pseudomonas aeruginosa*. Therefore, treatment should include anti-pseudomonas antibiotics such as ciprofloxacin (Ciloxan) or ofloxacin (Ocuflox) solutions. Patching and topical corticosteroids do not offer benefit and should not be used in any corneal abrasions.

Among patients presenting with unilateral red eye and pain, a corneal abrasion should be a strong consideration. Corneal abrasions may occur due to contact lens wear, fingernail scratch, or embedded foreign bodies. Contact lens wearers with an abrasion are at particular risk to get corneal ulcerations. Contact lenses should not be used until infection is completely resolved. Fluorescein staining and slit-lamp examinations should be performed to identify the corneal defect with cobalt blue light.

If there is a suspicion of a penetrating eye injury, CT scan of the orbit should be obtained. As iritis, conjunctivitis, uveitis, or vitritis may be associated with systemic diseases, a thorough personal and family history should be obtained. Inflammation of the iris and/or ciliary body may occur as a result of direct trauma. This can cause ciliary spasm and usually presents 1–4 days after the injury.

Take-Home Message

The recommended treatment of contact lens corneal abrasion is a broad-spectrum antibiotic, such as a fluoroquinolone which provides coverage against *Pseudomonas.*

ABP Content Outline

- Plan diagnostic evaluation and initial intervention for patients with red eyes

Question 5

A 3-year-old girl with a diagnosis of pauciarticular juvenile rheumatoid arthritis presents with severe left knee and right ankle pain and difficulty walking. The parents deny any fevers, chills, or weight loss. She has no family history of rheumatic illnesses. Her initial laboratory evaluation by the rheumatologist is as follows:

- ANA: positive
- dsDNA: negative
- Anti-Ro: negative
- Anti-La: negative

She is currently on a nonsteroidal anti-inflammatory drug therapy and has had occasional intraarticular injections of corticosteroids. Your medical student presents this patient to you and mentions that the parents are asking

about getting an "eye doctor to see her while she is here." Your student is unsure why she needs one since she has no eye complaints. Your best response should include:

A. This patient should have slit-lamp examination performed on presentation then every 3 months to screen for uveitis/iridocyclitis.
B. Patients like this should receive a vision screening on presentation then every 3 months thereafter.
C. Patients like this should receive a vision screening and slit-lamp examination every year.
D. Patients like this do not require a slit-lamp examination because the risk of uveitis is low compared to other forms of JIA.
E. Patients like this only need to be seen if they are having vision-related symptoms.

Correct Answer: A

Explanation
Uveitis is potentially a sight-threatening condition of the uveal tract. It is inflammation of the uveal tract of the eye (i.e., choroid, ciliary body, iris). It is thought to be related to an autoimmune reaction with predominant involvement of CD4+ T cells, but the underlying pathogenic mechanisms remain unclear. Uveitis can occur in children with JIA, which is one of the most common rheumatic diseases of childhood. Uveitis occurs mainly in children with oligoarticular juvenile idiopathic arthritis (JIA). It is the most serious complication of JIA that can cause severe or complete loss of vision. Oligoarticular JIA is defined as arthritis in one to four joints and accounts for 40–50% of JIA. Uveitis occurs in about 20–25% of patients because of the strong association with positive antinuclear antibody (ANA). However, no laboratory tests, such as a positive antinuclear antibody (ANA) or RF, are needed to establish a diagnosis of JIA. An objective evidence of arthritis is required in one or more joints for 6 weeks or longer, with exclusion of other causes for the arthritis.

Although photophobia, eye pain, and erythema can occur, uveitis is often asymptomatic initially. Therefore, children with JIA must receive frequent slit-lamp examinations. A referral should be made to a pediatric ophthalmologist on presentation, and slit-lamp examination must be repeated every 3–6 months. Patients at the highest risk are those less than 6 years of age at diagnosis with a positive ANA and may have an increased risk for vision-threatening complications.

Take-Home Message
Patients with oligoarthritis are at higher risk for uveitis and should receive a slit-lamp examination on presentation and every 3–6 months thereafter.

ABP Content Outline
- Know the physiology and understand the pathophysiology of uveitis
- Provide appropriate management for a child with uveitis
- Be aware of the systemic illnesses associated with uveitis

Question 6

You are examining a 16-year-old male restrained front seat passenger involved in a moderate speed motor vehicle accident. He hit his head on the dashboard because the airbags failed to deploy. He was extricated from the vehicle by the paramedics and restrained in a cervical collar. He has a GCS of 15 and the remainder of the physical examination is normal except for significant eye injuries. He is unable to open his eye because of swelling, but has no significant pain. You prop open his eye and note eye edema, chemosis, and blood in the anterior chamber with normal extraocular movements. Which of the following is a true statement regarding hyphemas?

A. It can occur due to shaken baby syndrome.
B. It is not common in children but can result from chest trauma or suffocation.
C. It can lead to glaucoma.
D. It can be seen due to significant retching.
E. It can be seen in patients with uveitis.

Correct Answer: C

Explanation

The presence of hyphema or anterior chamber hemorrhage after ocular trauma indicates significant intraocular injury. The complications of hyphema are increased intraocular pressure (IOP), rebleeding, and impaired vision. Several mechanisms are described for IOP.

- Contusion and inflammation of the trabecular meshwork
- Disruption of the meshwork
- Plugging of the meshwork by red blood cells

This increase in IOP may threaten vision as a result of optic nerve damage. Children with hyphema may present with acute loss of vision, with or without pain.

The degree of bleeding directly correlates to the risk of glaucoma given that more blood in the anterior chamber increases the intraocular pressure. The risk of rebleeding is highest within the first 5 days of presentation. The complications are more common when secondary bleeding occurs, usually 48–72 hours after the injury.

Patients with sickle cell and other hemoglobinopathies are at higher risk for hyphema complications. Even small amounts of blood in the anterior chamber may cause a severe increase in IOP and therefore, require more aggressive intervention.

Patients suspected of a hyphema should be examined in the sitting position as it may layer out posteriorly in the supine position. On presentation in the ED, the eye should be covered with a shield and the patient's head should be elevated to 30°. Management decisions should be made in consultation with a pediatric ophthalmologist. An immediate evaluation by an ophthalmologist is required in the presence of

- Large hyphema (Grade III or IV)
- Bleeding tendency
- Sickle hemoglobinopathy
- Increased IOP

An ophthalmologic consultation should be made once immediate stabilization has occurred. Carbonic anhydrase inhibitors should be avoided in patients with sickle cell disease as it may lower the aqueous pH in the anterior chamber and precipitate the sickling of red blood cells. Avoid nonsteroidal anti-inflammatory drugs (NSAIDs) and aspirin, because of their potential to worsen bleeding. Ketamine should be avoided because of the potential for an increased IOP. A cycloplegic agent should be used to immobilize the iris.

For a hyphema of greater than 50%, hospitalization is required. Other patients who should be hospitalized are patients who have increased intraocular pressure or have bleeding tendencies or sickle hemoglobinopathy. Patients who are discharged should have a next day follow-up with a pediatric ophthalmologist.

Hypopyons (pus in the anterior chamber) can be seen in patients with uveitis. Subconjunctival hemorrhages may be seen in children; chest trauma, suffocation, and retching are some of the causes. Retinal hemorrhage can occur from shaken baby syndrome. Look for this if you suspect abuse.

Beware that a retrobulbar hematoma may significantly increase intraocular pressure. In this situation, a lateral canthotomy is required in patients with significant eye trauma having retrobulbar hemorrhage which can cause orbital compartment syndrome. These patients present with increase intraocular pressure, proptosis, limited extraocular movements, diplopia, and an afferent pupillary defect. A lateral canthotomy is needed if the intraocular pressure >40 mm Hg.

Take-Home Message

The presence of hyphema after ocular trauma indicates significant intraocular injury and require urgent pediatric ophthalmologic consultation.

ABP Content Outline

- Recognize hyphema and plan appropriate management
- Recognize orbital trauma and plan appropriate management

Question 7

A 4-day-old infant presents to the Emergency Department with bilateral eye erythema and discharge. The mother notes that the patient's eyes were red yesterday and now have yellow discharge. She denies fever, cough, or congestion. The patient was born at full term with no complications. The mother had inadequate prenatal care and was presumptively treated for chlamydia and gonorrhea early in her pregnancy. On examination, you note bilateral conjunctival erythema and edema around the lids. Copious ocular yellow discharge was noted with mild clear rhinorrhea. The remainder of the physical examination is unremarkable except for posterior occipital caput and diffuse rash, consistent with erythema toxicum. You obtain a sample of the discharge for gram stain and culture. If untreated, what complications can occur from this condition?

A. Pneumonia
B. Corneal ulceration and perforation
C. None given that the symptoms will resolve on their own in approximately 48 hours
D. None given that the symptoms will resolve on their own in approximately 2–3 weeks
E. Corneal scarring

Correct Answer: B

Explanation

In approaching a newborn with conjunctivitis, several factors should be considered including patient's age, maternal history, and clinical characteristics of the conjunctivitis. This infant most likely has bacterial conjunctivitis secondary to gonococcal infection. Conjunctivitis caused by *Neisseria gonorrhoeae* is usually present between 2 and 5 days after birth with bilateral bulbar conjunctival erythema, marked eyelid edema, profound chemosis, and a copious purulent discharge. It can penetrate an intact epithelial surface and may invade the cornea, causing ulceration, perforation, and even endophthalmitis if not treated promptly and adequately.

Diagnosis is made by identification of Gram-negative intracellular diplococci on conjunctival smears. A sepsis evaluation should be performed. These infants should be treated with intravenous antibiotics, hospitalized and evaluated by the pediatric ophthalmologist.

Chlamydial conjunctivitis is the most common cause of infectious conjunctivitis in the neonatal period. It presents later at 5–14 days of age and presents with watery discharge and intense erythema of the palpebral conjunctiva. The follicular response may not develop in the neonate because of the immature immune system.

The major complication is chlamydia pneumonia, which develops between 4 and 6 weeks after birth and occurs in up to 10–20% of affected infants. Therefore, the treatment should include oral erythromycin for 14 days. The topical medications cannot treat pneumonia. Infants born to mothers with an untreated chlamydial infection have a 30–40% risk of developing conjunctivitis and a 10–20% risk of developing pneumonia.

Chemical conjunctivitis usually presents within 12–24 hours of birth. This is usually self-limited and resolves within 48 hours.

Viral conjunctivitis typically presents as an upper respiratory infection. The conjunctiva is red and swollen, with copious watery discharge. This is self-limiting and resolves completely. Any suspicion of a bacterial cause should warrant treatment for gonorrhea. If gonorrhea or chlamydial infection is suspected, conjunctival scrapings for smears and cultures should be obtained.

Take-Home Message

Neonatal conjunctivitis is a potentially vision threatening condition. Conjunctivitis presents after 48 hours should be evaluated for an infectious cause. Gonococcal conjunctivitis increases the risk of corneal ulceration.

ABP Content Outline

- Know the etiology of conjunctivitis
- Recognize the signs and symptoms of conjunctivitis

- Provide appropriate management with a child with conjunctivitis

Question 8

An 8-year-old girl presents to the Emergency Department via ambulance after being struck in the right eye with an arrow at summer camp. The campers were engaging in target practice when the patient ran in front of another student to retrieve her arrow. She was in pain and refused to open her eyes. On arrival in the ED she was crying, keeping her eye closed. You could perform a limited examination and note an irregularly shaped pupil, excessive lacrimation, and conjunctival erythema. What is your next step in the management of this child?

A. Have the patient lie supine and apply an eye patch to minimize further damage to the eye
B. Administer tetracaine to the right eye in order to perform a comfortable examination of the eye
C. Immediately apply an eye shield, administer ondansetron, and refer the patient for an urgent ophthalmologic evaluation
D. Sedate the patient and measure intraocular pressure using tonometry
E. Have the patient lie supine and administer an intramuscular injection of morphine to control the pain

Correct Answer: C

Explanation

This patient has sustained a penetrating eye injury with the tip of an arrow. Given the presentation and the presence of a "teardrop" or irregularly shaped pupil on examination, there should be consideration for a ruptured globe. It is a true vision-threatening emergency and an ophthalmologist should be consulted emergently.

A ruptured globe can be caused by blunt or penetrating injury to the eye. It involves a full-thickness defect in the cornea, sclera, or both. Once the cornea has been ruptured, the iris or choroid moves to plug the defect. The pupil then takes on a "tear drop" appearance. The common sites of rupture are at the insertions of the intraocular muscles or at the limbus, where the sclera is weak and thin.

The presenting symptoms are eye pain and decreased visual acuity which may not be readily apparent on examination. However, the following are suggestive of ruptured globe.

- Shallow anterior chamber on slit-lamp examination
- Hyphema
- Irregular (teardrop) pupil

The patient should remain NPO. Avoid direct pressure on the eye and place a protective eye shield. A patch should not be applied, as it would place pressure on the globe, and worsen the condition. In such situations, intraocular pressure should not be measured, as this may cause extrusion of globe contents. The examination should not be performed until the patient can be taken to the operating room by ophthalmology. Any attempt to examine the patient can cause further agitation leading to increased intraocular pressure. Eye drops should not be administered. If a patient is too agitated, sedation may be considered.

Although pain medication is very important, it should likely be given via IV since the patient will need operative intervention and attempts should be made to avoid the patient from performing any Valsalva maneuvers or crying. Antiemetics may be administered to assist with this.

An orbital CT scan should be obtained if globe rupture is suspected. The following are CT scan findings, which suggest globe rupture:

- Intraocular foreign body
- Intraocular air
- Deformity of the globe
- Vitreous hemorrhage

Take-Home Message

An irregularly shaped pupil after a penetrating or blunt trauma indicates a ruptured globe, and attempts should be made to ensure no increase in intraocular pressure. These patients require immediate ophthalmology consultation.

ABP Content Outline

- Recognize ocular trauma and plan appropriate management
- Recognize penetrating injury to the eye and plan appropriate management

Question 9

A 12-year-old girl has a right upper eyelid mass that has been present for 3 days. She denies any recent trauma or eye irritation but did state that she wears makeup occasionally. The mass is about 1 cm in diameter and located on the medial region of the upper eyelid. She has mild tenderness over the swelling and states that her right eye became red today. She has drainage that began 1 hour ago from the conjunctival side of the eye. What is the most likely diagnosis of this patient's eye condition?

A. Blepharitis
B. Internal hordeolum
C. Dacryoadenitis
D. Bacterial conjunctivitis
E. Preseptal cellulitis

Correct Answer: B

Explanation

A hordeolum is an acute purulent eyelid inflammation typically caused by *Staphylococcus* species. A chalazion or internal hordeolum is the inflammation of the Meibomian gland, whereas an external hordeolum or sty involves glands of Zeiss or sweat glands (Moll). The Meibomian glands are sebaceous glands located deep within both eyelids. In an internal hordeolum, the lesion points to the conjunctival surface of the lid, whereas in an external hordeolum, it points to the external surface of the skin or the margin of the lid.

A stye is usually self-limited and respond to warm compresses and topical antibiotics. However, if there is no improvement, a referral to ophthalmology for incision and curettage may be needed.

Oral antibiotics with Staphylococcal coverage may be provided if there is concurrent pre-septal cellulitis, which is a bacterial infection of the periorbital tissue usually caused by sinusitis but can have other inciting disease processes. It usually presents as a unilateral erythematous, tender, indurated, swollen, and warm eyelid and periorbital region.

Dacryoadenitis is inflammation of the lacrimal gland; it could present in a similar fashion, but the lacrimal gland is located on the lateral portion of the upper lid, and therefore presents with swelling in the region of the lateral upper lid. *S. aureus* is the most common organism.

Bacterial conjunctivitis is possible and should be considered in the differential diagnosis for any patient with red eyes. However, a mass is usually not associated with conjunctivitis.

Blepharitis is an inflammation of the eyelash follicles along the edge of the eyelid. It is usually bilateral and symmetrical. It is usually caused by staphylococcus and presents with eye redness, tearing, photophobia, crusting of the lid margin, swelling, or pruritus.

Take-Home Message

Internal and external hordeolums should be considered in the diagnosis of an acute inflamed eyelid swelling. Treatment options should include warm compresses, topical antibiotics, and, in unrelenting cases, incision and curettage by ophthalmology.

ABP Content Outline

- Know how to evaluate and manage hordeolum and chalazion

Question 10

A 7-year-old boy presents to the Emergency Department after his younger sister elbowed his right eye. He has mild periorbital swelling and tenderness but normal extraocular movements. His eye examination is positive for a subconjunctival hemorrhage to the lateral sclera, but

negative for hyphema and corneal abrasion. His pupils are round and reactive to light. His visual acuity is 20/20 in both eyes. You tell the mother that although everything looks good right now, it is important that she follows up with an eye doctor in the next 2 and 3 days. Which of the following is the most likely sequela of the injury?

A. Traumatic iritis
B. Glaucoma
C. Lens dislocation
D. Commotio retinae
E. Retinal hemorrhage

Correct Answer: A

Explanation
Traumatic iritis is an important complication of blunt eye trauma due to ciliary spasm. The iritis refers to inflammation of the iris or, more precisely, of the anterior uveal tract of the eye. Patients usually present with pain, photophobia (which is the hallmark), and blurred vision 24–72 hours after the trauma. The diagnostic finding in iritis is ciliary flush-injection that gives the appearance of a red ring around the iris. The slit-lamp examination may show a flare. In traumatic iritis, there is no discharge and there is minimal tearing. The initial treatment is to administer a cycloplegic such as homatropine. This paralyzes the ciliary body which results in a nonreactive, dilated pupil. Avoid topical steroids in the ED. However, it can be provided after an ophthalmology consultation and when the possibility of infection has been ruled out.

Among the causes listed, glaucoma would be least likely. Glaucoma is a complication of hyphema, which is not present in this patient. Since visual acuity is intact, lens dislocation is unlikely although it is a potential complication of blunt eye trauma. Commotio retinae is a relatively rare complication, due to retinal edema secondary to blunt ocular trauma. It usually presents within 24 hours of the injury. Retinal hemorrhage is generally due to shearing trauma such as abusive head trauma as opposed to simple blunt trauma.

Take-Home Message
The presentation of traumatic iritis includes eye pain, photophobia, eye redness, and vision impairment 1–3 days after injury.

ABP Content Outline
- Recognize the signs and symptoms of traumatic iritis
- Understand the significance of vision loss following trauma
- Know how to evaluate and manage glaucoma

Question 11

A 15-year-old girl who wears contact lenses, presents to the emergency department after waking up this morning with bilateral red and painful eyes. She reported that she forgot to remove her contact lenses last night. On examination you noted round, reactive pupils bilaterally with injected conjunctiva and no chemosis or white spots. The next step in caring for this patient should be

A. Removal of lenses and urgent ophthalmology consultation
B. Removal of lenses and topical antibiotics drop instillation
C. Removal of lenses and irrigation with saline
D. Removal of lenses and applying an eye patch
E. Removal of lenses and treatment with acyclovir

Correct Answer: A

Explanation
This patient should be seen urgently by an ophthalmologist because of the potential for corneal ulceration and secondary bacterial keratitis, which is the most common serious complication in a contact lens wearer. If there is a contact lens, it should be removed. Instillation of topical anesthetic may be helpful in removal of contact lenses. Soft contact lenses can be removed by pinching the edges of the lens at the four and eight o'clock positions with the thumb and index finger. The presenting symptoms are corneal haze, hyper-

emia, lid edema, pain, photophobia, tearing, and blepharospasm. A dislocated lens is most likely placed under the upper lid, where it is folded.

Empiric antibiotic drops are not recommended as they may obscure corneal culture results. Neither irrigation, eye patching nor empiric acyclovir are indicated in this patient. In contact lens wearers, visible white spots on the cornea with conjunctival injection may indicate the presence of corneal ulcers; however, their absence does not preclude corneal ulcer.

Take-Home Message
A red eye in a contact lens wearer is vision threatening and should be referred for an urgent consultation with an ophthalmologist.

Question 12

An 8-year-old boy complains of a sandy foreign-body sensation and eye redness since yesterday. This morning he woke up with marked eyelid swelling. His vital signs were as follows: temperature 100.7 °F, heart rate 100 beats/minute, and respiratory rate 20 breaths/minute. His pupils are round and reactive to light. His right eye has significant conjunctival injection with mucoid discharge, significant right lower eyelid swelling, and ipsilateral pre-auricular adenopathy. You also notice left conjunctival injection. His likely diagnosis is

A. Allergic conjunctivitis
B. Bacterial conjunctivitis
C. Viral conjunctivitis
D. Chemical conjunctivitis
E. Periorbital cellulitis

Correct Answer: C

Explanation
This patient exhibits signs and symptoms suggestive of epidemic keratoconjunctivitis (EKC) secondary to adenoviral infection which is the most common cause of viral conjunctivitis. The presentations include marked eye redness, photophobia, foreign-body sensation, and tearing. A fluorescein examination should be performed to evaluate whether herpetic dendrites are present.

Both viral and bacterial conjunctivitis can be unilateral or bilateral, but a viral etiology is more likely with a history of numerous infected contacts. Cultures are not required for the initial diagnosis and treatment of conjunctivitis. Allergic conjunctivitis is more often associated with significant itching, tearing, and chemosis. In addition to affecting the eyes consecutively, EKC can also be associated with photophobia and tearing but not chemosis. Periorbital cellulitis can present similarly to EKC with low-grade fever and preauricular adenopathy, but is mostly unilateral.

Take-Home Message
Nonpurulent nonpruritic conjunctivitis is usually due to viral etiology requiring supportive care. It does not require antibiotic therapy.

Question 13

A 17-year-old girl presents to the emergency department complaining of left eye pain and redness, but no discharge. She wears contact lenses, but did not put them in this morning because of her symptoms. She has a history of painful, recurrent red eye that up until now has resolved spontaneously. On fluorescein staining of the cornea you appreciate an area of a linear branching pattern. Management of this patient includes

A. Topical fluoroquinolone
B. Artificial tears
C. Topical steroids
D. Topical acyclovir
E. Hospital admission

Correct Answer: D

Explanation
The patient in this vignette is having an ophthalmologic emergency because of the risk for permanent visual impairment and eye perforation. Herpetic corneal infections are unilateral, show

the classic herpetic dendrite branching pattern on fluorescein staining, and require an immediate ophthalmologic consultation.

Topical acyclovir is the treatment of choice. Herpetic corneal infections can be caused by herpes simplex or by varicella-zoster viruses, and skin lesions are not always present. Unlike herpetic corneal infections that can be recurrent and sometimes painless because of induced corneal hypoesthesia, corneal abrasions and ulcers are not recurrent. Topical antibiotics are indicated for the treatment of corneal abrasions or bacterial conjunctivitis. Artificial tears are indicated for dry eyes. Topical steroids should not be prescribed without ophthalmologic consultation. Inappropriate use can lead to increased severity of corneal viral infection.

Keratitis is an inflammation or infection of the cornea usually due to minor trauma. Contact lenses, especially the extended-wear type, are the main risk factor for *P. aeruginosa* keratitis, due to contamination of lens solution or the use of tap water.

Take-Home Message
Avoid using topical steroids without ruling out herpetic keratitis as this can lead to rapid deterioration including loss of vision. Urgent ophthalmology consultation is required when herpetic corneal infection is suspected.

Question 14

A 2-year-old boy with a history of heterochromia presents to the emergency department with eye redness, increased tearing, and photophobia but no discharge. He was prescribed topical antibiotic drops by his primary care provider but has not improved. He has no history of fever. The most likely finding on the physical examination will be

A. Fluorescein uptake
B. Increased intraocular pressure
C. Erythema of the eyelid margins, flaking and crusting at the base of the eyelashes
D. Abnormal anterior chamber on slit-lamp examination
E. Chemosis

Correct Answer: B

Explanation
Glaucoma in children is rare. Acute acquired glaucoma in children is often associated with a painful red eye, possibly some corneal haziness and decreased visual acuity. Although a classic triad of epiphora (tearing), photophobia (sensitivity to light), and blepharospasm is described, it occurs in only 30% of patients. The signs include corneal edema, corneal and ocular enlargement, and conjunctival injection. An increase in intraocular pressure (IOP) results in expansion of the globe, including the cornea, and causes buphthalmos.

Certain conditions such as Sturge-Weber syndrome (SWS) and aniridia may increase the risk of glaucoma in children. Sturge-Weber syndrome (SWS) is a neurocutaneous disorder with three cardinal features; capillary malformation in the upper trigeminal neural distribution, ocular abnormalities (glaucoma, choroidal vascular anomalies), and leptomeningeal vascular malformation.

Intraocular pressure must be measured on all cases of suspected glaucoma but can be difficult in young children. Slit-lamp examination should be performed to evaluate for the presence of corneal involvement. All cases require ophthalmological evaluation. Treatment such as carbonic anhydrase inhibitors and β-blockers to reduce intraocular pressure should be started in the ED in consultation with pediatric ophthalmology service.

Take-Home Message
Although glaucoma is rare in children, it is imperative to consider this possibility in children presenting with a painful eye or with progressive loss of vision.

Question 15

A 10-year-old boy states that he is unable to see since he fell backward onto his head at school today. There was no loss of consciousness, no vomiting, and no change in his behavior. On physical examination, he has a large occipital contusion. His red reflex and direct ophthalmoscopy examinations are normal. He is unable to write his name on a piece of paper when asked to do so. The likely diagnosis is

A. Transient cortical blindness
B. Optic nerve injury
C. Retinal detachment
D. Commotio retinae
E. Feigned visual loss

Correct Answer: E

Explanation
The best screening tests for intraocular injury for the emergency physician are vision testing, red reflex, and direct ophthalmoscope examination. Children with true visual loss can write their names, whereas those that have feigned visual loss assume they are not able to write. Truly blind children also express anxiety, are unable to navigate their way around their environment, and their eyes will not track the motion of a mirror held in front of them.

Transient cortical blindness typically occurs after occipital head trauma and presents with a normal examination and true blindness. Optic nerve injury, retinal detachment, and commotio retinae will all have abnormal physical examination findings. Commotio retinae is retinal edema after a blunt closed globe injury. An evaluation by the ophthalmology service is often necessary to identify commotio retinae.

Take-Home Message
It is important to recognize the difference between feigned visual loss and true vision loss in children. Exaggeration of symptoms may be a sign of feigned vision loss.

Question 16

A 6-year-old girl sustained an eyelid laceration involving the lower eyelid margin. An ophthalmologist should be consulted if an eyelid laceration is associated with

A. Full-thickness laceration of the lid
B. Ptosis
C. Lid margin involvement
D. Tissue avulsion
E. All of the above

Correct Answer: E

Explanation
In general, the following lacerations should be repaired by the ophthalmology service.

- Lacerations of lid margin
- Lacerations in proximity of the medial canthus
- Lacerations involving the lacrimal duct or sac
- Lacerations involving the inner surface of the lid
- Presence of ptosis
- Lacerations involving the tarsal plate or levator palpebrae muscle

Ophthalmologic consultation is recommended if there is any globe injury or possible damage to the lacrimal system. Beware that full-thickness lid lacerations may be associated with corneal laceration, traumatic hyphema, and globe rupture.

Take-Home Message
Any involvement of the lid margins, lacrimal sac, or duct or injury to orbital muscles should be referred to a pediatric ophthalmologist.

Question 17

A 2-year-old girl with history of upper respiratory symptoms presents with fever and right upper and lower eyelid edema and redness. Her temperature is 101 °F, heart rate is 140 beats/minute, respiratory rate is 24 breaths/minute, and blood pressure is 80/60 mm Hg. On physical examination, she has conjunctival injection but no discharge. Her extraocular muscles are intact, the eyelid is warm and tender, but there is no proptosis. Correct treatment at this time is

A. Oral administration of amoxicillin
B. Intravenous administration of ceftriaxone
C. Topical ophthalmic bacitracin
D. Cool compresses
E. Warm compresses

Correct Answer: B

Explanation
Based on the involvement of the orbital septum, this entity is classified as periorbital or preseptal cellulitis and orbital or postseptal cellulitis. The orbital septum serves as a barrier to the spread of infection. Both periorbital and orbital cellulitis can present with fever, swollen eyelids, and a red eye. If the patient is febrile, and/ or there is severe disease, both periorbital and orbital cellulitis should be managed with IV antibiotics.

Periorbital cellulitis is characterized by the inflammation of the lids and periorbital area without orbital involvement. Typically, there is no impairment of extraocular movements, no eye pain, and no proptosis.

Orbital cellulitis involves infection into the orbit behind the septum. It is characterized by the following:

- Proptosis
- Limitation of EOM/pain on movement
- Edema of the conjunctiva (chemosis)
- Potential decreased visual acuity

The most common cause of orbital cellulitis in children is due to extension of a sinus infection into the orbit. Orbital cellulitis is characterized by inflammation of the tissues of the orbit, with proptosis, limitation of movement of the eye, edema of the conjunctiva (chemosis), and inflammation and swelling of the eyelids with potentially decreased visual acuity.

The organisms involved in periorbital cellulitis are those that cause sinusitis, such as *S. pneumoniae*, nontypeable *H. influenzae*, and *Moraxella catarrhalis*. Since it may not be possible to differentiate them clinically, a CT scan of the orbit may be required particularly in the presence of proptosis and restricted or painful EOM. Parenteral antibiotics are often required especially in patients who are febrile and have severe symptoms. The initial antibiotic of choice is either cefuroxime, or ceftriaxone. Orbital cellulitis has a potential for severe complications therefore must be immediately recognized and promptly treated. The following are the possible complications:

- Visual loss
- Spread to subperiosteal space with abscess formation
- Cavernous sinus thrombosis

The presence of an orbital or subperiosteal abscess necessitates urgent surgical drainage of the orbit.

Take-Home Message
Periorbital and orbital cellulitis constitute medical emergencies that should be promptly recognized and treated with IV antibiotics.

Question 18

A 12-year-old girl was helping her mother clean the bathroom when she was accidentally splashed in the right eye with “Drano.” The conjunctiva is pale. Immediate treatment in the emergency department should include

A. Debridement
B. Lid eversion
C. Topical anesthetic application
D. Ocular lavage
E. Fluorescein staining

Correct Answer: D

Explanation
Chemical injury to the eyeball is a true ocular emergency. Immediate ocular lavage can be vision-saving. Topical anesthetic application makes ocular lavage more comfortable, but it should never delay initiation of lavage. In the ED, irrigation should be performed with sterile normal saline or other isotonic solutions. Lavage should be continued until 2 L of fluid has been utilized or irrigation has lasted at least 20 minutes. Lid eversion should be performed once irrigation is under way to cleanse the conjunctiva under the upper lid. The end point for irrigation is a pH between 6.5 and 7.5.

Alkali injuries are more severe than acid injuries because they can cause rapid liquefactive tissue necrosis. They also penetrate into deeper tissue because of their lipophilic nature. An eye examination should be performed after irrigation and achieving an ocular pH of >7.4. Absence of conjunctival injection, especially blanching of the conjunctiva from alkali burns, is a poor prognostic sign. An urgent ophthalmology consultation should be obtained for patients with corneal clouding or an epithelial defect after irrigation. Alkali injuries are more common than acid injuries, due to widespread availability of household cleaning agents such as solvents, detergents, cement and drain cleaners. Acid burns result in protein coagulation.

Take-Home Message
Since acid tends to coagulate tissue and inhibit further penetration, alkali injuries are more severe than acid injuries. Preservation of vision depends on the time of exposure to the time of starting irrigation.

Question 19

A 5-year-old boy with a history of upper respiratory symptoms presents with fever and left eyelid edema and redness. He complains of eye pain, especially with movement of his eyes. There is no history of trauma. On physical examination, you notice that he cannot adduct his left eye. Management should include all the following EXCEPT

A. Intravenous administration of Ceftriaxone
B. CT scan of orbit
C. Ophthalmology consultation
D. Oral administration of amoxicillin/clavulanate
E. Analgesia

Correct Answer: D

Explanation
Orbital cellulitis involves an infection of the contents of the orbit (including ocular muscles), whereas preseptal cellulitis is an infection of the anterior portion of the eyelid.

The orbital septum demarcates between preseptal cellulitis and orbital cellulitis. It is a membranous sheet extending from the periosteum of the orbit to the tarsal plate. It forms the anterior boundary of the orbital compartment. Preseptal cellulitis does not involve the orbit or other ocular structures. Periorbital cellulitis is also used interchangeably instead of preseptal cellulitis. A common cause of orbital cellulitis is bacterial rhinosinusitis.

Patients with orbital cellulitis must be treated with parenteral antibiotics. The common organisms in orbital cellulitis are *Staphylococcus aureus* and *streptococci*. Appropriate antibiotic regimens for empiric treatment are ceftriaxone, cefotaxime, or ampicillin-sulbactam.

The cardinal signs of orbital cellulitis include proptosis, decreased eye movement, decreased vision, and signs of optic nerve involvement. The common CT scan findings include inflammation of extraocular muscles, fat stranding, and anterior displacement of the globe. However, in preseptal cellulitis inflammation is limited to the eyelids. Indications to obtain CT scan of the orbit include proptosis, restriction of eye movements, pain on eye movements, double vision, or change in vision. Operative intervention may be required in the presence of an orbital abscess with an abnormal physical examination finding.

Take-Home Message
Preseptal cellulitis is infection of the soft tissues anterior to the orbital septum, whereas orbital cellulitis is an infection to the posterior part of the septum.

Question 20

A 17-year-old boy complains of occasionally itchy dry eyes, photophobia and tearing, and a sandy foreign-body sensation. His symptoms worsen after TV watching or video game playing. On physical examination, he has erythematous eyelid margins, and flaking and crusting at the base of the eyelashes. There is no history of trauma. Which of the following will be most useful in the ED evaluation?

A. Slit-lamp examination
B. Fluorescein staining
C. Visual acuity check
D. Urgent Ophthalmology consultation
E. Intraocular pressure measurement

Correct Answer: A

Explanation
Blepharitis is the inflammation of the lid margins, which is characterized by erythema and crusting or scaling. It is usually bilateral, symmetrical, and chronic or recurrent. Since blepharitis arises as a result of inflammation, there is potential for bacterial overgrowth and superinfection such as *Staphylococcus epidermidis*, *Propionibacterium acnes,* and *Corynebacterium*. This can cause corneal infiltrate. Slit-lamp examination is therefore helpful to evaluate for corneal involvement.

The more common form is posterior blepharitis, which is characterized by inflammation of the inner portion of the eyelid at the level of the Meibomian glands. Anterior blepharitis involves inflammation at the base of the eyelashes and is less common. It may be associated with seborrheic dermatitis, atopic dermatitis, acne rosacea, or diabetes.

Visual acuity and intraocular pressure are not affected, and there will be no uptake on fluorescein staining. An urgent ophthalmologic consultation is not indicated in the initial evaluation; however, a referral should be considered if there are severe symptoms such as eye redness, pain, or light sensitivity, visual impairment or corneal findings such as erosions, ulcers, and scarring.

Take-Home Message
Seborrheic blepharitis is a chronic form of blepharitis, which arises from the Meibomian glands and causes scaling of the eyelids.

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Surgery

20

Soula Priovolos

Question 1

A 5-year-old boy presents to the emergency department with abdominal pain of 24 hours' duration. When asked to point to the area of maximal pain, he points to the right lower quadrant. On physical examination, he does not have fever. He is tender in the right lower quadrant of his abdomen.

Which of the following statements is true?

A. McBurney's point is the most common location for pain and tenderness in this condition.
B. Psoas sign is demonstrated by internally rotating the right thigh and obturator sign is demonstrated by extending the right hip.
C. Children with this condition are frequently moving around and are difficult to keep still.
D. A perforated appendix always results in generalized peritonitis.
E. A normal leukocyte count is present in 20% of patients.

Correct Answer: A

This patient likely has appendicitis. It is the most common condition requiring emergency abdominal surgery in children. Up to 8% of children who present with abdominal pain have appendicitis. McBurney's point is the most common location for pain and tenderness. Palpation in other parts of the abdomen may result in referred pain to the right lower quadrant. Palpation in the left lower quadrant results in pain in the right lower quadrant. This is called Rovsing's sign. Psoas sign is positive when the right hip is extended and the patient has pain in the right lower quadrant. Obturator sign is positive when pain is elicited in the right lower quadrant by internally rotating the right hip with flexed thigh. Children with appendicitis rarely squirm around; they lie still because movement provokes pain. It may be helpful to palpate the abdomen by placing the examiner's hand over the child's hand or stethoscope. Peritonitis can be assessed by asking the child to hop up and down on one leg; if the patient does not have pain while doing this, consider a low risk of appendicitis. Beware that the location of pain in appendicitis is variable in children, depending on the length and position of the appendix. Therefore, one should not dismiss appendicitis in children presenting with pain in the right upper quadrant, flank, groin, or suprapubic region.

Appendicitis results from obstruction of the appendiceal lumen, which then results in bacterial overgrowth. Obstruction can be caused by appendicoliths, hyperplastic lymphoid follicles, viral infections, parasitic infections, carcinoid tumors, and foreign bodies.

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_20

Perforation is the most concerning complication of acute appendicitis which may result in either generalized peritonitis or a localized abscess. Younger children have a higher risk for perforation. Diffuse peritonitis is more common in infants than older children because the omentum is underdeveloped and cannot seal the perforation. The leukocyte count in early appendicitis may be normal and typically is only mildly elevated with a left shift. A normal white blood cell (WBC) count never completely eliminates the possibility of appendicitis. A normal white blood cell count is found in 10% of cases; therefore, it should not be used as an isolated test to exclude the presence of appendicitis.

Sonography and CT scan are the most common imaging modalities used to diagnose appendicitis. The rate of CT utilization in the evaluation of appendicitis has declined significantly due to concerns about radiation exposure in children.

The inflamed appendix is typically enlarged, immobile, and noncompressible on ultrasound exam. It is operator dependent and its sensitivity ranges from 78% to 83%, whereas the specificity ranges from 83% to 93%. The sensitivity of ultrasound in identifying appendicitis increases linearly with increasing pain duration. Therefore, one should not rely on ultrasonography early in the course of illness. When an initial ultrasound is nondiagnostic, but the patient has severe clinical symptoms or an elevated WBC count, one should consider obtaining a CT scan which has superior test characteristics.

Positive CT scan findings include the following: an appendix greater than 6 mm in diameter, appendiceal wall thickening, and fat stranding around the appendix.

Acute appendicitis is rare in children younger than 2 years old. Toddlers may be difficult to evaluate for appendicitis and often present with perforated appendicitis. Children with appendicitis commonly present with fever and vomiting. When the diagnosis is unclear, one should avoid making a diagnosis of acute gastroenteritis in young children without diarrhea. Analgesics do not mask physical signs of appendicitis therefore early and adequate pain control should be provided.

Take-Home Message

The initial presentation of appendicitis may be nonspecific in children. Physical examination is the most important tool to diagnose appendicitis but it may be difficult in very young children.

ABP Content Specification

- Know the physical findings in appendicitis.
- Know how to correlate ancillary studies (CBC, abdominal imaging).
- Know the etiology of appendicitis.

Question 2

A 2-year-old boy is brought to the emergency department for rectal bleeding. The parents state the child had two bowel movements mixed with red blood. The child was not complaining of any pain. He was born full term and is otherwise healthy. He has normal eating and bowel habits. He last visited the pediatrician 2 months ago and is in the 75th percentile for height and age. On examination, the vital signs are normal. The child appears well nourished and hydrated. He is not pale. The abdomen is soft and nontender. The anorectal examination is normal. What diagnostic test will be helpful in making a diagnosis?

A. Upper endoscopy
B. Colonoscopy
C. Barium enema
D. Radioisotope scan
E. Exploratory laparotomy

Correct Answer: D

Meckel's diverticulum is the most frequently encountered congenital anomaly of the GI tract. It is one of the malformations resulting from persistence of the yolk sac. It is a true diverticulum. The incidence of Meckel's diverticulum is 2% with a 2:1 male to female ratio. Half the patients who become symptomatic are younger than 2 years old. It usually occurs 2 feet from the ileocecal junction.

Up to 75% of symptomatic diverticulae contain heterotopic gastric mucosa or pancreatic tis-

sue. The most common presentation is painless rectal bleeding due to ectopic gastric mucosa. Bleeding occurs as a result of peptic ulceration of the adjacent ileal mucosa, not from the diverticulum itself. It is usually bright red or maroon colored. Since ectopic mucosa may cause acid secretion, ulceration of the adjacent tissue results in bleeding and may present as melena.

The next most common manifestation of a Meckel's diverticulum is intestinal obstruction. It is caused either by intussusception with the diverticulum as the lead point or by herniation through, or volvulus around, a persistent fibrous cord remnant of the vestigial vitelline duct. Another condition associated with a Meckel's diverticulum is Meckel's diverticulitis. These patients may initially be considered as having acute appendicitis, and the diagnosis of Meckel's diverticulitis is made during laparoscopy or exploratory laparotomy. Perforation may occur in about a third of patients due to peptic ulceration.

The diagnostic test of choice is the 99 m Tc-pertechnetate radioisotope scan (Meckel's scan). The isotope has an affinity for the heterotopic gastric mucosa; therefore, uptake occurs by the mucus-secreting cells of the gastric mucosa, not the parietal cells. The usual imaging studies such as abdominal plain films and ultrasonographic imaging are not helpful to make this diagnosis. The sensitivity of the Meckel's scan for children is 85–97%. Treatment for a symptomatic Meckel's diverticulum is resection of the Meckel's diverticulum along with the adjacent small bowel if affected.

Take-Home Message

Consider Meckel's diverticulum in an infant or child with significant painless rectal bleeding.

The diagnostic test of choice for Meckel's diverticulum is the 99 m Tc-pertechnetate radioisotope scan (Meckel's scan) to identify ectopic gastric mucosa.

ABP Content Specification

- Recognize the signs and symptoms of Meckel's diverticulum.
- Recognize ancillary studies in Meckel's diverticulum.
- Know the management of a symptomatic Meckel's diverticulum

Question 3

A 1-year-old boy is brought to the emergency department for abdominal pain, vomiting, and bloody stool. The child was born full term by normal vaginal delivery. APGARS were 10. He does not have any medical problems and is generally healthy. The parents state he was in his usual state of health until today when he developed acute colicky abdominal pain. The child also vomited and had a bloody bowel movement. On examination, the child appears dehydrated. He has a palpable mass on the right side of the abdomen. There is dark red gelatinous stool in the diaper. What radiologic study is recommended?

A. CT scan of the abdomen
B. MRI of the abdomen
C. Upper endoscopy
D. Nuclear scan
E. Contrast enema

Correct Answer: E

The history and physical findings in this child are suggestive of intussusception. Lethargy may be the only presenting symptom and may delay the diagnosis. Intussusception results from the invagination of one part of the intestine into another part. The invaginated part is called the intussusceptum and the recipient bowel is called the intussuscipiens. It is the most common cause of intestinal obstruction in children 3 months to 5 years of age. It peaks between the ages of 4 and 7 months, and the majority occurs before 1 year of age.

The majority of the cases are idiopathic, in which lymphoid hyperplasia in Peyer's patches (lymphoid tissue in the bowel wall) is presumed. This lymphoid hyperplasia may serve as a lead point. The lymphoid hyperplasia is usually associated with viral infection particularly adenovirus. In up to 25% of cases, intussusception may be associated with an underlying cause that acts

as a lead point. Examples include Meckel's diverticulum, intestinal polyps, duplication cysts, appendiceal stump, intestinal lymphoma or tumors, and Henoch-Schönlein purpura. The most common type is ileocolic which involves the ileocecal region.

The incidence of intussusception is 1–4 in 2000 infants and children. The male to female ratio is 2:1 or 3:2. The classic triad (i.e., colicky abdominal pain, vomiting, currant jelly stools) associated with a sausage-shaped abdominal mass is often absent in children and occurs in less than 15% of cases. Beware that the presentation may be variable and atypical signs or symptoms are common. This should be considered in children presenting with vomiting (with or without diarrhea, abdominal pain, altered mental status, abdominal mass, or rectal bleeding). Vomiting may become bilious when intestinal obstruction occurs. Beware that 20% to 40% of infants and children do not present with pain during intussusception.

The diagnosis may be suspected if there is paucity of gas and/or a target or crescent sign on abdominal radiography. However, the abdominal radiograph may be normal and this does not rule out diagnosis of intussusception.

Hydrostatic contrast enema is both diagnostic and therapeutic. It is the study and treatment of choice. Most cases can be reduced by a contrast enema. A surgical consultation should be obtained before the air enema is performed due to the risk of perforation from the procedure.

Contraindications to contrast enema are the following: peritonitis, shock, and free air. Surgery is recommended in these cases. Surgery is also recommended when there is a pathologic lead point or reduction with enema is unsuccessful. Both laparotomy and laparoscopy can be performed.

Ultrasound is operator dependent. Accuracy can approach 100% with an experienced ultrasonographer with the identification of a positive target (Donut) sign. Colonoscopy may be useful if a polyp is suspected as the lead point. CT scan and MRI are not routinely used to make the diagnosis of intussusception in children. Older children and children with recurrences may be at increased risk for a pathologic lead point.

Take-Home Message

Hydrostatic enema is both diagnostic and therapeutic for intussusception. The most common type of intussusception is ileocolic, which predominantly occurs in the ileocecal region.

The triad of classic symptoms including colicky abdominal pain, vomiting, and currant jelly stools associated with an abdominal mass is often absent in children with intussusception.

ABP Content Specification

- Recognize the etiology and pathophysiology of intussusception.
- Recognize the signs and symptoms of intussusception.
- Recognize what imaging studies can be used to diagnose intussusception.
- Plan the management of intussusception.

Question 4

An 11-month-old boy is brought to the emergency department by his parents. They report that when the child cries, he develops a bulge in his groin that disappears when he stops crying. Today the bulge has not gone away, although the child stopped crying. It has been "stuck" for 30 minutes. The child does not want to eat. He was born prematurely but is healthy. On physical examination, the child is afebrile. He is irritable. The abdomen is not distended or tender. The right groin demonstrates an irreducible mass which does not transilluminate. The testicles are both descended. There are no infections on the lower extremities.

What should the physician do next?

A. Order a STAT CT scan
B. Perform a nuclear study
C. Attempt a reduction
D. Call the OR to set up for emergency surgery
E. Perform a needle aspiration

Correct Answer: C

This patient has an incarcerated inguinal hernia. The majority of inguinal hernias can be diag-

nosed by history and physical examination. It presents as a nonreducible mass in the inguinal canal, scrotum, or labia. The structures involved include the small bowel, appendix, omentum, colon, or, rarely, Meckel's diverticulum. The ovary, fallopian tube, or both may be incarcerated in female patients. The incidence of inguinal hernia is 1–3% in healthy full-term children. It is 3–5% in premature children. It is more common in children with connective tissue disorders and in children with ventriculoperitoneal shunts and peritoneal dialysis catheters. For an inguinal hernia, the incidence of incarceration is between 12% and 17%. The initial presentation in infants may be nonspecific and includes irritability, feeding intolerance, or abdominal distention. Physical examination shows a tense, nonfluctuant mass in the inguinal region which can extend down into the scrotum or labia. This is usually firm and does not reduce.

When the hernia is not incarcerated, it is sometimes difficult to palpate. Photographs taken when the bulge is detected by parents can help with the diagnosis. Once a hernia is diagnosed, elective surgery should be performed to avoid incarceration. Seventy-one percent of operations for incarcerated inguinal hernias occur in infants less than 11 months of age. Since the diagnosis is clear, nuclear scan is not appropriate. Ultrasound may be used in selected cases where the diagnosis is in doubt.

Manual reduction should be attempted as soon as possible. Emergency surgery is not indicated unless reduction is unsuccessful. Needle aspiration should never be attempted to differentiate between a hernia and a hydrocoele. The differential diagnosis for a groin mass includes the following: undescended testicle, groin lymphadenopathy, and hydrocoele.

Take-Home Message
Emergency surgery is required when an incarcerated inguinal hernia cannot be manually reduced.

ABP Content Specification
- Recognize the signs and symptoms of an inguinal hernia.
- Plan the management of an inguinal hernia.

Question 5

Parents rush their newborn to the emergency department for respiratory distress after a planned home delivery. The mother had intermittent prenatal care and states she had an ultrasound that demonstrated "too much amniotic fluid" and the fetus' stomach was "not in the right place."

Upon physical examination, the newborn is cyanotic and gasping for air. The abdomen is scaphoid and the chest is distended.

Which of the following is a true statement?

A. The defect is most commonly found on the right side.
B. Associated abnormalities are uncommon.
C. The classic defect is found in a posterolateral position.
D. ECMO is required in the majority of patients.
E. Immediate surgery prevents chronic pulmonary symptoms.

Correct Answer: C

This newborn has a congenital diaphragmatic hernia (CDH). This is a diaphragmatic defect, present since birth, which allows herniation of abdominal organs into the thoracic cavity. Bochdalek and Morgagni hernias are types of CDH. Morgagni hernia occurs anteriorly at the sternocostal junctions of the diaphragm, and Bochdalek hernias develop posterolaterally at the lumbocostal junctions of the diaphragm. Bochdalek hernia presents immediately after birth and is commonly associated with pulmonary hypoplasia.

In the United States, approximately 1000 babies are born with this condition annually. Most patients are diagnosed in the first 24 hours, but 10–20% may present later in life. The etiology is unknown. CDH results from a failure of closure of the pleuroperitoneal canals during the eighth week of gestation which in turn has an impact on pulmonary development. Associated malformations may be found in 10–50% of patients. Eighty percent of congenital diaphragmatic hernias occur on the left side. The typical left-sided CDH is a 2.0- to 4.0-cm defect on the

posterolateral aspect of the diaphragm. The abdominal viscera (liver, spleen, stomach, and GI tract) herniate into the hemithorax through this defect.

Bochdalek hernia occurs on the left side in up to 80% of patients. Right-sided Bochdalek hernia contains liver in the right chest. Morgagni hernias constitute approximately 2–3% of surgically treated diaphragmatic hernias. Both lungs are affected by unilateral CDH, although hypoplasia is worse on the side with the defect. The pulmonary vascular bed is also abnormal. Prenatal diagnosis is made by ultrasound. Findings include polyhydramnios and stomach or other viscera located in the chest. Prenatal MRI may also be indicated at times. After birth, a chest radiograph is diagnostic. Abdominal viscera are seen in the chest.

Initial treatment is both physiologic and surgical. The infant is intubated and resuscitated. A nasogastric tube should be placed to decompress the bowel. Pulmonary hypertension is treated and surgical correction is scheduled. A total of 10–20% of infants will require ECMO.

Take-Home Message

Late presentation of congenital diaphragmatic hernia occurs with nonspecific gastrointestinal signs and symptoms and rarely strangulated herniated viscera.

Initial stabilization is crucial before surgical intervention.

ABP Content Specification

- Recognize the pathophysiology of diaphragmatic hernia.
- Recognize the signs and symptoms of a diaphragmatic hernia.
- Know what ancillary studies are used to diagnose diaphragmatic hernia.
- Know the treatment of diaphragmatic hernias.

Question 6

A 1-month-old girl is sent to the emergency department by her pediatrician for bilious vomiting and appearing sick. The infant was previously healthy and has achieved normal developmental milestones. She is in the 80th percentile for height and weight. In the emergency department, the infant is tachycardic. She has bilious vomiting. She is afebrile and appears dehydrated and ill. The abdomen is scaphoid and diffusely tender.

Which of the following radiologic studies may be useful in making the diagnosis?

A. Plain abdominal radiograph
B. CT scan of the abdomen
C. Ultrasound of the abdomen
D. Upper GI series
E. All of the above

Correct Answer: E

This patient has a midgut volvulus. Although the abdominal X-ray may not always be useful, it can demonstrate paucity of air in the abdomen except for an air bubble in the stomach and one in the duodenum. Ultrasound may be used as a screening tool. It demonstrates a "whirlpool" flow pattern of the superior mesenteric vessels. CT scan can also demonstrate a "whirlpool" flow pattern. The study of choice is an upper GI contrast study which is the "gold standard" for the diagnosis of malrotation and volvulus. The duodenojejunal junction is seen to the right side of the abdomen, as is the small bowel. The colon and cecum are located in the left side of the abdomen. Generally, the small intestine is rotated to the right side of the abdomen and a narrowing at the site of obstruction has a corkscrew appearance.

Midgut volvulus occurs as a result of intestinal malrotation. Normal midgut fixation occurs during weeks 5 to 12 of gestation. Interruption of this process leads to malrotation. Intestinal malrotation causes the intestines not to be properly "fixed" by the mesentery. The term malrotation refers to a spectrum of rotational abnormalities; they are present in about 1% of the population.

Midgut volvulus is a surgical emergency and an expeditious diagnosis must be made to prevent intestinal infarction. A laparotomy is performed and the bowel is detorsed in a

counterclockwise manner. Peritoneal bands tethering the bowel and mesentery are released. Peritoneal attachments between the cecum and abdominal wall are released. An appendectomy is performed. This operation is referred to as the Ladd Procedure.

Acute duodenal obstruction may occur as a result of a Ladd's band causing extrinsic compression. A "double bubble" sign may sometimes be seen on an abdominal X-ray. The proximal "bubble" is gas-filled stomach on the left side. The distal bubble is proximal to the duodenum on the right side. Malrotation should be considered in any neonate who presents with bilious emesis.

Take-Home Message

Bilious vomiting is suggestive of intestinal obstruction and should be considered a surgical emergency until proven otherwise. Midgut volvulus is a surgical emergency and requires immediate treatment. A delay in diagnosis may result in extensive bowel infarction and death.

ABP Content Specification

- Know what ancillary studies are used to diagnose midgut volvulus.
- Know that midgut volvulus is a surgical emergency and delay in treatment will result in bowel infarction.
- Know the pathophysiology of volvulus.
- Know the treatment of midgut volvulus.

Question 7

The parents of a 4-week-old boy bring their child to the emergency department because the child vomits after each feeding. The vomiting has gotten worse over the last day and is now described as projectile. Prior to the last 3 days, the infant was well. He recently started vomiting and the parents changed the formula to see if that would help, but the vomiting has gotten worse.

On physical examination, the child is crying and is initially difficult to examine. Once the patient stops crying, a mass is palpated in the right upper quadrant. Results of his basic metabolic profile are shown below:

- Sodium 124 mEq/L
- Potassium 2.6 mEq/L
- Chloride 79 mEq/L
- Bicarbonate, 40 mEq/L
- Glucose, 96 mg/dL
- Blood urea nitrogen (BUN) 33 mg/dL
- Creatinine 1.0 mg/dL

The emergency physician discusses the diagnosis with the parents. The next step is the following:

A. Emergency surgery
B. Repletion of fluid and electrolytes
C. CT scan of the abdomen
D. Reassurance that this is a viral condition which is self-limiting
E. A contrast study

Correct Answer: B

This child has hypertrophic pyloric stenosis. Hypertrophy of the pyloric smooth muscle results in gastric outlet obstruction. There is a male to female ratio of 4:1 and there is a familial disposition.

The typical history is that of a healthy child that develops progressive nonbilious projectile vomiting after feeding. Typical presentation occurs between the ages of 2 and 12 weeks. A pathognomonic finding on physical examination is a mobile "olive" in the right upper quadrant or in the right epigastric region. This represents the hypertrophied pylorus. This may be apparent in a thin, dehydrated child with prolonged illness. A peristaltic wave may be visible across the abdomen after eating. Repeated vomiting of gastric contents and loss of chloride lead to a hypochloremic, hypokalemic metabolic alkalosis from loss of hydrogen and chloride ions from the stomach contents.

Diagnosis is made via abdominal ultrasound. A normal pylorus is 3–4 mm thick, 15–19 mm, in length, and 10–14 mm in diameter. Sonographic measurements exceeding these strongly suggest the diagnosis. Contrast studies may diagnose other causes of vomiting. A CT scan is not recom-

mended for the diagnosis of pyloric stenosis. The treatment is pyloromyotomy after appropriate correction of metabolic derangements. This repletion of fluids and correction of electrolyte imbalance may take 12–72 hours, depending on the severity at presentation. These children are often hypovolemic and hypokalemic and the administration of general anesthesia can result in complications or death without adequate correction.

The following are a few considerations for the anesthesiologist:

- Full stomach
- Metabolic alkalosis with hypochloremia and hypokalemia
- Severe dehydration

Opioids should be avoided because of the risk of postanesthetic apnea in pyloric stenosis patients.

Postoperatively, these children should be observed with apnea monitors and pulse oximetry.

Take-Home Message

The pathognomonic finding for pyloric stenosis on physical exam is a mobile "olive" in the right upper quadrant. ED management should consist of rehydration and correction of electrolyte before surgical procedure.

ABP Content Specification

- Know the pathophysiology of pyloric stenosis.
- Recognize the signs and symptoms of pyloric stenosis.
- Know the indications and interpret results of imaging studies.
- Know the management of pyloric stenosis.

Question 8

A 5-day-old is brought to the emergency department for inability to feed. Upon further questioning, the parents state the infant has been having bilious vomiting and abdominal distention. In addition, the child has not had a bowel movement since she left the hospital when 2 days old. The mother had prenatal care and had prenatal ultrasounds. She was told she had polyhydramnios, but the fetus did not exhibit any abnormalities. On physical examination, the neonate has a distended abdomen, and there are visible peristaltic waves. The diaper is clean and the anorectal exam is normal.

The next step in managing this neonate is:

A. Emergency laparotomy to prevent midgut gangrene
B. Upper GI contrast study
C. Ultrasound of the abdomen
D. Contrast enema
E. Diagnostic laparoscopy

Correct Answer: D

This patient has neonatal intestinal obstruction. The maternal history of polyhydramnios is suggestive of an obstruction. Amniotic fluid is normally absorbed into the fetal intestine. This process is interrupted in a fetus with a congenital small bowel obstruction and the amniotic fluid accumulates in the amniotic sac.

The history and physical examination of the neonate also suggests neonatal intestinal obstruction. These patients are unable to pass meconium and they develop bilious emesis and abdominal distention. The degree of distention depends on how proximal the obstruction is. A nasogastric tube should be placed to decompress the intestine.

Nonbilious vomiting suggests upper gastrointestinal tract obstruction proximal to the ampulla. Examples include esophageal atresia, gastric/duodenal webs, pyloric and duodenal stenosis, and atresia. Bilious vomiting suggests intestinal obstruction. Jejunoileal atresia and stenosis are the most common congenital anomalies of the small intestine and are a major cause of intestinal obstruction in neonates.

An abdominal radiograph is part of the initial evaluation for intestinal obstruction caused by jejunal or ileal atresia. The intestine proximal to the atresia will be dilated and the intestine distal to the atresia will be gasless. An upper GI contrast

study is contraindicated because this will result in vomiting and possible aspiration. A contrast enema is used to confirm the diagnosis. Findings include the inability of the contrast to reflux into the small intestine proximal to the obstruction and microcolon (normal but unused colon). Ultrasound is not helpful in the diagnosis.

The treatment of intestinal atresia is surgical, but a specific diagnosis should be made prior to surgery. Each procedure is individualized and depends on the type and extent of the atresia.

Take-Home Message

Neonatal intestinal obstruction results from congenital anomalies of the small intestine. Intestinal atresia and stenosis are common causes.

ABP Content Specification

- Recognize the signs and symptoms of obstruction.
- Know what ancillary studies are used to diagnose obstruction.
- Know the treatment plan of bowel obstruction.

Question 9

You are a volunteer on a medical mission in a low resource country. You are woken up at night by a colleague to help with a newborn that was just delivered. The mother is very young and a primigravida. She has received no prenatal care. The neonate is premature, has a low birth weight, but is breathing spontaneously. APGARS are 7. The most notable part of the physical examination is evisceration of the small bowel. There is no covering over the bowel that is thickened and inflamed.

Which of the following statements is true?

A. Associated anomalies occur in 90% of patients.
B. The defect is almost always to the left of the umbilicus.
C. Herniation of the liver is common.
D. Both A and B are correct.
E. None of the above.

Correct Answer: E

This neonate has a gastroschisis. Gastroschisis is the most common abdominal wall defect. It is characterized by a full-thickness defect of the abdominal wall, usually to the right of midline and not involving the umbilicus. This causes evisceration of abdominal contents without any sac or covering membrane. The lack of amniotic sac covering causes the exposure of a large surface area to the external environment. This can result in rapid insensible fluid losses and hypothermia. Therefore, adequate fluid resuscitation along with early physiologic coverage is important for survival. The small intestine is always present, which is inflamed, edematous, and covered with fibrinous exudate. This appears to be a reaction to direct contact with the amniotic fluid. The abdominal wall defect is almost always on the right side. The liver is rarely involved. Children with gastroschisis are less likely to have other associated defects (10%).

An omphalocele is characterized by a midline defect of the ventral abdominal wall. This causes extrusion of intra-abdominal contents, which are covered by a membrane composed of peritoneum, Wharton's jelly, and amnion. This may contain bowel, liver, and other organs.

Initial management of patients with gastroschisis and omphalocele are similar. An airway and orogastric tube must be secured. Attention to maintaining body temperature is imperative. Fluid resuscitation may be necessary in patients with gastroschisis. A temporary covering for the viscera must be established—this can be done by wrapping the viscera in gauze soaked in warm saline or by covering the lower half of the infant in a plastic bowel bag. Surgical correction involves closure of the abdominal wall defect. This can be accomplished in 60–70% of patients. Staged closure with a silo is required in the remainder of these patients.

Take-Home Message

Gastroschisis is the most common abdominal wall defect and it requires surgical correction. Clinically omphalocele and gastroschisis can be

differentiated by the covering of the viscera by peritoneum; omphalocele is covered and gastroschisis is not.

ABP Content Specification

- Recognize the different types of abdominal wall defects.
- Differentiate the pathophysiology of the two types of defects.
- Know that omphalocele has a higher incidence of associated anomalies.
- Know the treatment plan of abdominal wall defects.

Question 10

A grandparent is caring for a neonate because the single parent of the child has been hospitalized. The grandparent is frantic because the neonate is not tolerating feeding and has vomited once. The baby was born full term and the mother is healthy. Prenatal care was intermittent, but no problems were identified during these visits. The grandparent also thinks it is unusual that the infant's diaper has not had any stool in it.

On physical examination, the vital signs are normal. The child is not vomiting in the emergency department. There are no findings other than a distended abdomen. There is no peritonitis. An abdominal X-ray is performed that shows a distal bowel obstruction. A contrast enema is subsequently performed. It demonstrates a transition zone between the dilated sigmoid and a constricted rectosigmoid junction.

Which of the following is true?

A. This condition is not seen in older children.
B. Some patients have enterocolitis.
C. There are almost never other anomalies associated.
D. Anorectal manometry is the diagnostic study of choice.
E. This condition is self-limiting and requires only observation.

Correct Answer: B

This patient has Hirschsprung's disease. Hirschsprung's disease is a condition that is defined by absence of the ganglion cells in the myenteric and submucosal plexuses of the distal intestine. As a result of this, there is no peristalsis in the affected segment and the patient develops a functional obstruction. Up to 80% of patients are male.

The clinical presentation includes delayed passage of meconium, feeding intolerance, abdominal distension, and bilious vomiting. The presentation usually starts shortly after birth with abdominal gaseous distention, delayed meconium passage, and a tight anal sphincter. However, some patients with a relatively short segment of involved colon may present later in life.

Less common presentations include the following. Chronic constipation may be seen in older children and even adults. The complications include acute intestinal obstruction and enterocolitis. Clostridium difficile has been isolated in children with associated enterocolitis. A mortality rate of up to 30% has been reported in this type of enterocolitis.

There is a spectrum of associated anomalies that can be seen with Hirschsprung's disease, including Down's syndrome. The diagnosis is suspected by the history and physical examination, especially the history of delayed passage of meconium. An abdominal X-ray may show a distal bowel obstruction. A contrast enema shows a transition zone between the narrowed distal and dilated proximal intestine.

A suction rectal biopsy is the gold standard for making the diagnosis of Hirschsprung's disease. Pathology demonstrates the absence of ganglion cells in the submucosal and myenteric plexuses. Anorectal manometry is not widely available for neonates and is difficult to perform. It is used in older children with chronic constipation. A false-positive result may occur due to a capacious rectum in a child with constipation or megacolon. In such children, balloon distention may not stimulate the reflex.

Take-Home Message

Obstruction at the level of the sigmoid should raise the suspicion for Hirschsprung's disease.

This is a functional obstruction caused by absence of ganglion cells resulting in a lack of peristalsis. The typical presentation is failure to pass meconium in first 48 hours of life.

ABP Content Specification

- Understand the pathophysiology of Hirschsprung's disease.
- Recognize the signs and symptoms of Hirschsprung's disease.
- Know what studies are performed to evaluate for Hirschsprung's disease.
- Know potential complications (Hirschsprung-associated enterocolitis).
- Know that the management is surgical.

Question 11

A 9-year-old child is brought to the emergency department by her foster mother. The foster mother does not know a great deal of medical history about the child, but she knows that the patient had infections and abscesses of the neck area that were previously drained. Today the child is complaining of pain and redness near the jaw. On physical examination, the child is not in distress. There is no fever and the vital signs are normal. The child is breathing without difficulty. There is a punctate opening in the left side of the neck in the submandibular area and there is surrounding cellulitis.

The differential diagnosis includes the following:

A. Hygroma
B. Hemangioma
C. Infected 1st branchial cleft cyst
D. Sialadenitis
E. Thyroglossal duct cyst

Correct Answer: C

The history and physical examination in this child suggest an infected branchial cleft cyst arising from the first branchial cleft remnant.

In children, branchial cleft remnants typically present as lateral neck masses. Incomplete development results in cysts, sinuses, and fistulas. These occur along the course of the 1st, 2nd, 3rd, or 4th branchial clefts as a result of improper closure during embryonic life.

These branchial remnants are present at the time of birth but often not recognized until later in life. These lesions can manifest as sinuses, fistulas, or cartilaginous rests in infants. All of these lesions are at risk of infection. Secondary infection may cause sudden swelling of the lesions. Second branchial cleft remnants are the most common (80%).

Branchial cleft	Internal opening	External opening
First	External auditory canal	Angle of mandible or in the front or back of the ear
Second	Tonsillar fossa	Anterior border of the sternocleidomastoid muscle
Third	Piriform sinus	Suprasternal notch or clavicular region

The first branchial cleft is seen as a sinus opening in the submandibular area. It is often misdiagnosed and there can be a previous history of drainage. The 4th branchial anomalies are rare. They occur mostly on the left side. There is a fistulous connection between the piriform sinus and the neck.

The treatment is complete excision of the branchial anomaly; this may prevent recurrent infections. The entire tract should be excised and attention is paid to the nerves that are in proximity to the lesions. Beware that first branchial cleft remnants are in close proximity of the parotid gland and facial nerve. Also, the third branchial cleft is near the superior laryngeal and recurrent laryngeal nerve.

Thyroglossal duct cysts are located in the midline. Hemangiomas are endothelial tumors and are red or blue. They can be found anywhere on the body. The natural history is growth and involution. A hygroma is a lymphatic malformation. These lesions can be found in the submandibular area and can become infected. There is no punctate opening at the skin level as with branchial anomalies. Sialadenitis occurs mostly in adults

when stones within the salivary gland cause obstruction and swelling predisposing to secondary infection.

Take-Home Message
During embryogenesis branchial arches and clefts may not develop normally. There is a spectrum of congenital neck anomalies that can result in cysts, sinuses, and fistulas. These can present as abscesses and "masses" in the neck.

ABP Content Specification
- Recognize how embryologic development can result in a spectrum of neck anomalies.
- Know the differential diagnosis of neck masses.
- Know the treatment for branchial cleft cysts.

Question 12

A 4-year-old boy is brought to the emergency department by his parents because of a neck mass. The parents state the mass changes size and sometimes it is smaller than what it appears today. The child was born full term and is otherwise healthy. He does not have any other symptoms. On physical examination, the patient is not in any distress. He has no fever and the vital signs are normal. He is able to speak without difficulty and is able to swallow his secretions. The mass is approximately 2 × 2 cm and is located in the midline of the neck. When the patient swallows, the mass moves cephalad.

Which of the following statements is true regarding this condition?

A. The lesions are always midline.
B. Less than 10% of lesions are adjacent to the hyoid bone.
C. During development the thyroglossal duct does not communicate with the ectoderm, and therefore there is no risk for infection.
D. In 1–2% of patients, the midline lesion is ectopic thyroid.
E. These lesions are never malignant.

Correct Answer: D

Thyroglossal duct cysts are the most common midline neck masses seen in children. During embryologic development, the thyroid descends from the base of the tongue to its position in the neck. Usually, the thyroglossal duct becomes obliterated early in embryonic life. Thyroglossal duct cysts represent failure of the thyroglossal duct to completely involute; remnants of the duct may develop into cysts.

Although thyroglossal duct cysts are congenital, they do not manifest in infancy. They generally present as a mass or sinus by the age of five. The cyst and tract are attached to the foramen cecum of the tongue and this is why the lesion moves with tongue movement. The majority of lesions are midline but up to 40% are lateral to the midline. Sixty percent of lesions are adjacent to the hyoid bone. There is no communication with ectoderm but there is communication with the oral cavity. It is for this reason the lesion can change size and get infected. Thyroglossal duct remnants can contain ectopic thyroid. In 1–2% of the time, the midline lesion is a median ectopic thyroid and may be the only thyroid tissue present in the patient. It is important to determine whether patient has a normal thyroid gland before surgery; removal of ectopic thyroid gland tissue may result in hypothyroidism if no other functional thyroid gland tissue is present.

The recommended treatment is surgical to prevent recurrent infections. The operation is called the Sistrunk procedure and involves complete resection of the cyst and its tract in continuity with the central hyoid bone. Malignancy within the thyroglossal duct cyst has been described.

Take-Home Message
Thyroglossal duct cysts are the most common anterior midline neck masses seen in children. These are remnants of the embryologic thyroglossal duct that failed to involute.

ABP Content Specification
- Understand the anatomy of thyroglossal duct cysts.
- Know the treatment is operative and requires removal of the cyst and a part of the hyoid bone.

Question 13

A family has recently immigrated to the United States. The youngest child, who is 10 years old, has a neck mass. The family brought the child to the emergency room because they do not have a pediatrician yet. The child has been enrolled in a local school but has not yet started. He was previously healthy and playful but recently he has been more withdrawn. The parents attributed this to the recent move. The mother noticed a mass on the lateral aspect of the neck 2 weeks ago, and it has not gone away as she had hoped it would. She also says the bed sheets are damp with sweat in the mornings after the child wakes up. On physical examination, the child is sitting quietly in a chair. He does not complain of anything. His oral temperature is 100.0. The pulse and heart rate are normal. There is a palpable mass in the lateral aspect of the neck. It is approximately 2 × 2 cm. It is not tender. It feels rubbery. There is no overlying cellulitis. The oropharynx is clear. There are no exudates in the throat. The tonsils are not enlarged. The chest exam has congestion and the abdomen is benign. There is a scratch at the base of the neck of the patient.

The differential diagnosis includes the following:

A. Cat scratch disease
B. Mononucleosis
C. Lymphoma
D. Tuberculosis
E. All of the above

Correct Answer: E

Enlarged cervical lymph nodes are the most common neck masses in children. Mostly these represent benign reactive cervical lymphadenopathy which arises secondary to nonspecific reactive hyperplasia.

Bacterial and viral infections can lead to lymphadenopathy and acute suppurative lymphadenitis. Fungal infections can be seen in immunocompromised children. Cat scratch disease is a common cause of lymphadenopathy in children. It is caused by a gram-negative bacillus, *Bartonella henselae*. The diagnosis can be made by skin testing or serology. It is a self-limiting disease. Cervical lymphadenitis secondary to tuberculosis is called scrofula. The mycobacterial infections can cause cervical adenopathy. The most common presentation is due to *Mycobacterium avium-intracellulare-scrofulaceum* (MAIS) complex which causes localized cervical lymphadenopathy.

Mycobacterial tuberculosis usually causes pulmonary infection and hilar adenopathy but cervical node enlargement is uncommon. However, atypical mycobacterial organisms may involve the submandibular, submaxillary, or preauricular lymph nodal regions.

The diagnosis is made by chest X-ray and a purified protein derivative (PPD) panel. A negative or indeterminate PPD test is noted in atypical mycobacterial infection and QuantiFERON gold test can be useful to differentiate tuberculosis from nontuberculous mycobacterial infections. Children with scrofula have pulmonary symptoms.

Nontuberculous mycobacterial lymphadenitis occurs in children between the ages of 1 and 5 years. It is caused by any one of a number of acid-fast bacilli found in the environment. It is not associated with disseminated disease and is limited to a lymph node, usually a submandibular node. Treatment includes surgery and/or antibiotics. Surgery can be curative if the entire node is removed. If removing the node poses a risk to the facial nerve, antibiotics are recommended as an alternative.

Cervical lymphadenopathy can less frequently be secondary to malignancy. Lymphoma can present in this manner. The diagnosis is made by a thorough history and physical, imaging, and FNA or lymph node biopsy.

Take-Home Message

Cervical lymphadenopathy can be benign or it can be pathologic. The differential diagnosis includes infectious and malignant causes. Resection should be avoided in *Mycobacterium tuberculosis* infection because of the risk of developing chronically draining sinuses. If the cause is nontuberculous mycobacterium, surgery may be the definitive treatment.

ABP Content Specification

- Understand the evaluation and management of neck masses in children.

Question 14

A 12-year-old girl went fishing for the first time with her father. While he was pulling a fish out of the water, his daughter got the fishhook caught in her finger. The father rushed his daughter to the emergency department. After calming the father down, you get the patient into an exam room. Which of the following statements is *false?*

A. Most injuries with fishhooks involve the face, head, or hand.
B. Simple retrograde technique, string pull technique, and needle cover technique are all methods for removing superficial fishhooks.
C. Advance and cut technique is useful for deeply embedded fishhooks.
D. The incision technique is not usually successful in removing fishhooks.
E. Barbs on hooks can injure the treating physician.

Correct Answer: D

Fishhook injuries are frequently found in the face, head, or hands. These are usually contaminated injuries. In all techniques, the area should be prepped and local anesthesia infiltrated. Care should be taken by the treating physician while removing hooks with barbs in order to avoid injury.

For a hook that is deeply embedded, the advance and cut technique is usually successful. In this technique, the hook is advanced till the tip breaks through the skin. The tip with the barb is then cut and the remaining part of the hook is withdrawn in a retrograde manner through the original entry point.

The incision technique is usually successful. In this technique, a #11 blade is slid along the entry into the skin and a small incision is made down to the barb along the shaft of the hook. The barb is disengaged and then withdrawn through the incision.

If the hook is superficial, the simple retrograde technique may be useful. Pressure is applied to both the skin over the hook and the shank of the hook. This allows the barb to disengage and the hook can be withdrawn in a retrograde manner. In the string pull technique, a string is wrapped around the curve of the hook. While pressure is applied to the shank, the string is quickly pulled and the hook is withdrawn in a retrograde manner. In the needle cover technique, an 18-gauge needle is inserted at the entry point of the hook into the skin and it is advanced to cover the barb. The hook with the needle cover over the barb is then withdrawn in a retrograde manner.

Take-Home Message

Caution is needed when removing a fish hook. It may be more traumatic to back out the hook.

It is often necessary to advance the hook and cut the barb first.

ABP Content Specification

- Understand that a fish hook should not simply be pulled out because the barb will get stuck.
- The advance and cut technique involve pushing the hook out, cutting the barb, and then pulling it back out the way it entered the skin.
- Know alternative ways to remove a fish hook.

Question 15

The parents of a 2-week-old infant bring the baby to the emergency department because of a persistent cough. The child was born full term and the mother had all her prenatal visits. Prenatal ultrasounds did not show any congenital problems. Upon examination the child appears healthy and well nourished. There is no fever. The lungs are clear. The mother asks the emergency physician to evaluate the umbilicus. A 5 mm moist pedunculated lesion encompasses the umbilicus. She wants a second opinion. She says the pediatrician has "treated" this lesion once but it persists. Which of the following statements is *false?*

A. Umbilical granulomas are congenital.
B. Urachal duct, umbilical polyps, and omphalomesenteric duct remnants may be confused with umbilical granulomas.
C. The most common treatment is cauterization with a silver nitrate stick.
D. Silver nitrate can burn the surrounding umbilical skin.
E. Surgical excision of an umbilical granuloma is rarely necessary.

Correct Answer: A

An umbilical granuloma is granulation tissue at the umbilicus that has not epithelialized and is wet and inflamed. It sometimes develops in the umbilicus soon after separation of the cord. It can vary in size from 3 to 10 mm. It may be misinterpreted as a urachal duct, an umbilical polyp, or an omphalomesenteric duct remnant. If an umbilical granuloma is repeatedly treated and does not resolve, the lesion may represent one of these conditions. A silver nitrate stick may be used to cauterize the lesion; this may require multiple applications. Care should be taken not to burn the surrounding skin. Surgical excision is usually not necessary. Umbilical granulomas are not congenital lesions.

Take-Home Message
Umbilical granulomas can be treated with serial application of silver nitrate sticks.

ABP Content Specification
- Know the significance of an umbilical granuloma.
- Know the differential diagnosis of umbilical lesions.
- Know how to treat an umbilical granuloma.

Question 16

An 11-year-old boy fell off his skateboard during recess. He sustained isolated lacerations to his forehead and left knee. The school nurse covered the wounds with gauze, and he was referred to the emergency department of the local hospital. The patient is calm but the patient's mother is hysterical. She is concerned about infection, foreign bodies, and cosmesis. The child is healthy and up to date on his vaccinations. On physical examination, there are two lacerations and no suspicion for other injuries. The forehead laceration is 0.5 cm, clean, superficial, and linear. The knee laceration is 3 cm, jagged, and has debris in it.

Which of the following statements is true?

A. The forehead laceration should be closed within 1 hour to prevent infection.
B. Staples should be used to close the knee laceration.
C. The knee laceration can be closed with skin adhesive.
D. The maximum dose of lidocaine with epinephrine is 4 mg/kg.
E. The most important intervention to decrease wound infection is irrigation.

Correct Answer: E

Wound care and closure is based on both patient factors and mechanism of injury. The presence of foreign bodies, devitalized tissue, and bites increases the risk for wound infection. The timing of closure also influences infection rates; 6–12 hours are considered the cut-off value for closing open wounds. This time line may be extended in face and scalp lacerations because of the abundant blood supply. These wounds may be closed up to 24 hours after injury. In general, bites should not be closed unless they are gaping. Antibiotics are recommended for contaminated wounds, bites, and injuries involving tendons and joints. Irrigation and removal of foreign bodies and devitalized tissue are the most important steps to prevent infection. Tetanus immunization status should be considered. If the wound is contaminated and the child has not completed his vaccinations, tetanus immune globulin should be administered IM and around the wound. If the history suggests the possibility of a foreign body, a radiograph should be obtained. In certain instances, ultrasound or CT scan may be necessary if radiographs are negative but clinical suspicion is high.

Lidocaine with or without epinephrine is generally used for anesthesia. The maximal dose of Lidocaine without epinephrine is 4 mg/kg; with epinephrine is 7 mg/kg. Lidocaine is fast acting, and the duration of action is 1–2 hours.

The wound should be irrigated with water or saline and foreign debris removed if present. Superficial wounds may be closed with a single layer of sutures or staples. Staples are not recommended for irregular wounds. Steristrips and tissue adhesives can be used on superficial lacerations that are not under tension. They should not be used over joints.

Take-Home Message
Wound management depends on both wound and patient factors

ABP Content Specification
- Know the acceptable timing of wound closure.
- Know the basic principles of wound care.
- Remember to consider foreign bodies and know imaging techniques to assess for them.
- Know maximal doses of local anesthetic.

Question 17

A 10-year-old boy with a progressive neurologic disorder had a gastrostomy placed 3 months ago. The parents have not yet grown accustomed to the tube. While trying to bathe the child, it was accidentally dislodged. They rushed the child to the emergency department and are anxious that "something bad is going to happen." They have the tube with them. Upon physical examination, the child is at his baseline neurologic state. The vital signs are normal and he has no fever. He is in no apparent distress. There is a 1 cm stoma in the left upper quadrant from where the gastrostomy tube became dislodged. There is no surrounding erythema or drainage. The abdomen is soft and nontender. The tube the parents show you is not broken and the balloon is intact.

Which of the following statements is *false* regarding feeding tubes?

A. Accidental removal of a feeding tube is common.
B. If a replacement G-tube is unavailable, a Foley catheter may be used temporarily.
C. If flushing the replaced tube is not easily accomplished, a contrast study is required.
D. A sterile stylet should be used to remove particulate matter from the G-tube.
E. Flushing the G-tube with warm water and a 60cc syringe may unclog a tube.

Correct Answer: D

Common complications of feeding tubes include dislodgement, fracture, clogging, leakage, stoma cellulitis, gastric ulceration, and gastric obstruction. Dislodgement of the tube is the most common complication. The date of insertion is an important part of the history because tubes that have been in place less than a month do not have a mature tract that has formed. Attempts at reinsertion of a tube in a tract that is not mature may result in the misplacement of the tube into the peritoneum. This will result in peritonitis if the child is fed through the misplaced tube. If a G-tube has been present for more than 1 month, it may be replaced with a replacement G-tube. If a G-tube is not available, a Foley catheter may be used as a substitute. Also important is information regarding how long the tube has been out. The longer the tube has been out, the increased likelihood that the stoma has started to contract; a smaller tube may be required for reinsertion. A tube should never forcefully be reinserted. If there is any question regarding the position of a tube that has been reinserted, a contrast study should be obtained. A dislodged jejunostomy tube that was originally placed in the operating room should be evaluated by a surgeon.

Tubes that are in place but cannot be flushed may be twisted, kinked, or clogged. Aspirating and flushing with warm saline may help unclog a tube. A 60 mL syringe should be used. If the tube is old, it may have to be replaced. Inserting a sharp object into the tube is discouraged as this may perforate the tube.

Take-Home Message
Prompt replacement of a dislodged G-tube should be accomplished to avoid contraction and closure of the gastric stoma.

ABP Content Specification
- Know the different types of feeding tubes.
- Recognize common complications of feeding tubes.
- Know how to treat complications of feeding tubes.

Question 18

A 1-year-old boy is brought to the emergency room by his father. The child has been uncharacteristically inconsolable. He is healthy and was last seen by his pediatrician 1 month ago. He was eating and playing normally up until 2 days ago. Since then he has been pulling at his foot and today the father noticed that the third toe on his left foot is swollen and red. On physical examination, the patient does not have fever. Blood pressure and pulse are within normal limits. He is crying and nothing seems to distract or quiet him down. Inspection of his lower extremities is normal except for the third toe of his left foot. There is swelling and erythema of the distal phalanx. There is a demarcation and constrictive element though no foreign body is seen.

Which of the following statements is true regarding this condition?

A. Antibiotics and warm compresses should be initiated, and the patient should be followed up with the pediatrician in 1 week.
B. Examination of an inconsolable child with no apparent reason should involve a careful examination of the fingers, toes, and genitalia.
C. Child protective services should be called immediately.
D. Obtain immediate radiograph of his foot.
E. Obtain urgent CBC, ESR, and CRP.

Correct Answer: B

This child has Hair-tourniquet syndrome (also known as acquired constricting ring syndrome). This condition occurs when a strand of hair or thread inadvertently gets wrapped around a digit or the genitalia. As the hair or thread starts to desiccate, it shrinks and causes a constriction which then leads to edema distal to the constriction. Initially the offending agent may be visible, but as the edema progresses, the hair or thread may become embedded deep in the tissue and is no longer visible. The child may then appear to be inconsolable for a reason that is not immediately evident. The parent and the physician may be fooled into thinking there is a cellulitis of the affected area without a thorough examination.

Hair-thread tourniquet syndrome can occur in infants, older children, and adolescents. It may involve the fingers, toes, penis, clitoris, or labia. A child that is inconsolable and does not have an obvious etiology should be thoroughly examined and have socks and shoes removed. The genitalia should also be examined. Hair-thread tourniquet is usually accidental; child abuse may occasionally be suspected.

If left untreated, the affected area will become gangrenous. Treatment requires complete removal of the hair or thread. A No. 11 blade can be used to cut the constricting band. It is sometimes difficult to assess if all of the thread or hair has been removed because the affected area initially maintains the same appearance with a constricting groove. Application of hair removing agents (Depilatory agents) has met with success in some cases.

Take-Home Message
An inconsolable child with no apparent reason should involve a careful examination of fingers, toes, and genitalia to evaluate for hair-tourniquet syndrome.

ABP Content Specification
- Know what hair-tourniquet syndrome is.
- Know how it presents.
- Know how to treat it.

Question 19

A mother brings her 5-year-old daughter to the emergency department because, in a moment of jealousy, the girl put her younger sister's ring on her finger and now it is stuck. The mother tried pulling it off but the girl is crying inconsolably. The mother says the finger has swollen considerably on the way to the emergency department. On physical examination, the child is crying. The temperature is 98, and the pulse and blood pressure are within normal limits. The ring finger on the right hand has a gold ring that is clearly constricting the digit. The finger distal to the ring is swollen.

Maneuvers to remove the ring include all of the following except

A. Lubricated the digit with soap or petroleum jelly
B. Winding a suture around the digit to decrease the edema
C. Using a ring cutter
D. Using a high-speed rotary cutting instrument on loan from engineering
E. Heating the ring to cause expansion of the metal

Correct Answer: E

Rings can become stuck on fingers and create a tourniquet effect. Venous and lymphatic return is occluded and the digit distal to the ring becomes edematous and may become ischemic if the ring is not removed.

Elevation of the limb should begin immediately. If the finger is not significantly swollen, lubrication is applied with soap or petrolatum jelly and an attempt is made to remove the ring. If this is not successful, a silk suture or umbilical tape can be wrapped around the finger starting at the tip and progressing toward the ring. The free end is passed under the ring and an attempt is made to remove the ring by unwinding the suture or tape.

If these maneuvers are attempted and fail, or if the finger is too edematous to try these initial methods, a ring cutter may be necessary. Ring cutters may be manual or electric. Occasionally the constricting "ring" is not a piece of jewelry. It may be a metallic object (a steel washer, nut, or other hardware) and a high-speed rotary cutting instrument is necessary to remove it. In these cases, caution is necessary to prevent secondary injuries by generated heat or filings of metal created by the tool. The ring should never be heated—this will result in a circumferential burn of the finger.

Take-Home Message

There are multiple ways to remove a ring that is constricting a finger. The method will depend on how swollen the finger is. In the presence of extreme swelling, there may not be a sufficient gap between the ring and the finger to slip on a string.

ABP Content Specification

- Know that a constricting ring should be immediately removed.
- Know the different approaches to ring removal.

Question 20

A 16-year-old boy is brought to the emergency department by his 30-year-old brother who is his legal guardian. The teen has been limping for the last 2 days, and his brother finally convinced him to remove his new sneakers that he has been wearing nonstop. The older brother noticed the big toe of the left foot was red and the nail "looked funny." The teen tells the physician that his sneakers were a little tight and he thought that if he trimmed his toenails, the sneakers would fit better. The sneakers initially felt better but over the last few days, the big toe on his left foot has become painful along the nail. It has gotten progressively more red and swollen. On physical examination, the patient has no fever. The hallux of the left foot has a shortened toe nail and there is surrounding erythema on the lateral aspect of the nail.

Which of the following statements is true?

A. A podiatrist is almost always needed to treat this condition.

B. Oral antibiotics are always needed to treat this condition.
C. The nail should never be removed because it will result in a permanent cosmetic deformity.
D. The use of phenol is contraindicated in the treatment of this condition.
E. The procedure can be performed under digital block.

Correct Answer: E

This patient has an ingrown toenail. Ingrown toenails occur when the surrounding soft tissue becomes irritated by the nail and grows over the nail sulcus. Ingrown toenails may result from improper nail care, tight shoes, or toe deformities. Toenails trimmed in a curve may increase the risk that the lateral nail margin will impinge on the lateral nail fold. There is a spectrum of affliction that ranges from erythema and edema to purulent drainage and overgrowth of granulation tissue.

Patients with ingrown toenails commonly present to the emergency department. In the early stages, antibiotics, warm soaks, and simple nail elevation may be all that is needed. In more advanced stages, nail removal may be necessary. In treating this condition, the toe is cleansed with an antiseptic agent. A digital block is performed with Lidocaine. Next, one of several techniques may be used.

In early stages, the ingrown part of the nail may simply be elevated and rotated away from the skin edge. A small piece of gauze or cotton may be used to temporarily (3–6 weeks) keep the nail away from the affected soft tissue. Alternatively, the ingrown portion of the nail and the surrounding nail can be trimmed. In more advanced cases, a portion of the nail and the nail bed will need to be removed. After prepping and numbing the patient, a tourniquet maybe applied at the base of the toe. A hemostat is used to elevate the nail from the nail bed on the affected side (if both the medial and lateral sides are affected, the entire nail may need to be removed). The nail should be freed down to the matrix. A scissors or nail splitter is then used to cut the involved nail away from the remaining nail. This segment of nail is then entirely removed. The granulation and surrounding soft tissue must also be removed with a blade or curette. Once the nail is removed, chemical nail ablation may be performed with phenol followed by alcohol. A topical antibiotic and dressing are applied at the end of the procedure. Loose fitting shoes or sandals should be worn. Follow-up should occur in 24–48 hours.

Take-Home Message

The treatment of an ingrown toenail requires removal of the part of the nail that is embedded in the soft tissue and any surrounding granulation tissue. This procedure can be performed under a digital block.

ABP Content Specification

- Understand the pathophysiology of the ingrown toenail.
- Know how to treat an ingrown toenail.

Question 21

A 16-year-old girl is complaining of pain in the tip of her right thumb. She is not diabetic. She denies trauma. She cannot identify an inciting event. She expresses to you that she finds your incessant questioning annoying and does not see the point in answering your irrelevant questions. She is distraught because you cannot recognize her crisis of not being able to effectively text message her friends. On physical examination, her temperature is 100.4, pulse rate is 60 beats/min, and BP is 100/60 mmHg. The pulp of her right thumb is erythematous, fluctuant, and tender. There is no sign of trauma or a wound indicating a foreign body.

Which of the following statements is true regarding this condition?

A. A foreign body is found in the wound 75% of the time.
B. The organism involved is usually a gram-negative bacterium.
C. An incision should be made down to the bone to drain deep pus.
D. A transverse incision should be performed.
E. A longitudinal incision should be performed.

Correct Answer: E

This teenager has a felon. A felon is a closed space infection of the pulp of a fingertip. Multiple small compartments are formed in the pulp by septa that attach the bone to the skin. The thumb and index finger are most commonly affected. Felons are exquisitely tender. Splinters and cuts can lead to infection; the etiology remains unknown in 50% of cases. Staph aureus is the most common organism involved. Immunocompromised and diabetic patients may grow out gram-negative organisms on culture. Treatment is required to prevent increasing pressure in the closed space that can result in ischemic necrosis of the pulp.

Treatment involves antibiotics and drainage. The finger is cleansed with an antiseptic agent. A digital block is performed with Lidocaine. A longitudinal incision is made over the area of maximal fluctuance. Occasionally a lateral incision may be required if the area of maximal fluctuance is on the radial or ulnar aspect of the digit. Some authors advise against lateral incisions because this may place the neurovascular bundle at risk. If the abscess lends itself to this type of incision, it should be made high and close to the nail bed to avoid the neurovascular bundle. Incisions should never cross the joint, should not be deeper than the skin, and should not be transverse. A small clamp is used to gently break loculations and irrigation is performed with an angiocatheter. Packing should be inserted and a bulky dressing and splint are used to finish the dressing. The patient should be re-evaluated in 24–48 hours.

Take-Home Message

A felon is an infection of the pulp of the distal end of the finger. Treatment of a felon is incision, drainage, and antibiotics. The incision should not be carried proximal to the closed pulp space because of the danger of entrance into the tendon sheath or the joint capsule

ABP Content Specification

- Know what a felon is.
- Know what organisms cause felons.
- Know how to treat a felon.

Question 22

The frantic parents of a 1-year-old boy run into the emergency department yelling that their child is dying. You immediately put the child in an examination room and see a healthy appearing boy wrapped in blankets. He is breathing normally and the vital signs are normal. The mother keeps pointing to his diaper. Upon removal of the blankets and the diaper you visualize what has terrified the parents. There is a rectal prolapse. Which of the following statements is true regarding rectal prolapse?

A. Rectal prolapse is most common in 5- to 10-year-old children.
B. Surgery is usually required.
C. The urethra should be examined as well since urethral prolapse is often seen with rectal prolapse.
D. A digital examination should never be performed after reduction is accomplished because this may cause a prolapse again.
E. Application of sugar may help with reduction.

Correct Answer: E

Rectal prolapse most commonly occurs under 4 years of age. Predisposing factors include the following: increased intra-abdominal pressure (constipation, diarrhea, parasites, coughing, vomiting), fibrocystic disease, neuropathic (myelomeningocele), pelvic floor weakness, post-surgical (pull through procedures), and cystic fibrosis. Although increased intraabdominal pressure is also associated with urethral prolapse, the two are generally not seen together. Symptoms of rectal prolapse may include pain or bleeding. The mucosa or all the layers of the rectum may prolapse. Rectal prolapse can be reduced in the office or the emergency department. Nonoperative treatment is successful in most young children. The prognosis is worse in children over 4 years old and these children may require surgery.

Reduction of rectal prolapse involves the following steps. Determine whether sedation is necessary; if so, Ketamine or Midazolam can be used. The child should then be placed in a

Trendelenburg position with the legs elevated and the hips flexed. Gentle cephalad pressure is applied with a lubricated gloved hand. A digital rectal exam is performed at the end to ensure that the reduction is complete. If simple reduction is unsuccessful, other maneuvers include creating a perianal field block with local anesthesia, using a rectal tube over which the rectum is reduced, or application of sucrose or salt to the area to reduce the edema. If these secondary measures do not work, operative reduction will be necessary.

Take-Home Message

Rectal prolapse can be reduced in the emergency department and most young children may not need operative intervention**.** The usual management includes manual reduction and treatment of the primary inciting factor.

ABP Content Specification

- Know how to reduce rectal prolapse in the emergency department.

Question 23

A 13-year-old boy is complaining of having too much homework and not enough time to do it. The patient's mother feels that as a result of this he has started biting his nails. He has been complaining of pain in his left index finger that has gotten worse over the last 2 days. He has finals coming up and did not want to come to the hospital but his mother made him. On physical exam the patient is afebrile and appears well. The lateral aspect of the index finger nail plate is erythematous and fluctuant. There is evidence of nail biting on all the fingers.

Which of the following statements is true regarding this condition?

A. The patient has a felon.
B. This condition occurs exclusively on fingers (it is never seen on toes).
C. This patient has herpetic Whitlow.
D. If untreated, osteomyelitis can develop.
E. The patient is just trying to get out of taking his final exam.

Correct Answer: D

Bacterial infections of the nail usually involve the paronychium and produce paronychia in the proximal and/or lateral nail folds. (*Paronychium* is an anatomic region that refers to the soft tissue that surrounds the nail. *Paronychia* is an infection of the paronychium). These infections result from trauma to the eponychial or paronychial regions.

Paronychia can occur in the fingers or toes. Physical examination reveals erythema, swelling, tenderness, and fluctuance along the nail plate. If the cuticle is involved it is called an eponychia.

These infections may occur secondary to nail biting, manicures, or trauma. MRSA can cause paronychia.

It is important that the incision should not involve the eponychium to drain the infection. A single incision is made to drain the affected paronychium. This allows elevation of the eponychial fold when both eponychium and paronychium are involved.

A felon is an infection of the subcutaneous pulp space of the fingertip. In this condition, the swelling and pain are confined to the pulp space distal to the distal interphalangeal flexion crease. The most common cause is *Staphylococcus aureus*.

Herpetic Whitlow is a viral infection, Herpes simplex type 1 (60%) or 2 (40%). It is caused by viral inoculation of the host with infected body fluids. Clear vesicles are seen with this infection. These lesions should not be drained because they can become secondarily infected. They are self-limiting and will resolve on their own.

Treatment of an early paronychia includes warm soaks, elevation, topical and sometimes oral antibiotics. Once an abscess forms, drainage is recommended. The patient should be made comfortable. The finger should be soaked in warm water and then prepped with an antiseptic agent. A digital block is performed with local anesthesia or ethyl chloride is applied topically. A #11 blade is used to make an incision over the most fluctuant area of the abscess. The pus is then evacuated by pressure. A small hemostat is used to break up loculations. The cavity is then irrigated with an

angiocatheter. A culture may be sent. A small piece of iodoform gauze can be packed in the cavity. The patient should have followed up in 24 hours.

If left untreated, osteomyelitis of the distal phalanx can develop. Other complications include development of a felon or tenosynovitis.

Take-Home Message

Bacterial infections of the nail usually involve the paronychium and produce paronychia in the proximal and/or lateral nail folds. (*Paronychium* is an anatomic region that refers to the soft tissue that surrounds the nail. *Paronychia* is an infection of the paronychium). These infections result from trauma to the eponychial or paronychial regions.

ABP Content Specification

- Know what a paronychia is.
- Know what other types of infections occur on fingers.
- Know the treatment of a paronychia.

Question 24

A 5-year-old boy is brought to the emergency department by his uncle/caretaker for rectal bleeding. The child does not have any medical problems and does not take any medications. The patient initially says he is "ok" but gets very anxious when the examination is about to start. The patient has no fever and the vital signs are within normal limits. The abdomen is nondistended, soft, and nontender. The patient starts to cry when the anus is examined. There is a small amount of blood at the anal verge. Digital exam is performed. The examiner feels something mobile in the rectum. The patient is sent to Radiology for an abdominal X-ray and a pen is visualized in the rectum.

Which of the following statements is true?

A. A large ingested foreign body will never travel to the rectum—it will get trapped at the ileocecal valve.
B. If the foreign body cannot be felt, a single "blind" attempt can be made to grab the object with a clamp. If the single attempt is unsuccessful, the patient should go to the operating room for removal under general anesthesia.
C. A Foley catheter can sometimes be used to extract a rectal foreign body.
D. Obstetrical forceps are frequently used to remove round, smooth objects from the rectum.
E. A patient complaining of abdominal pain after removal of a rectal foreign body should be given analgesia and discharged from the emergency department.

Correct Answer: C

Foreign bodies in the rectum result from direct insertion or occasionally from ingestion and transit through the GI tract. Rectal foreign bodies in children may result from insertion by a curious child or by an abuser. The presenting symptom is often rectal bleeding. The technique for removal of a foreign body depends on the patient's anatomy, the type of foreign body, the location, and the presence or absence of peritonitis. Peritonitis is a contraindication to removal of a rectal foreign body in the emergency department; these patients need to go to the operating room for laparotomy to assess for intestinal perforation. Sharp objects should also be removed in the operating room. Enemas and cathartics should not be used because these increase the risk of perforation.

There are various techniques for removal of a rectal foreign body. The patient should be made comfortable. If the foreign body is visualized and an X-ray confirms it is not sharp, an attempt is made to simply pull it out. If the object is not easily removed, IV sedation should be administered. It may also be necessary to perform an anal or pudendal nerve block with local anesthesia. The patient is then positioned in a lateral or lithotomy position. A digital exam is performed. The object should be visualized and grasped either with fingers or a clamp. Blind attempts at grabbing the object should never be performed as this may damage to the rectum or push the object more proximal. If the object creates suction, a Foley

catheter may be inserted beyond the object. Once this is done, the balloon is blown up and the Foley is pulled out, dragging the object out with it. An endotracheal tube may be used in a similar manner.

A rectal examination should be performed at the end of the procedure to check for sphincter tone. A patient complaining of abdominal pain after a rectal foreign body and removal should be evaluated and observed for perforation.

Take-Home Message
Since delay in treatment is associated with a higher complication rate, prompt diagnosis is important. Blind attempts at removal should be avoided as this may cause rectal perforation or push the object higher. Sedation and analgesia may be required for better visualization and removal.

ABP Content Specification
- Know the various techniques for retrieval of a foreign body from the rectum.
- Know that a patient may require general anesthesia in the OR if attempts in the emergency department are unsuccessful.

Question 25

A 17-year-old girl is complaining of pain with defecation. She is obese but both she and her parents report that she is healthy. In addition to anal pain, she complains of constipation. She states that she took Loperamide hydrochloride (Imodium) to decrease her bowel movements in order to avoid the pain. On physical examination, the patient appears to be in mild discomfort. The patient has no fever and the blood pressure is 160/70 mmHg. Pulse is 90 beats/minute. A rectal examination elicits tenderness but does not reveal any masses or external hemorrhoids. Sphincter tone is normal. Which of the following will be the most helpful in visualizing the cause of anal pain?

A. CT scan of the abdomen and pelvis
B. MRI
C. Rigid sigmoidoscopy
D. CT colonography
E. Anoscopy

Correct Answer: E

This patient likely has an anal fissure. This is a longitudinal tear in the epithelium of the anal canal which usually extends from the dentate line toward the anal verge.

Direct visualization of the anus with anoscopy would help to make the diagnosis. These patients usually have significant pain and may not allow anoscopy without sedation and pain control. Anoscopy is used in conjunction with digital examination to evaluate anal complaints: pain, bleeding, hemorrhoids, fistulas, and foreign bodies.

Anoscopy is performed as follows. The patient is placed in the lateral decubitus position with knees bent or in the prone jackknife position. If a proctoscopy table is available, it should be used. Inspection followed by digital examination is the next step. Once this is completed, the obturator is inserted into the anoscope and the scope is lubricated. The anoscope is gently inserted to its full length and the obturator is removed. The anoscope has a fenestration through which the anal mucosa can be examined. The anus is inspected in a circumferential manner. Lidocaine jelly may be used as lubricant to help with pain control.

CT scan and MRI are not helpful to evaluate benign anal disease. Rigid sigmoidoscopy may miss anal pathology. CT colonography (virtual colonoscopy) is used for colon cancer screening in some patients.

Take-Home Message
Digital rectal examination can be difficult due to intense pain in patients with anal fissures. Rectal inspection and anoscopy reveal the diagnosis, not radiologic studies.

ABP Content Specification
- Know the indication for anoscopy.
- Know how to perform anoscopy.

Question 26

A 7-year-old boy is in "time out" for instigating a fight with his 5-year-old brother. While his mother is cooking, he sneaks into the garage and accidentally steps on a piece of broken wood with a nail sticking out. The nail punctures a hole in his sneaker and penetrates the plantar aspect of the foot. He lets out a scream when this happens and his mother comes running into the garage. He starts to cry when he sees his mother because he realizes the trouble he is in. The mother starts to cry when she sees the piece of wood and a broken rusty nail next to the foot of her son. She looks at the bottom of his sneaker and sees a hole. When she takes the sneaker off, there is also a hole on the bottom of his foot. She runs to get the 5-year-old and the car keys and drives everyone to the emergency department. On physical examination the child has calmed down. He complains of pain in his foot. The right foot has a punctate laceration consistent with a nail injury. There is a small amount of bleeding. No foreign body is visible. An X-ray reveals a metallic foreign body in the foot.

Which of the following statements is *true*?

A. This is a type IV puncture wound.
B. Glass is generally seen on X-ray.
C. Wood is visible on X-ray.
D. If the foreign body is not seen on X-ray, gentle blunt probing may help identify the object.
E. If osteomyelitis is going to occur, it will be evident by 3 days.

Correct Answer: B

Puncture wounds are penetrating injuries caused by a sharp object whose depth is greater than its width. These injuries are common and can occur at any age and any part of the body. Plantar injury through a penetrated sneaker is a common ED presentation and has a higher rate of infection than other parts of the body, especially if there is a retained foreign body. Puncture wounds can be caused by foreign bodies (nails, wood, and plastic) and teeth (from bites).

Physical examination will show a puncture wound. A retained foreign body should be suspected if the area is very tender. An X-ray should be performed. Metal and glass are radiopaque. Wood and plastic are often radiolucent and US or CT scan may be better imaging modalities.

Fluoroscopy can be helpful in removal of a radiopaque foreign body. This injury is too recent for osteomyelitis to occur, although not an infrequent complication.

All wounds require assessment of tetanus status. Superficial wounds without retained foreign body require simple wound care. Deeper wounds require exploration and removal of the foreign body if present. Blunt probing is not recommended because the foreign body may be pushed deeper into the foot. Exploration may require increasing the length of the incision or removing an ellipse of tissue around the puncture site.

Infections occur in 6–11% of injuries. The most common organisms are staphylococcus and streptococcus. Pseudomonas is associated with osteomyelitis and sneaker punctures. Cellulitis usually occurs after 4 days and osteomyelitis after 7 days.

Take-Home Message

Puncture wounds of the foot may appear innocuous on initial evaluation. It is important to make sure there is no retained foreign body. Some types of foreign bodies can be seen on X-ray (e.g., metal), while others are radiolucent (e.g., wood). Other imaging modalities are US and CT scan. There should be follow-up to check for infection.

ABP Content Specification

- Know the five categories of puncture wounds.
- Know the treatment of puncture wounds.
- Know what organism is associated with infections related to puncture wounds and sneakers.

Question 27

Two 8-year-old girls decide to play with "swords" (wooden sticks they found in the park).

While conducting their pretend joust they fall on top of each other and the wooden sticks. One

of the two has the wood partially driven into her arm and she feels like a piece broke off inside her extremity. Two days later, the area appears slightly red and the father sees the girl guarding her arm. He brings her to the emergency department. On physical examination the extensor side of her right forearm has a 2 × 2 cm erythematous area that is very tender. There is no fluctuance. An X-ray does not show a foreign body. What is the next step?

A. Discharge the patient with instructions to apply warm compresses
B. Discharge the patient with oral antibiotics
C. Take the patient to the operating room to have the arm explored
D. Perform an Ultrasound
E. Admit the patient for observation

Correct Answer: D

A good history and physical examination are important in order to determine the level of suspicion for a retained foreign body and the extent of a search for a foreign body. Radiographs and bedside ultrasound are useful for locating foreign material. Small foreign bodies under 3 mm diameter may be difficult to detect by either modality. If there is strong suspicion of a foreign body despite a negative plain radiograph, a CT scan should be obtained. Organic materials such as wood tend to be radiolucent. Infected wounds with a retained foreign body can be resistant to antibiotics. Organic materials trigger more of a reaction than inert objects like glass. An inert foreign body does not always need to be removed if the patient is asymptomatic. Complications of retained foreign bodies include infection, pain, tendon rupture, tenosynovitis, and osteomyelitis.

Ultrasound can help visualize materials like wood and plastic if not seen on an X-ray. It can be performed at the bedside by the emergency medicine physician. A 7.5 MHz transducer (or higher) is recommended. Wood has a characteristic appearance: it is hyperechoic and has posterior shadowing. If no foreign body is seen during bedside US and there is a high index of suspicion, a study in the radiology department should be performed. Small objects (<3 mm diameter) may be difficult to detect by these modalities. If there is a strong suspicion despite a negative radiograph, a CT or MRI scan may be obtained.

Deeply embedded objects should be removed in the operating room. Superficial objects can be removed in the emergency department with adequate anesthesia. Caution should be used when removing organic foreign bodies as they may break apart during removal. US can be used as a tool to help locate and remove foreign bodies.

Hand surgery consultation and removal of foreign body in the OR is required in these situations:

- Multiple foreign bodies
- Tendon and neurovascular involvement
- Deep space penetration (palmar, thenar or hypothenar space)
- Joint involvement
- Fracture or bone penetration
- Significant contamination

Take-Home Message

When there is a history of trauma, an abscess may be due to a retained foreign body. It is important to remove it to prevent recurrent infections. Biologic materials such as wood might not be radio-opaque. If the X-ray is negative but the suspicion is high, US may be helpful.

ABP Content Specification

- Know that history may be suggestive of a retained foreign body.
- Know that X-ray and ultrasound may be helpful in assessing for foreign bodies.
- Know that superficial foreign bodies can be removed in the emergency department, but deeper objects should be removed in the operating room.

Question 28

A 16-year-old runaway is using drugs and injected himself in the left upper extremity a week ago. Almost immediately the area became red and since then has gotten progressively more tender and warmer. On physical examination the

patient has a temperature of 100.4 F, the blood pressure is 120/70 mmHg, and the pulse is 90 beats/minute. The flexor aspect of the left forearm has a 4 × 4 cm erythematous area that is warm and tender. It is difficult to discern fluctuation. Sensory and motor examination is intact.

Which of the following is a true statement?

A. An abscess in the antecubital fossa that is pulsatile should be immediately incised and drained to prevent bacteremia and endocarditis.
B. Intravenous antibiotics in the emergency department and oral antibiotics at home are the mainstay treatment for an abscess.
C. The best way to determine if there is a deep space infection is to explore the upper extremity.
D. Ultrasound is a very helpful adjunct to determine if there is an abscess if the physical exam is indeterminate.
E. Hidradenitis suppurativa is an infection of the endocrine glands.

Correct Answer: D

An abscess is a collection of pus and can be located anywhere in the body. A cutaneous abscess presents as a red, fluctuant, warm, tender area on the body. Abscesses in certain anatomic areas may be referred to by specific names. Furuncles (also referred to as boils) occur in the skin and subcutaneous tissues and often involve a hair follicle. These are commonly located in the face and neck. Carbuncles are clusters of furuncles. Hidradenitis suppurativa is a chronic infection of the apocrine sweat glands. (Endocrine glands secrete hormones). These abscesses can be multiple and coalesce. They are commonly found in the axilla, under the breasts, and in the groin and perineum. Paronychia and eponychia are abscesses involving the nail and nail beds. A felon is an abscess of the volar pad of the fingers. Pilonidal cysts and sebaceous cysts can become infected and develop abscesses.

Staph aureus and community acquired MRSA are commonly seen organisms in skin and subcutaneous abscesses. If there is no surrounding cellulitis, antibiotics are not necessary.

The definitive treatment for an abscess is incision and drainage. Some abscesses should not be drained in the emergency department. Orbital, facial, genital, and perirectal abscesses should be drained in the operating room. A pulsatile "abscess" may be an infected pseudoaneurysm and should not be incised. Immature abscesses will not benefit from incision and drainage. If the clinical diagnosis is equivocal, further evaluation by US or needle aspiration should be performed.

Incision and drainage is performed in the following manner. Determine the need for IV sedation and administer if necessary. Lidocaine is infiltrated in the dermis using a 25- or 27-gauge needle. A # 11 or 15 blade is used to make an adequate incision for drainage. A hemostat is used to break up any loculations within the cavity. Irrigation of the cavity is then performed. The patient should be followed up in 24–48 hours.

Take-Home Message

The definitive treatment for an abscess is incision and drainage. If there is no surrounding cellulitis, antibiotics are not always necessary.

ABP Content Specification

- Know the definitions of different types of abscesses.
- Know the treatment of an abscess.
- Know what common organisms are found in skin abscesses.

Question 29

A 10-year-old girl was trapped in a house fire. The floor on which she was standing collapsed and she fell an undetermined height. She was rescued by the fire department and transported to the local hospital which is not a burn center or a trauma hospital. She is awake and speaking but sounds hoarse. The vital signs are normal and oxygen saturation is 95%. She weighs 30 kg. She has second-degree burns over half of her head. Which of the following statements is true?

A. The mortality of a child with a 60% burn is 50%.

B. The patient should be immediately transferred to a burn center.
C. A third-degree burn is extremely painful.
D. Burn care takes priority over management of other injuries.
E. This patient may have impending airway obstruction.

Correct Answer: E

Burns are the 5th leading cause of unintentional deaths in children. The mortality of children with a 60% total body surface area burn has decreased from 33% to 14% over the last 20 years. Scald burns are more common in children less than 4 years old. Flame burns are more common in older children. Certain burn patterns should alert the physician to the possibility of child abuse (i.e., burns in a stocking distribution on the legs suggest intentional immersion into scalding water).

Burns can result from thermal, electrical, or chemical mechanisms.

Burn patients should be evaluated first as a trauma patient and then as a burn patient. A primary and secondary survey should be performed, and nonburn-related injuries need to be addressed. Once other life-threatening injuries are ruled out, attention can be focused on burn resuscitation and management. Carbonaceous sputum, singed nasal hairs, perioral burns, and oropharyngeal edema should be assessed during the airway evaluation. These findings suggest the possibility of airway edema and intubation should be considered. Hoarseness, wheezing, stridor, and subjective dyspnea are also suggestive of impending airway obstruction. Transfer should not be initiated until the patient is stabilized.

Burns are classified by depth of injury. Superficial burns are first degree. They are painful and do not form blisters. Sunburn is a common example. Partial-thickness burns are second degree. These burns are then classified as either superficial or deep partial-thickness burns (depth of involved dermis). They are painful and form blisters. Full thickness burns are third degree. These burns involve the full depth of the epidermis and dermis. They are painless (because the nerve endings are destroyed), hard, and do not blanch with pressure. Full thickness burns that involve underlying structures (muscles, tendons, bone) are fourth degree.

Take-Home Message

Burn patients should be evaluated as trauma patients first, and then as burn patients.

They may have life threatening injuries that should take precedence over burn care.

ABP Content Specification

- Understand the importance of a trauma assessment in addition to a burn assessment.
- Know how burns are classified according to depth.

Question 30

A 10-year-old child with blistering to half of her head requires intubation for airway edema. Large bore IVs have been placed. X-rays and FAST are negative. Vital signs remain stable. Which of the following statements are *false?*

A. She has a 9% total body surface area burn.
B. She needs to be transferred to a burn center.
C. Broad-spectrum antibiotics should not be given.
D. Topical antibiotic should not be applied prior to transfer.
E. One half of the calculated resuscitation fluid should be given in the first 8 hours.

Correct Answer: A

The Rule of Nines is used to estimate total body surface area burn in adults. In children, the Lund and Browder chart is used because the surface area of the head is larger in children than adults. The child's palm and fingers can also be used to estimate the burn size (the palm and fingers is estimated to be 1% of the total BSA). In a 10-year-old child, half of the head is 5.5% body surface area. Only second and third-degree burns are used to calculate body surface area burns (and therefore fluid resuscitation).

The Parkland formula is commonly used to calculate resuscitative fluids. The formula is 4 mL/kg/%BSA burn. Half the volume is given over the first 8 hours and the remainder over the next 16 hours. Normal 24-hour maintenance fluid requirements are additional and not included in this formula. The fluid of choice is crystalloid and many centers use Lactated Ringer's as their first choice.

Broad-spectrum antibiotics should not be given to a burn patient. This leads to the development of resistance and fungal infections in burn patients. Topical antibiotics should not be applied if a patient is going to be transferred so the receiving physicians can assess the burns. A tetanus booster should be administered in the emergency department. Inhalation burn is an indication for transfer to a burn center.

Take-Home Message

Burn patients should be assessed for trauma as well as burns. It is imperative to determine the need for airway protection and intubation. Fluid resuscitation is based on weight and percent burn.

ABP Content Specification

- Know what physical findings are suggestive of airway involvement.
- Know how to calculate what percentage of the body is burned.
- Know how to calculate fluid requirements in burns.

Question 31

A 4-year-old child that is in good health starts having "accidents" and wets his bed at night. There is a family history of enuresis and the child is experiencing stress in pre-kindergarten and at home. The parents are going through a divorce and the child is singled out for being inattentive. The child is brought in for an evaluation. He does not want to talk about his bedwetting episodes. A thorough review of symptoms is performed and he says that he is having back pain that wakes him up at night. There is no fever and the vital signs are normal. On physical examination the patient appears withdrawn. He is tender along the lower spine.

Which of the following statements is true?

A. He should be referred to the school psychologist to help with stress at school.
B. He is likely to have spondylolysis.
C. He should be referred to a pediatric urologist.
D. An MRI of the lower spine might be diagnostic.
E. Desmopressin should be initiated.

Correct Answer: D

Although back pain is a common complaint in children, few children seek medical attention for back pain. The differential diagnosis for back pain is broad and covers multiple systems. Most of the time back pain has a benign etiology, but back pain is more frequently due to a serious condition in children as compared to adults, particularly pain that is persistent or progressive. "Red flags" include age less than 4 years old, systemic complaints, escalating pain, previous history of malignancy, and neurologic dysfunction.

The history of back pain should include systemic questions (i.e., fever, weight loss, night sweats, TB exposure), and questions about physical activity and trauma. Physical examination should include a general impression, a neurologic exam that includes observation of gait, and range of motion of the back. Infectious, rheumatologic, and malignant etiologies are suggested by fever and weight loss; spinal tumors by bowel or bladder dysfunction and weakness of the extremities; infection, inflammation, or tumor by spine stiffness.

The causes of back pain in children and adolescents can be divided into several groups:

1. *Infectious*—vertebral osteomyelitis, spinal epidural abscess, discitis, paraspinal pyomyositis, pneumonia, pyelonephritis, and viral illness
2. *Orthopedic*—nonspecific musculoskeletal pain (muscles, bones, or discs), Scheuermann's (juvenile) kyphosis, spondy-

lolysis/spondylolisthesis, scoliosis, intervertebral disk herniation, intervertebral disc space calcification, trauma, and aneurysmal bone cyst
3. *Rheumatologic*—juvenile ankylosing spondylitis, juvenile rheumatoid arthritis, and IBD-associated arthritis
4. *Neoplastic*—osteoid osteoma, neuroblastoma, ganglioneuroma, lymphoma, leukemia, eosinophilic granuloma, and solid malignancy (primary or metastatic)
5. *Miscellaneous*—Sickle cell disease, nephrolithiasis, and syringomyelia

Patients <18 years old have a higher incidence of congenital abnormalities such as spondylolysis, spondylolisthesis, and Scheuermann kyphosis, but these tend to present at puberty. Spinal epidural abscess is rare and presents with fever, spine pain, and neurologic deficits. Discitis is an inflammatory process associated with Staphylococcus. It is seen in patients less than 10 years old who complain of back pain and inability to bear weight. Patients with spinal cord tumors may present with incontinence.

There should be a stepwise approach in evaluating children with back pain directed by the history and physical. Transient back pain following an injury is common in children. If back pain persists or worsens, further evaluation should be pursued. Diagnostic imaging includes X-rays, CT scan, MRI, bone scan and myelogram. Infection and malignancy are the most concerning entities to accurately diagnose. Warning signs include systemic findings such as fever and weight loss (infectious or malignant causes), constant pain, history of malignancy (metastatic disease to spine), and abnormal neurologic findings (nerve root compression, epidural abscess, transverse myelitis). Laboratory tests and imaging should be directed by the history and physical findings.

Desmopressin is a synthetic analog of arginine vasopressin (antidiuretic hormone, or ADH) which is sometimes used in children with enuresis. It is important to rule out other serious conditions prior to starting Desmopressin.

Take-Home Message

Back pain is a common complaint in children and is usually benign. It can sometimes be more serious and a history should include questions about neurologic dysfunction and escalating pain.

ABP Content Specification

- Know the differential diagnosis for back pain in children.
- Know what the "red flags" are for a potentially serious condition.

Question 32

An 11-year-old girl is brought to the emergency department after 72 hours of abdominal pain and an episode of vomiting. In the emergency department, the patient states her pain began in the umbilical area and is now located in the right lower quadrant. She has a temperature of 101. She is pale and lying without moving on the examination table. She is tender in the right lower quadrant with local guarding, but the rest of the abdomen is without tenderness. There is mass on deep palpation in the right lower quadrant.

A CT scan of the abdomen reveals a perforated appendix and a walled off abscess in the right lower quadrant.

Which of the following statements is true?

A. Immediate surgery is required in all cases of perforated appendicitis.
B. A CT scan is the only way to accurately make the diagnosis of appendicitis.
C. A negative appendectomy rate should not exceed 1–2%.
D. The differential for appendicitis includes intra-abdominal testicular or ovarian torsion.
E. Intraabdominal abscess is the most common complication of appendicitis.

Correct Answer: D

Appendicitis is the most common abdominal surgical condition in children. Appendicitis is present in up to 8% of children seen in the ED with abdominal pain. Appendicitis is rare in children

younger than 5 years old. Symptoms of appendicitis in young children are nonspecific and may mimic gastroenteritis. The mean age is 11–12 years old.

This patient has perforated appendicitis and the mass felt on palpation is an abscess. A history and physical alone can make the diagnosis in 80–90% of cases. Sonography is an additional imaging modality that can diagnose appendicitis. Prior to current recent advances in imaging, the acceptable negative appendectomy rate was 10–20%; currently it is 5–10%.

Perforated appendicitis occurs in 30–45% of pediatric cases. Most perforations occur after 24 hours; however, 13% may occur in less than 24 hours. There are three ways to manage perforated appendicitis. Surgery (open or laparoscopic) may be performed with removal of the appendix and drainage of the abscess. IV antibiotics may be administered with or without drainage of the abscess by interventional radiology followed by interval appendectomy in 6–8 weeks. IV antibiotics may be administered with or without drainage of the abscess and no interval appendectomy (appendectomy performed only if the patient develops symptoms).

Important aspects of the physical examination include rectal exam, pelvic exam in sexually active patients, and genital examination. Pelvic inflammatory disease and ovarian torsion are in the differential diagnosis for appendicitis. Vaginal discharge and cervical motion tenderness are more consistent with PID than with appendicitis. Testicular torsion can occur in the scrotum and in the abdomen. A scrotum without a testicle should raise concern for the latter.

Wound infection rates for uncomplicated appendicitis are less than 3%; and in complicated appendicitis, 6–8%. It is the most common complication of appendicitis. Intraabdominal abscess is the second most common complication but occur less commonly in children and infants than in adults.

Take-Home Message

Appendicitis is a clinical diagnosis and can be diagnosed by history and physical examination in up to 80–90% of patients.

ABP Content Specification

- Know that history and physical can make an accurate diagnosis.
- Know that imaging is not always necessary.
- Know what imaging tests are available to assist in the diagnosis.
- Know the differential diagnosis for appendicitis.

Question 33

The differential diagnosis for acute appendicitis includes the following:

A. Meckel's diverticulitis
B. Ovarian torsion
C. Mesenteric adenitis
D. Acute gastroenteritis
E. All of the above

Correct Answer: E

Acute appendicitis is the most common surgical abdominal condition in children. The differential diagnosis is very broad and includes conditions that are surgical, potentially surgical, or nonsurgical.

Surgical conditions that can mimic appendicitis include GI perforation, ectopic pregnancy, ruptured ovarian cyst, ovarian torsion, testicular torsion, intestinal obstruction, and Meckel's diverticulitis.

Conditions that are potentially surgical include intussusception, cholecystitis, Crohn's disease, stercoral ulcer, primary peritonitis, and PID.

Nonsurgical conditions that can be mistaken for appendicitis include gastroenteritis, mesenteric adenitis, omental torsion, epiploic appendigitis, pancreatitis, sickle cell disease, constipation, urinary tract infection/pyelonephritis, renal colic, right lower lobe pneumonia, DKA, lead poisoning, and porphyria.

Take-Home Message

There is a broad differential diagnosis for appendicitis. It is the most common surgical condition in children. Conditions that can mimic appendi-

citis include surgical and nonsurgical illnesses. A detailed history and a thorough physical will identify appendicitis in the majority of cases. Imaging is confirmatory and can rule out other conditions.

ABP Content Specification

- Know the differential diagnosis of appendicitis.

Question 34

A 6-year-old child is seen in the emergency department for asthma. During the review of symptoms, the doctor elicits a history of intermittent drainage from the umbilicus. There are no other symptoms related to drainage. The patient has no fever. The abdomen is soft and not tender. The umbilicus is moist and without erythema.

Which of the following statements is true?

A. In the embryo, the gut is connected to the yolk sac through the urachus.
B. Umbilical hernias in children are usually acquired after full impact sports activities.
C. Intestinal obstruction may result from intussusception, volvulus, or adhesive bands involving a Meckel's diverticulum.
D. In the embryo, the bladder is connected to the allantoic sac through the vitelline duct.
E. Umbilical hernias rarely close and should be operated on before the child turns 2 years of age.

Correct Answer: C

The umbilical ring and its contents develop during the fourth to sixth weeks of gestation. The umbilical ring contains the umbilical vessels, the allantois, and the vitelline (omphalomesenteric) duct. The vitelline duct connects the primitive gut and the yolk sac. The urachus connects the allantois and the bladder. In normal development, both the vitelline duct and urachus degenerate. Incomplete degeneration leads to various congenital anomalies. Persistence of the vitelline duct can result a Meckel's diverticulum. Complications of a Meckel's diverticulum include infection, bleeding, and obstruction. Obstruction results from intussusception of a Meckel's diverticulum. Persistence of the vitelline duct can lead to an umbilicointestinal fistula that drains through the umbilicus. Volvulus of the small bowel can occur around a persistent vitelline duct. Persistence of the urachus can lead to fistulae, sinuses, or cysts and periumbilical granulation, drainage, and infections.

Failure of umbilical ring closure results in an umbilical hernia. The overall incidence is 10–25%.

Most umbilical hernias will close by age 4.

Take-Home Message

Persistence of the vitelline duct can result a Meckel's diverticulum. There are multiple conditions that can arise from a Meckel's diverticulum such as infection, bleeding, obstruction, etc.

ABP Content Specification

- Know what a Meckel's diverticulum is.
- Know what complications can arise from a Meckel's diverticulum.

Question 35

An 18-month-old child has a history of intermittent abdominal pain and lethargy. The child is normal in between pain episodes. Dance's sign is present on physical exam. There is occult blood in the stool. Ultrasound shows a target sign.

This patient has:

A. Necrotizing enterocolitis
B. Malrotation and volvulus
C. Intussusception
D. Appendicitis
E. Acute gastroenteritis

Correct Answer: C

There is a broad differential diagnosis for abdominal pain in children. In order to help distinguish the cause of abdominal pain, it is helpful to know the age of the child and if the symptoms

are chronic or acute. Bilious vomiting in children should be considered a surgical emergency until proven otherwise. Up to 51% of children with bilious vomiting will require surgery.

Gastroenteritis is the most common cause of abdominal pain in children. The patient presents with nausea and vomiting. The patient may also be lethargic. This is usually an acute process. The abdominal examination demonstrates mild diffuse tenderness. Treatment is rehydration. Constipation is also a common cause of abdominal pain in children. This is common during toilet training.

Necrotizing enterocolitis (NEC) usually occurs in infants 0 to 3 months old. Pain is constant. Most cases occur in the neonatal ICU in premature infants. Ten percent of cases occur in infants that are full term. NEC is a surgical emergency. Other conditions that are surgical emergencies in this age group are: volvulus, incarcerated hernia, testicular torsion, and Hirschsprung's enterocolitis.

Intussusception typically occurs in the 3 months to 3-year-old range. It is the most common cause of bowel obstruction in children less than 2 years of age. Children may have an antecedent history of intermittent abdominal pain alternating with "normal" episodes. Dance's sign is the finding of a mass in the right upper quadrant (representing the intussusception) and the absence of bowel in the right lower quadrant. The "classic" currant jelly stool is rarely seen and gross blood is seen in 50% of patients. Seventy percent of patients will have occult blood in the stool. Intussusception is caused by bowel telescoping into another part of the bowel. This is an emergency because if it left untreated, the bowel will become gangrenous. Ultrasound findings include the target sign (bowel inside of bowel). If the patient has peritonitis or is in shock, emergency laparotomy is necessary. If the patient is stable, an air contrast enema should be performed. This is both diagnostic and therapeutic.

The most common surgical emergency in the 3- to 15-year-old range is appendicitis. Other surgical emergencies in the 3 months to 3-year-old range include volvulus, testicular torsion, and appendicitis.

Take-Home Message

Bilious vomiting in children should be considered a surgical emergency and require immediate evaluation. Up to 51% of children with bilious vomiting will require surgery.

ABP Content Specification

- Know the differential diagnosis of abdominal pain in infants and children.
- Know that bilious vomiting can be an ominous sign in infants and children.

Question 36

A mother brings her 2-year-old child to the emergency department because he has an acutely painful mass in the right scrotum. She is frantic because her cousin's son had a similar problem and he ended up losing his testicle. She is determined that the doctors listen to her because she "knows exactly what is happening" and her son's testicle is "twisted" and he needs an emergency operation. After calming down the mother, the child is examined. He is irritable and clearly uncomfortable. His temperature is 100.4 F and the pulse is 142 beats/minute. There is a firm, tender, irreducible mass in the scrotum. It is separate from the testicle.

Which of the following is true?

A. The mother is correct because the child has a testicular torsion.
B. The mother is incorrect because the child has a hydrocoele.
C. The mother is incorrect because the child has a torsed appendix testis.
D. The mother is incorrect because the child has an incarcerated inguinal hernia.
E. The mother is incorrect because the patient has a varicocele.

Correct Answer: D

Testicular torsion and incarcerated inguinal hernia both present as a painful irreducible scrotal mass. Both these conditions are surgical emergencies that if left untreated will result in a

gangrenous testicle or gangrenous bowel, respectively. Other conditions that present with scrotal findings include hydrocoele, varicocele, torsion of the appendix testis, lymphadenopathy, abscess, trauma, and tumors.

History may or may not be helpful in making the diagnosis. Both testicular torsion and inguinal hernia may present with intermittent symptoms. Physical exam is important to make the diagnosis. In addition to a painful scrotal mass, testicular torsion has the finding described as "bell-clapper" deformity (similar to the inner part of a bell). This is caused by a paucity of attachments of the testicle and this allows the spermatic cord and the testicle to twist and lie horizontally. Because the blood supply in the spermatic cord is compromised, the testicle becomes gangrenous if the spermatic cord is not detorsed in a timely manner. Prehn's sign results when elevation of the testicle does not relieve the pain as it does with epididymitis. If there is a delay in obtaining a urologic consult, an attempt at manual detorsion may be performed in the ED, after sedation is achieved.

Appendix testis is a vestigial remnant of the Mullerian duct. It can also torse and necrose. It is not a surgical emergency and does not require surgery, but it presents in a manner similar to testicular torsion. Its importance lies in ruling out testicular torsion. Physical exam elicits extreme tenderness of the scrotum. At times a "blue dot" may be seen. This is the ischemic or gangrenous appendix testes. Ultrasound is important to evaluate the blood flow to the testicle.

Inguinal hernias are common in children. Ten percent will incarcerate. An incarcerated inguinal hernia will present as a tender, irreducible groin and/or scrotal mass. It is important to try and distinguish the testicle from the "mass." If the testicle is separate and not tender, a hernia is more likely. An undescended testicle may also appear as a groin mass and give the impression of a hernia.

Varicoceles are painless and present as scrotal swelling. They look like a "bag of worms." They result from venous engorgement of the testicular veins and pampiniform plexus. They occur in approximately 15% of the population.

Take-Home Message

The differential diagnosis for acute scrotal pain includes two diagnoses that are surgical emergencies: testicular torsion and incarcerated inguinal hernia.

ABP Content Specification

- Know the differential diagnosis for acute scrotal pain.
- Know the complications of untreated testicular torsion and incarcerated inguinal hernia.

Question 37

A neonate is in respiratory distress. The mother did not have prenatal care or imaging. She is unable to give any pertinent medical history. The baby requires intubation. Which of the following statements is true?

A. Chest X-ray is unlikely to give an accurate diagnosis.
B. Associated findings include a distended abdomen.
C. The differential diagnosis for neonatal respiratory distress includes congenital lobar emphysema.
D. Morgagni hernia is the most common type of diaphragmatic hernia.
E. If congenital diaphragmatic hernia is a prenatal diagnosis, every effort should be made to correct the defect before birth because the outcomes are better.

Correct Answer: C

The differential diagnosis for neonatal respiratory distress includes congenital diaphragmatic hernia (CDH), congenital lobar emphysema, and meconium aspiration. The physical exam in a patient with CDH demonstrates a lack of breath sounds on the affected side and a scaphoid abdomen (because the abdominal contents are in the chest). In a left-sided CDH, a chest X-ray will show the abdominal organs in the chest and the heart and mediastinum may be shifted to the contralateral

side. In a right-sided CDH, the liver and some bowel may be in the right thorax.

Most CDHs are located on the left side. The septum transversum is the precursor to the diaphragm and if development is incomplete, a diaphragmatic hernia result. The most common type of CDH is the Bochdalek hernia. It is a posterolateral defect. The Morgagni defect is less common and is anterior and retrosternal.

The herniated abdominal organs cause lung compression and subsequent pulmonary hypoplasia. The lung on the side of the defect shows more severe changes, but the contralateral lung is also affected. Associated anomalies and genetic mutations can be seen with CDH.

Management includes intubation, decompression of the stomach with a nasogastric tube, control of pulmonary hypertension and maintaining oxygenation while avoiding barotrauma. In some cases, ECMO may be necessary. Surfactant therapy has not proven to be beneficial. Surgical intervention is delayed until the patient the pulmonary hypertension is controlled and oxygenation is optimized.

Fetal ultrasound can make a prenatal diagnosis. Prenatal surgery has been performed and studied, but there is no improvement in morbidity or mortality.

Take-Home Message

Congenital diaphragmatic hernia is not a surgical emergency. Although surgery needs to be performed early, pulmonary hypertension and hypoxia need to be corrected first.

ABP Content Specification

- Know the differential diagnosis for neonatal respiratory distress.
- Know the physical and radiologic findings associated with CDH.
- Know that surgical repair is necessary but only after the infant is intubated and the pulmonary hypertension is improved.

Question 38

A 12-year-old boy is brought to the ED for abdominal pain and vomiting. The father states that the child has a history of "colic" as an infant and chronic abdominal pain as a child. The pain is accompanied by vomiting. Today the pain is of the same nature only it is more severe. There is associated vomiting. The patient never had surgery. The patient is afebrile. He looks younger than the documented age. He is clearly uncomfortable. The abdomen is distended and is diffusely tender. A plain abdominal X-ray shows a small bowel obstruction.

Which of the following statements are true?

A. The only presentation of malrotation is midgut volvulus.
B. Midgut volvulus can be ruled out if the child is older than 1 year.
C. Chronic symptoms including failure to thrive may be manifestations of malrotation.
D. Malrotation is almost always an isolated abnormality.
E. UGI studies are never indicated.

Correct Answer: C

Malrotation encompasses a spectrum of anatomic abnormalities that result from incomplete rotation and fixation of the intestine during early fetal development. The midgut develops and rotates during the 5th to 12th weeks of fetal development. When development is normal, the ligament of Treitz is in the left upper quadrant and the cecum is in the right lower quadrant. The mesentery of the bowel becomes fixed to the posterior abdominal wall. When development is abnormal, the rotation is incomplete and the mesentery is not fixed, allowing the bowel to twist on the mesentery and result in volvulus. If not recognized in a timely manner, the entire small bowel can become gangrenous; therefore, midgut volvulus is a surgical emergency. Duodenal obstruction is another presentation of malrotation; this can result from Ladd's bands (abnormal mesenteric/peritoneal bands) that compress the duodenum.

Approximately half the patients will have associated anomalies. Most cases are diagnosed in the first month of life and almost all by the age of one. There are some patients that have a delayed presentation because the malrotation is

incomplete. These patients have a history of intermittent pain that is associated with vomiting (that is not always bilious). Associated findings include weight loss and failure to thrive. An UGI study can make the diagnosis of malrotation.

Take-Home Message
Midgut volvulus is a surgical emergency. If left untreated, the entire small bowel can become gangrenous.

ABP Content Specification
- Know that malrotation encompasses a spectrum of anatomic abnormalities.
- Know that these abnormalities result from incomplete rotation and fixation of the intestine during early fetal development.
- Recognize that midgut volvulus is a surgical emergency.

Question 39

The parents of a 5-week-old full term baby bring their infant to the hospital because although he is always hungry and tries to eat, he vomits after feeding. The vomit resembles the formula and is not bilious. This has been going on for approximately 1 week. On examination, the patient is dehydrated. It is difficult to perform a thorough abdominal exam because the patient is irritable and he is crying. Which of the following statements is true?

A. Patients with infantile hypertrophic pyloric stenosis (IHPS) are born with the muscle hypertrophied.
B. Erythromycin administration can be prophylactic in high-risk cases.
C. A pyloric channel that is 3 mm thick and 2 cm long is diagnostic for pyloric stenosis.
D. "String sign" seen on US is diagnostic for pyloric stenosis.
E. Postoperative vomiting should prompt an immediate return to the operating room.

Correct Answer: C

Pyloric stenosis typically occurs in infants 3–8 weeks old. It is the most common cause of nonbilious vomiting in infants. The pylorus is not hypertrophied at birth which is why the infant is able to eat initially. As the muscle hypertrophies the symptoms get progressively worse. Erythromycin has been implicated as a contributing factor to pyloric stenosis.

The pathognomonic presentation is projectile vomiting after feeding, a palpable mobile mass (the hypertrophied pylorus or "olive") and visible peristalsis. It may be difficult to perform an adequate physical if the infant is crying. US is a useful adjunct. Ultrasonography is the preferred modality because of its high rate of accuracy, and no radiation exposure is involved. It shows the hypertrophied pylorus. Diagnostic measurements are a thickness of 3 mm and a length of 15–20 mm. UGI series shows a "string sign" which is the contrast "trickling" through the hypertrophied pylorus.

These children are dehydrated and have electrolyte abnormalities (hypochloremia & hypokalemia). They have a metabolic alkalosis. The metabolic derangements need to be corrected before surgery.

Pyloromyotomy is the surgical treatment. Recurrence is less than 1%. Vomiting is not unusual in the postoperative period (up to 50%). It will resolve within 24 hours, and full feeding will be achieved in 24–36 hours.

Take-Home Message
Pyloric stenosis is an important cause of nonbilious vomiting in infants. The pathognomonic presentation is projectile vomiting after feeding and a palpable mobile mass. Overfeeding is the most common cause of nonbilious emesis in neonates and infants, followed by gastrointestinal reflux.

ABP Content Specification
- Know at what age pyloric stenosis presents.
- Know how pyloric stenosis presents.
- Know what electrolyte abnormalities are present with pyloric stenosis.
- Know the treatment for pyloric stenosis.

Question 40

A neonate with cystic fibrosis is brought to the ED for vomiting. As per the family, the infant had a normal weight at birth. He never passed any meconium. He has a distended abdomen and distended loops of bowel can be palpated.

Which of the following statements is true?

A. Increased amniotic fluid is a sign of a healthy fetus.
B. Bilious vomiting represents an obstruction proximal to the ampulla of Vater.
C. Similar to adults, the small and large bowel in a neonate can be distinguished on plain X-rays.
D. Bilious projectile vomiting is pathognomonic for pyloric stenosis.
E. Patients with meconium ileus develop obstruction by inspissated meconium, usually in the terminal ileum.

Correct Answer: E

Increased amniotic fluid (polyhydramnios) is a sign of fetal obstruction. Fetuses swallow amniotic fluid and excrete it in their urine. If there is an obstruction in the GI tract, there is an excess of amniotic fluid; the more proximal the obstruction, the more volume of amniotic fluid.

Vomiting can be a sign of obstruction in the neonate. If the vomiting is bilious, the obstruction is distal to the ampulla of Vater. If the obstruction is proximal to the ampulla of Vater, the vomiting is nonbilious.

In hypertrophic pyloric stenosis, the vomiting is nonbilious. Vomiting results from obstruction secondary to a hypertrophic pyloric muscle. This is the most common *surgical* cause of vomiting in infants. Findings on physical exam include dehydration, gastric peristaltic waves, and a palpable pylorus. Diagnosis can be made by history and physical alone. Adjunct studies include US and UGI series. The treatment is hydration, correction of the hypochloremic, hypokalemic metabolic alkalosis, and surgery (pyloromyotomy). Obstruction resulting in bilious vomiting includes the following conditions:

- Congenital Duodenal Obstruction can result from Ladd's bands, annular pancreas, atresia, stenosis, or a mucosal web. Similar to pyloric stenosis, vomiting occurs after feeding; however, in the case of duodenal obstruction, vomiting is bilious in 75% of cases. Treatment is surgical.
- Atresia of the jejunum, ileum, & colon results from in utero mesenteric vascular accidents. There is a spectrum of anomalies and the treatment is surgical.
- Intestinal malrotation is a spectrum of disorders related to developmental errors in rotation and mesenteric fixation. Volvulus resulting from malrotation is a surgical emergency. Thirty percent of infants treated for volvulus will die from gangrenous bowel.
- Meconium ileus develops in 10–20% of infants with cystic fibrosis. It can also occur in infants without any etiology. The patients do not pass meconium. Inspissated meconium results in bowel obstruction, commonly in the terminal ileum. X-ray findings include the "soap bubble" sign (air mixed with meconium). Treatment is primarily nonsurgical. The patient should be hydrated, an NGT should be inserted, and a contrast enema should be performed. If unsuccessful, surgery may be indicated.
- Hirschsprung's Disease results from the absence of ganglion cells in the distal colon and rectum. The patients have a functional obstruction and develop abdominal pain, distention, and bilious vomiting. The diagnosis is made by rectal biopsy. The treatment is surgical.
- Intussusception results from the telescoping of one segment of bowel into the other. The classic clinical description is that of vomiting and "currant jelly stool." A contrast enema is diagnostic and can be therapeutic. If the enema does not reduce the intussusception, surgery may be necessary.

Unlike adults, the small and large bowel in a neonate cannot be distinguished by markings on plain X-rays.

Take-Home Message
Nonbilious projectile vomiting is pathognomonic for pyloric stenosis. Pyloric stenosis is the most common *surgical* cause of vomiting in infants. Surgery is required after rehydration and correction of electrolyte disturbances.

ABP Content Specification
- Know the differential diagnosis for neonatal intestinal obstruction.
- Know that increased amniotic fluid (polyhydramnios) is a sign of fetal obstruction.
- Know that congenital duodenal obstruction can result from Ladd's bands.

Question 41

You are walking to work when a woman delivers a baby in the hallway outside the emergency department. Immediately you notice that the newborn has an abdominal wall defect and it appears as if there is bowel evisceration. The child appears normal otherwise. Which of the following statements is true?

A. The bowel in gastroschisis is covered by a protective membrane.
B. The bowel in an omphalocele is not covered by a protective membrane.
C. The abdominal wall defect in gastroschisis is located to the left side of the umbilicus.
D. The abdominal wall defect in gastroschisis is located to the right side of the umbilicus.
E. Once the defect is closed in gastroschisis, the infant can immediately start feeding.

Correct Answer: D

There are two types of open abdominal wall defects that occur in the newborn: gastroschisis and omphalocele. In both there is evisceration of intra-abdominal organs (usually intestines and gonads). In gastroschisis, there is no protective membrane covering the intestines; there is often a fibrinous peel. In omphalocele there is a protective membrane covering the eviscerated organs.

Gastroschisis occurs in the 6th or 7th week of gestation. It is thought that there may be vascular compromise of the right abdominal wall because of involution of the right umbilical vein. Omphalocele likely results from failure of fusion of the lateral embryonic folds at the umbilical ring. The defect involves the umbilicus (unlike in gastroschisis). The eviscerated organs can include intestines, gonads, liver, spleen, or bladder.

Patients with omphalocele are more likely to have associated defects than patients with gastroschisis.

There is usually a prolonged ileus in neonates with closure after gastroschisis. This is because there is pre-existing intestinal dysmotility. It may be several weeks before these infants can have enteral feeding. This is not the case with omphalocele where the intestine does not have associated dysmotility. These infants can usually be fed soon after repair of the abdominal wall defect.

Take-Home Message
There are two types of open abdominal wall defects that occur in the newborn: gastroschisis and omphalocele. In gastroschisis, there is no protective membrane covering the intestines; there is often a fibrinous peel. In omphalocele there is a protective membrane covering the eviscerated organs.

ABP Content Specification
- Know the different types of abdominal wall defects in the newborn.
- Know the embryology behind these defects.
- Know how to manage abdominal wall defects.

Question 42

The parents of a neonate are concerned that the baby is always constipated. The perinatal history includes no passage of meconium for 48 hours. The infant also has not been gaining weight as anticipated. On examination, the child has a soft but slightly distended abdomen. There is no tenderness.

Which of the following statements are true?

A. The obstruction in Hirschsprung's disorder is caused by a mechanical obstruction in the rectum.
B. The mortality related to Hirschsprung's disease is 25%.
C. Hirschsprung's disease is usually an isolated pathology.
D. Diarrhea can be seen in Hirschsprung's disease.
E. Rectal biopsy in children less than 5 years old is contraindicated.

Correct Answer: D

Hirschsprung's disease is a motility disorder. Obstructive symptoms result from a functional not a mechanical cause. There is an absence of neurons in the distal colon that leads to the lack of motility in that segment and therefore the proximal colon gets dilated and the patient gets constipated.

Neonates often have a history of not passing meconium for 24–48 hours. They present with constipation, abdominal distension, and failure to thrive. Rarely patients present with explosive diarrhea (Hirschsprung-associated enterocolitis, HAEC). Other anomalies are often seen with Hirschsprung's disease.

Infants with chronic constipation for more than 3 months should have a thorough evaluation that includes the inspection of the anus and a rectal exam. A contrast enema should also be performed. If there is no mechanical cause for obstruction, a suction rectal biopsy should be performed next. The sensitivity of biopsy is 93% and the specificity is 100%.

Treatment is surgical. It involves resection of the aganglionic segment. Mortality is 1%.

Take-Home Message

Hirschsprung's disease is a motility disorder. Constipation is the most common symptom. Obstructive symptoms result from a functional not a mechanical cause. The treatment involves surgical resection of the aganglionic segment.

ABP Content Specification

- Know what causes Hirschsprung's disease.
- Know that infants can develop Hirschsprung-associated enterocolitis (HAEC).

Question 43

A 4-year-old girl is rushed to the emergency department after overturning a pot of boiling water on herself. She has burns on her face, chest, and hand. She has no other injuries.

Which of the following statements is true?

A. Scald injuries are uncommon in young children.
B. Flame injuries are most common in children less than 4 years old.
C. IV fluids should be restricted to prevent edema in burn patients.
D. Second-degree burns are also known as partial-thickness burns.
E. Morphine should be avoided in burn patients because the risks of administering a narcotic outweigh the benefits.

Correct Answer: D

Burns are the fifth leading cause of unintentional death related to injury. Children less than 4 years of age most commonly have scald injuries. These types of injuries include spilling hot or boiling water on themselves, touching hot objects like an iron, or immersion into a bath with hot water. Flame injuries are more commonly seen in older children.

Burn injuries can result in coagulation necrosis and severe inflammation. The injury continues even after the inciting factor (i.e., flame, boiling water) is removed because the injured cells release vasoactive mediators. This results in an increased permeability of capillaries that are damaged and significant fluid losses and hypovolemia. Fluid replacement is a significant part of burn treatment. Burn surface area (BSA) is important for determining how much volume to give.

The Lund and Browder chart is often used to calculate percent body surface area with the appropriate adjustments that take age into account. Children have different body proportions than adults (e.g., the BSA of the head of an infant is 19% and in an adult is 7%). Another way to estimate the BSA is using the estimate that the child's hand is 1% of total BSA.

Once the BSA is determined, it can be entered into the Parkland equation to calculate fluid requirements. The formula is 4 mL/kg/% BSA for the first 24 hours. Half the fluid is given in the first 8 hours and the other half in the next 16 hours. Only second- and third-degree burns should be used in determining the percent BSA. First-degree burns are limited to the epidermis. Second-degree burns involve the epidermis and part of the dermis. They are also referred to as partial-thickness burns. Third-degree burns penetrate the epidermis and the entire dermis. Fourth-degree burns extend beyond the skin to underlying muscles, tendons, and bone.

Second-degree burns are very painful. Third-degree burns are often insensate because nerve endings are damaged. Pain management is an important part of wound care. Morphine is commonly used and administered IV.

Take-Home Message

Burn surface area (BSA) is important for determining how much volume to give. Only second- and third-degree burns should be used in determining the percent BSA. The Parkland equation for volume resuscitation is 4 mL/kg/% BSA for the first 24 hours.

ABP Content Specification

- Understand how to calculate the volume of fluid needed for burn patients.

Question 44

Two brothers, ages 5 and 7 years old, were playing and pretending to have a sword fight.

The younger brother "stabbed" the older brother with a piece of wood in the hand. The older brother now has a laceration to the forearm. In the emergency department, the arm is inspected. There is a jagged laceration measuring 2 cm to the left palm. Subcutaneous fat is exposed. Both brothers are still fighting.

Which of the following statements is true?

A. The wound should be immediately irrigated and closed to prevent infection.
B. Infiltration of local anesthesia before the examination is recommended in children in order to facilitate the examination.
C. The duration of action of Lidocaine is 3 hours.
D. The maximal dose of Lidocaine is 4.5 mg/kg.
E. Tissue adhesive has a higher tensile strength than sutures.

Correct Answer: D

ED visits for lacerations and soft tissue injuries are very common. It is important not to solely focus on the superficial aspect of the injury. The evaluation should assess for deeper and more serious and complex injuries prior to repair of the laceration. For example, injuries to the hand and extremities should prompt an evaluation of nerves, blood vessels, and tendons. Injuries to the trunk should raise the possibility of cavitary injury.

Sensation should be assessed prior to administration of local anesthesia. Once sensation is assessed, local anesthesia should be infiltrated and the wound can be explored for foreign bodies and irrigated. Imaging sometimes needs to be performed to evaluate for foreign bodies. The maximal dose of Lidocaine without epinephrine is 4.5 mg/kg. The maximal dose of Lidocaine with epinephrine is 7 mg/kg. The onset of action is rapid and the effect lasts for 1–2 hours. If possible, anesthesia should be infiltrated prior to irrigation of the wound. The skin surrounding the wound should be cleansed with an antiseptic agent like chlorhexidine or betadine. Removal of

hair is not always necessary, but if it is removed, it is preferable to clip the hair rather than shave it. The eyebrows should never be shaved.

If the injury is less than 12 hours old on the body and less than 24 hours old on the face, it should be closed after irrigation and evaluation for foreign bodies. Depending on the wound characteristics, it can be closed with tissue adhesives, steristrips, sutures, or staples. With sutures and staples, the skin should be everted. Adhesives can be used in low tension wounds—they have less tensile strength than sutures.

Take-Home Message
Lacerations should be assessed for deeper injuries (tendons and nerves).

ABP Content Specification
- Understand the need to look for deeper injuries (tendons, nerves, blood vessels, and cavity).
- Know the maximal dose for local anesthesia.
- Know alternative closure techniques for sutures.

Question 45

A 5-year-old child presents with a palm laceration which is irrigated and examined. No foreign bodies are present and the wound is closed. Which of the following statements regarding wound care is true?

A. Lacerations heal best in a dry environment, therefore avoid an occlusive dressing.
B. Avoid splints across joints or areas of movement because this will result in a stiff immobile joint.
C. The final appearance of the scar is best evaluated after 6–12 months.
D. Epithelialization of the wound occurs after 96 hours.
E. It is important to avoid compressive dressings to the ear in order to avoid ischemia of the cartilage.

Correct Answer: C

Wounds heal best in a moist environment. An occlusive or semiocclusive dressing should be applied over the wound after cleaning the skin. Splints are recommended over areas of movement (a joint for example) in order to prevent dehiscence of the wound. Epithelialization occurs within 24 hours and it is best to keep the wound covered for this duration. The final appearance of the wound is best appreciated at 6–12 months.

Special consideration is given to wounds in specific anatomic areas. Exposed cartilage in ear lacerations needs to be covered to prevent infection of the cartilage. Once the cartilage and skin are approximated, a bolster dressing should be applied to the ear to prevent hematoma formation which can result in a deformity referred to as cauliflower ear.

Take-Home Message
Wound closure is a part of open wound care. Equally important are the dressings. Wounds heal best in a moist environment. Lacerations across joints should be splinted to prevent dehiscence of the wound from movement. Exposed cartilage should be covered with tissue to prevent infection.

ABP Content Specification
- Know how to dress wounds.
- Know that the final appearance of a scar will occur 6–12 months after injury.

Question 46

The family of a 5-year-old child with a feeding tube brings the child to the emergency department because the skin around the tube is red and the child seems irritable. The percutaneous endoscopic gastrostomy tube (PEG) was placed recently. The child is afebrile, the abdomen is nondistended, and there is a ring of erythema around the PEG tube.

Which of the following statements is true?

A. A PEG can be replaced safely 2 weeks after insertion.

B. A PEG is recommended for children who will require enteral access for 1 month.
C. Pyloric obstruction is a complication of PEG tubes.
D. It is dangerous to flush a tube that is clogged.
E. PEG tubes avoid aspiration.

Correct Answer: C

Enteral access devices can be short term or long term (greater than 2–3 months). Temporary feeding tubes can be inserted through the nose into the stomach (nasogastric) or jejunum (nasojejunal). Feeding tubes meant to stay for extended periods of time can be placed by a surgeon, and endoscopist, or an interventional radiologist. These tubes are placed in the stomach (gastrostomy) or the jejunum (jejunostomy) tubes. Sometimes the jejunum is accessed through the stomach (transgastric jejunal tube). A gastrostomy placed by endoscopic means is a percutaneous endoscopic gastrostomy tube (PEG). A gastrostomy placed during an operation (open or laparoscopic) is a gastrostomy.

There are several complications that can occur with PEG tubes. These include infection in the soft tissue surrounding the tube, bleeding in the soft tissue or in the stomach, gastrocolic fistula, pyloric obstruction, peritonitis, and dislodgement of the feeding tube.

Problems that commonly arise can sometimes be addressed in the ED. Gastric contents may leak because the tube is too small for the opening. A larger diameter tube will correct this problem.

If the balloon is deflated, a leak may occur. This can be managed by inflating the balloon. Erythema around the tube may be normal or result from irritation (leak or device is too tight) or from infection. Antibiotics should be reserved for infection. A clogged tube can result from inspissation of feeding or medications. It is important to flush the tube frequently and use liquid forms of medication when available.

Removal of a gastrostomy should not be done until there is a mature tract that has formed. This is generally after 2–3 months. A tube that becomes accidentally dislodged after a tract has formed can usually be replaced if recognized early. Gastrostomy tubes do not prevent aspiration.

Take-Home Message

A well-formed tract forms at 2 to 3 months after gastrostomy placement.

At that time, a tube can be withdrawn and replaced at the bedside.

ABP Content Specification

- Know the different types of enteral access.
- Know the complications of these tubes.
- Know basic strategies to troubleshoot these complications in the ED.

Question 47

A 16-year-old boy is brought to the emergency department for a painful red area in the left groin. The patient says he was in his usual state of health until a few days ago when he noticed that his groin was slightly red and over the last few days the area of redness has increased and it is causing him more pain. The patient has a temperature of 100 F and pulse is 100 beats/minute. He appears uncomfortable and other than the groin, there are no other findings. The left groin has a 3 × 3 cm area of erythema that is tender to palpation. There is no fluctuance or lymphadenopathy. The patient is hirsute. There are no wounds on the leg.

Which of the following statements is true?

A. Impetigo involves the dermis and subcutaneous tissue.
B. Cellulitis involves only the dermis.
C. Imaging has no role in the assessment of soft tissue infections.
D. Folliculitis is commonly caused by Staph aureus
E. Patients with necrotizing soft tissue infections do not have pain because the nerves are destroyed and the area is insensate.

Correct Answer: D

This patient has folliculitis. Soft tissue infections can occur anywhere on the body. They can be categorized as deep or superficial and necrotizing or non-necrotizing. Superficial infections

involve the epidermis and dermis (which is where the term pyoderma comes from). Typical superficial infections are impetigo and erysipelas. Impetigo commonly occurs in patients with other skin conditions such as eczema or dermatitis. It can be caused by Staphylococcus or Streptococcus. Erysipelas is usually caused by Streptococcus pyogenes.

Folliculitis is a superficial infection of a hair follicle. Most cases resolve spontaneously. Topical antibiotics can shorten the duration of the infection. Furuncles and carbuncles are also infections of hair follicles but these infections extend beyond the follicle into the subcutaneous tissue. A furuncle is a small abscess that involves one hair follicle. A carbuncle involves more than one hair follicle and forms multiple abscesses that are interconnected and may have sinus tracts. Furuncles and carbuncles often need antibiotics and drainage. The causative organism for folliculitis, furuncles, and carbuncles is usually Staph aureus.

Cellulitis is a bacterial infection that involves the dermis and deeper subcutaneous tissue. Staphylococcus and Streptococcus are the most common organisms. The treatment is antibiotics. If the patient has systemic signs and fever, blood cultures should be obtained.

Necrotizing infections can be limited to the dermis and subcutaneous tissues or can involve deeper tissue like the fascia and muscle. Pain is out of proportion to the physical findings. The area is red, tender, and edematous. There may be crepitus or blisters. An X-ray can show air in the subcutaneous tissues. The organism seen in these infections is often Clostridium. The treatment is antibiotics and expeditious surgical debridement.

Take-Home Message

Soft tissue infections can be "benign" or may be necrotizing. It is important to distinguish necrotizing soft tissue infections because these require prompt aggressive surgical debridement. Symptoms (pain out of proportion to physical findings), physical findings (rapid progression of erythema, bullae, crepitus), radiologic findings (gas in soft tissue), and laboratory findings (hyponatremia, elevated WBC) can help distinguish necrotizing soft tissue infections from benign infections.

ABP Content Specification

- Know the definitions of different soft tissue infections.
- Know the signs of a necrotizing soft tissue infection.
- Know the treatment for soft tissue infections.

Question 48

A 16-year-old girl was working on a car with her father. She sustained a puncture wound to the palmar aspect of her left index finger with a piece of metal a few days before presentation the ED. She is certain there is no foreign body. She washed her hands immediately after this happened. She is now complaining pain in the finger. She has a temperature of 100.4 F and a pulse of 82 beats/minute. The left ring finger is swollen and tense. It is tender to palpation along the palmar aspect. She cannot bend the finger completely and when she tries, it is extremely painful.

Which of the following statements is true?

A. Clamping arterial bleeding in an acute hand injury is safer than a tourniquet.
B. The flexor digitorum profundus moves the proximal interphalangeal joint.
C. The flexor digitorum superficialis is innervated by the ulnar nerve.
D. Patients with suppurative tenosynovitis have pain with passive stretch.
E. Complex hand injuries are not life threatening and do not require transfer to "specialty" hospitals with hand surgery capabilities.

Correct Answer: D

This patient has tenosynovitis. Infection within the flexor tendon sheath may occur due to the spread of adjacent pulp infections or puncture wounds in the flexor creases. Hand injuries and infections are commonly seen in the pediatric emergency department. The hand is a complex structure and the examination must be thorough

in order to avoid a delay in diagnosis that may have lifelong consequences. Complex hand injuries are best treated in tertiary hospitals with expertise in this area. Attempts at controlling bleeding in hand injuries by blind clamping should be avoided. Tourniquets can be helpful.

Knowledge of hand anatomy is crucial for the examination and diagnosis of injuries and infections. The flexor digitorum profundus (FDP) moves the distal interphalangeal joint. The FDP of the index and middle fingers is innervated by the median nerve. The FDP of the ring and little fingers is innervated by the ulnar nerve. The flexor pollicis longus flexes the interphalangeal joint of the thumb and is innervated by the median nerve. The digital extensors are innervated by the radial nerve. Sensation is best tested by 2-point discrimination prior to administration of local anesthesia.

Suppurative tenosynovitis is an infection involving the tendon sheath of the fingers. It can result from trauma. As pus accumulates in the tendon sheath, the patient's finger becomes swollen and the finger tends to stay in a flexed position. Pain with passive extension is typical. Immediate treatment is warranted. This includes antibiotics and surgical drainage. If diagnosed early, IV antibiotics may be adequate, but the patient must be observed. If there is no improvement within 24 hours, operative management is necessary.

Take-Home Message
Tenosynovitis is a serious condition that often needs operative management.

ABP Content Specification
- Recognize tenosynovitis.
- Know the treatment of tenosynovitis.
- Recognize other types of hand and finger infections.

Question 49

A 15-year-old child is complaining of back pain. The child describes himself as a "nerd" who is not involved in sports except for mandatory gym class at school. He is mostly sedentary and likes playing computer games. The pain is in the lower back and not associated with leg pain or weakness or bowel or bladder changes. He is afebrile. On examination, he has mild back tenderness to deep palpation. The neurologic examination is normal. Which of the following statements are *false?*

A. History and physical are important in the evaluation of back pain.
B. Plain X-rays can help to make a diagnosis.
C. Surgery is almost always necessary to treat spondylolisthesis.
D. Spondylolysis is a microfracture of the spine.
E. Pain that wakes the patient up from sleep should prompt a thorough evaluation.

Correct Answer: C

Back pain is common in children and is often determined to be "benign" if there are no associated neurologic symptoms, it improves with rest, it does not wake the patient up at night, and there is no associated weight loss.

X-rays of the spine in multiple views can assist in making the diagnosis. Spondylolysis is a microfracture of the spine. Spondylolisthesis is anterior displacement of one vertebra on another. This commonly occurs with L5 "slipping" anteriorly on S1. Treatment includes core strengthening and hamstring stretching. Surgery is rarely indicated.

Take-Home Message
Spondylolisthesis is anterior displacement of one vertebra on another. It is a common cause of back pain in children. Surgery is rarely required.

ABP Content Specification
- Be able to define spondylolisthesis.
- Know the treatment.

Question 50

The parents of a neonate are complaining of erythema and a foul smell "from the belly button." The child was premature and had "a tube placed

in the belly button" in the NICU. The patient is awake and not crying. He is afebrile and pulse is normal for his age. The abdomen is nondistended, and there is cellulitis around the umbilicus. There is also a foul smell originating from the umbilical area. Which of the following statements is true?

A. Silver nitrate will help treat this condition.
B. This is not an acute infection and there is no need for antibiotics.
C. A fistulogram should be performed.
D. This is an umbilical polyp.
E. This may be a life-threatening infection and the patient needs broad-spectrum antibiotics.

Correct Answer: E

This patient has omphalitis. This is a potentially life-threatening infection of the umbilical stump which is an excellent medium for bacterial growth. Presentation involves erythema, swelling, discharge, and induration around the stump. It may remain localized or may spread to the abdominal wall, the peritoneum, the umbilical or portal vessels, or liver. The colonized necrotic tissue is in the close vicinity to umbilical vessels. Therefore, invasion of pathogens via the umbilicus may occur with or without the presence of signs of omphalitis. These infections are polymicrobial, and patients should receive broad-spectrum antibiotics.

Omphalitis is in the differential diagnosis for umbilical granuloma. Umbilical granulomas form in the remnant of the umbilicus. The size is variable and they can be up to 1 cm. They are moist and respond well to application of silver nitrate. There is no involvement of the skin around the umbilicus (as seen in omphalitis).

Umbilical polyps are masses found in the umbilicus. They consist of intestinal or uroepithelium. They do not respond to application of silver nitrate and the treatment is excision.

A draining sinus in the umbilicus may represent incomplete closure of the omphalomesenteric duct. These patients need a more extensive evaluation that includes a fistulogram.

Take-Home Message

Omphalitis is a potentially life-threatening infection of the umbilical stump. Possible complications include abdominal wall cellulitis or necrotizing fasciitis, with associated sepsis.

ABP Content Specification

- Know how omphalitis presents.
- Know the differential diagnosis of omphalitis.

Trauma

21

Jaryd Zummer and Mark Fenig

Question 1

A 3-year-old boy is brought to the emergency department by his mother. The mother reports that the child was stopped from running into traffic by forcefully holding his left hand. The child immediately began crying and would not move his arm. Initial examination reveals a well appearing, nontoxic child who is holding his left arm adducted and semiflexed and prone. On further examination, the patient is resistant to any arm manipulation and cries when attempting to pronate or supinate the forearm. There is no obvious deformity or traumatic lesion noted. Which of the following is correct?

A. Obtain radiographs of the elbow.
B. Reduce the elbow using a hyperpronation or supination-flexion technique.
C. Prepare a room for conscious sedation.
D. Since the child is 3 years old, dislocation is unlikely.
E. The injury is likely the first manifestation of a connective tissue disorder.

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Correct Answer: B

Subluxation of radial head (nursemaid's elbow) occurs after sudden longitudinal traction of wrist/forearm. The mechanism is radial head subluxation with consequent annular ligament slipping into the radiocapitellar space. It most commonly occurs in children between 1 and 4 years of age.

Patients classically present with the arm held in adduction, semi flexed, and pronated.

The two techniques to reduce nursemaid's elbow are the hyperpronation and the supination-flexion. In the hyperpronation technique, the elbow is held at 90° with a thumb over the radial head, and the wrist is briskly hyperpronated using the other hand. Alternately, the supination-flexion technique could be attempted. The elbow is held firmly at 90° while the other hand is used to briskly supinate the wrist. This maneuver is then followed by flexion. If this still does not result in immediate reduction, radiographs should be obtained to further evaluate the osseous structures and confirm that there is no fracture. Successful reduction provides immediate relief and return to full range of motion at the elbow.

Take-Home Message

There is no need to obtain radiographs on presentation if the history and examination are typical for subluxation of radial head (nursemaid's elbow). Immediate reduction should be performed without radiographs for typical presentation.

M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_21

ABP Content Specification

- Know and understand the mechanism of injury in dislocation (subluxation) of the radial head.
- Plan the management of a child with dislocation (subluxation) of the radial head.

Question 2

A 3-year-old child is brought to the emergency department by her mother after the child, accidentally ran into a telephone pole and fell to the ground. After a few seconds, the child began to cry loudly. The mother noticed a large bump on the right side of the head. The child's vital signs in the ED were as follows: heart rate 80 beats/minute, respiratory rate 20 breaths/minute, and blood pressure 105/65 mm Hg. The patient is alert and interactive, reaching for the stethoscope. Secondary survey is significant for a 3 × 3 cm hematoma over the right side of scalp which is tender to palpation. The mother asks you for your opinion about whether a CT scan of the brain is warranted. The most appropriate response is:

A. The chance that there is any bleeding around the brain is extremely low.
B. The chance that the child will need any surgical intervention is extremely low.
C. A CT scan is recommended to confirm that there is no bleeding around the brain.
D. If there was dried blood at the hematoma site, a CT scan is strongly recommended.
E. Loss of consciousness is an absolute indication for a CT scan.

Correct Answer: B

The PECARN Pediatric Head Injury Prediction Rule is a well-validated clinical decision tool that allows physicians to safely rule out the possibility of clinically important traumatic brain injuries.

The publication and its prediction tool suggest that routine CT scan of the brain may confer more harm than benefit, given the stochastic effects of radiation to the brain at this age, that is, lethal malignancy. Lethal malignancy rates are approximately 1 in 1000–1500 in 1-year-olds and 1 in 5000 in 10-year-olds.

According to the PECARN prediction tool, the chance that this patient has a clinically significant brain injury, defined as requiring neurosurgical intervention, intubation, and extended hospitalization is less than 0.05%. Therefore, the PECARN recommendation would be to not pursue a head CT scan. In September 2014, PECARN published another study that showed that isolated loss of consciousness (LOC) is not associated with clinically significant TBI therefore do not routinely require computed tomographic evaluation.

Take-Home Message

The PECARN prediction rule is helpful to avoid unnecessary head CT scans for children presenting with head trauma and is sensitive in detecting clinically important traumatic brain injury (ciTBI).

ABP Content Specification

- Know the indications for computed tomography of the head in a patient with blunt head trauma.

Question 3

A 15-year-old boy is brought to the ED by EMS after an aggressive tackle at football practice that left him dazed and confused on the field, and unable to answer questions appropriately for several minutes. EMS immobilized the patient's neck. En route to the hospital the patient was conversant and answered all questions appropriately. The patient has no prior medical history and is otherwise healthy.

On physical examination, the patient is in a C-collar. His eyes are open and he is appropriately conversant. He has no difficulty following commands and his exam is only remarkable for an abrasion on the patient's left cheek. The coach would like to know if the patient can return to play for tomorrow's early morning practice.

A. Since there was no loss of consciousness, concussion is not a concern.
B. Return to play should be determined using the Cantu 3 scoring system.

C. Return to play should be determined using the Colorado 3 Scoring system.
D. Return to play should be determined using the AAN 3 Scoring system.
E. Return to play should be determined using individualized assessment by a licensed health care professional.

Correct Answer: E

Football, hockey, rugby, and soccer have the highest risk for concussion injuries. Common concussive symptoms include: headache, blurry vision, sensitivity to light, confusion, dizziness, generalized weakness, or fatigue. Younger children have been shown to take more time to recover from concussive symptoms than adults and a more conservative approach to return to play should be utilized in younger patients.

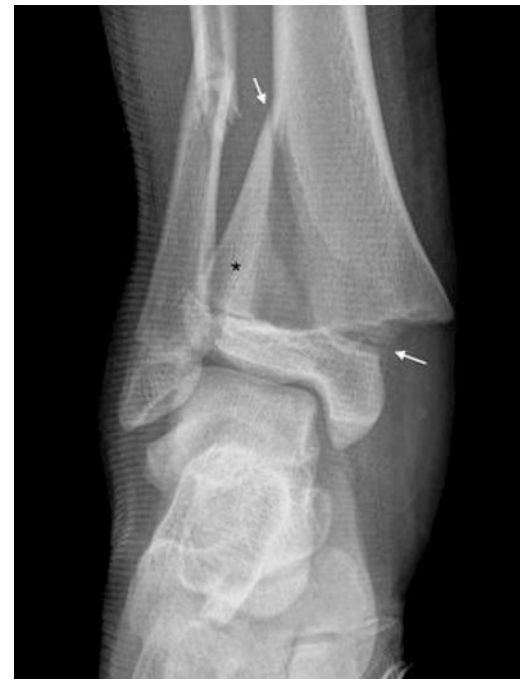
After a concussion, athletes should not return to play until all symptoms are resolved, and current recommendations are for no same-day return to play, especially for the pediatric or adolescent athlete. An athlete must immediately be removed from play for at least 24 hours and should never return to play while symptomatic, and all return-to-play programs should be individualized because every athlete recovers at a different pace.

Take-Home Message
A return to play should only be determined by a licensed health care practitioner who is knowledgeable about sports concussion, after evaluating the individual.

ABP Content Specification
- Know the principles of the management of minor head injury.

Question 4

An 11-year-old boy is brought to the emergency department by ambulance after his older brother accidentally fell onto his left lower leg. The patient immediately began yelling in pain and was not able to bend his left ankle or put weight on his leg. Initial examination reveals a patient in significant pain and holding his left leg still. There is significant swelling and ecchymosis over the ankle (bilateral malleoli and anteriorly). The patient cannot tolerate a joint examination as any manipulation of the ankle is causing intolerable pain. The portable plain film of the left ankle is shown below.

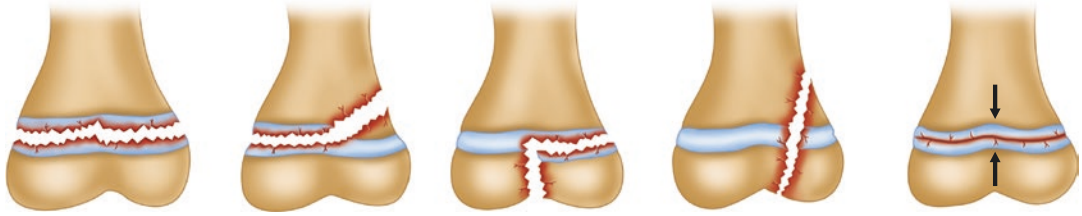


What is the diagnosis and most appropriate management?

A. Salter–Harris type II, ankle immobilization, nonweight bearing, and urgent orthopedic follow-up
B. Salter–Harris type II and immediate orthopedic consultation
C. Salter–Harris type III, ankle immobilization, nonweight bearing, and urgent orthopedic follow-up
D. Salter–Harris type IV, immediate orthopedic consultation
E. Salter–Harris type IV, ankle immobilization, nonweight bearing, and urgent orthopedic follow–up

Correct Answer: D

Before closure of growth plate spaces, the locus menorus resistensia (place of least resistance) is the growth plate—physis—and is, about a third of the time, the location of pediatric fractures. The Salter–Harris system is commonly used to classify the type of physeal fracture. Lower numbers in the Salter–Harris system tend to be associated with good outcomes and no significant permanent growth plate damage, whereas higher numbers are associated with poorer outcomes due to significant growth plate damage and articular surface involvement.



Salter–Harris classification. (Courtesy Springer publications: Clinical orthopaedics and related research®, 2016, 474(11):2531–7)

The Salter–Harris classification of physeal fracture relates the relationship of the fracture to the germinal layer of the physis and have prognostic significance in term of disturbance of bone growth.

- Type I = Epiphysis separates from the metaphysis.
- Type II = Involves the physis and the metaphysis. This is most common (approximately 75%) and bone growth is usually preserved.
- Type III = Involves the physis and the epiphysis. These are intra-articular fractures. Typical site tibia.
- Type IV = Involves both the epiphysis and metaphysis. Typical site distal humerus.
- Type V = Crush or compression injury to physis which are difficult to visualize on radiographs. Typical site knee or ankle.

The pneumonic, S—straight across, A—above, L—lower, T—through, and ER—erasure.

The injury this patient sustained is a Salter Harris IV fracture of the distal tibial and fibular physes. The articular surface is involved and compartment syndrome is a potential risk therefore immediate orthopedic consultation is indicated for reduction.

Take-Home Message

The type of physeal fracture, (Salter–Harris classification system) can help determine the management and prognosis of the injury. The most frequent type of epiphyseal fractures is type II, and types III, IV, and V involve the articular surface and prognosis should be guarded due to the possibility of impaired joint mechanics and growth arrest.

ABP Content Specification

- Know the five types of epiphyseal fractures defined by the Salter–Harris classification system.

Question 5

A 14-year-old female patient presents to the ED after she inverted her ankle while doing a cartwheel. She has some swelling and pain over her lateral ankle, but without any tenderness over her medial or lateral malleoli or proximally. There is pain with ankle dorsiflexion but she completes a full range of motion of the ankle, and can walk down the hall on the affected ankle without diffi-

culty. What is the most appropriate course of action?

A. Discharge home with RICE precautions, NSAIDs as needed, and ankle bracing when she returns to activity.
B. Obtain X-ray to rule out an avulsion fracture.
C. Place in short leg cast and refer to Orthopedic surgery.
D. Obtain X-ray to assess for Mortise opening.
E. Obtain a CT scan to rule out an occult Tillaux fracture.

Correct Answer: A

The Ottawa Knee Rules have been well validated as a clinical decision tool to be used in patients above the age of two. If any of the following are true, then radiographs may be indicated; otherwise, they may be deferred:

1. Age between <2 or >55
2. Tenderness at head of the fibula
3. Isolated tenderness of the patella
4. Inability to flex knee to 90°
5. Inability to transfer weight for four steps both immediately after the injury and in the ED

Similarly, the Ottawa Ankle Rule is helpful to reduce the number of X-rays for ankle injuries and has been successfully used in children over the age of 6 years. A radiograph should be obtained if there is

1. Tenderness at the posterior edge of the distal 6 cm or the tip of the lateral malleolus
2. Tenderness at the posterior edge of the distal 6 cm or the tip of the medial malleolus
3. Inability to bear weight for at least four steps both immediately at the scene and at the time of the ED evaluation

Take-Home Message
Use decision rules such as the Ottawa Knee and Ankle Rules to reduce unnecessary X-ray use in ankle and knee injured patients.

ABP Content Specification
- Recognize a child with a femoral, tibial, or fibular fracture.

Question 6

You receive an EMS notification that a 7-year-old boy will be arriving in your ED in 5 minutes after struck in the right chest with a dart. The report states that the child is in respiratory distress. On arrival to the ED, you note that the child is listless and cyanotic. You palpate a rapid, thready pulse. His clothing has been removed and you notice a tegaderm over the right anterior chest wall just below the nipple line. When auscultating his chest, you note no air movement in his right lung field.

What is the next appropriate step in management?

A. Prepare for immediate chest tube placement
B. Prepare for immediate needle thoracostomy
C. Obtain a portable chest X-ray
D. Prepare for endotracheal intubation
E. Apply bilevel positive airway pressure (BiPAP)

Correct Answer: B

Clinical presentation of a tension pneumothorax requires immediate decompression. This is a life-saving procedure that must not be delayed. The presence of free air within the pleural cavity causes the mediastinal structures to shift toward the contralateral side. This increase intrathoracic pressures result in dramatically decreased venous return into the right heart and cardiac output, often causing cardiac arrest. The common presentation is severe respiratory distress, decreased breath sounds and displaced maximal cardiac impulse. In severe cases, mediastinal shift, tracheal deviation away from the pneumothorax, and distention of the neck veins may be present. In children, signs of tension pneumothorax may be subtle. The recognition of tracheal deviation may be difficult due to short neck and increased soft tissue.

Transitioning the patient from negative pressure spontaneous ventilation to positive pressure ventilation via endotracheal tube may worsen the tension pneumothorax by introducing more air into the pleural space and encouraging further lung collapse and increased intrathoracic pressures. This diagnosis should be made clinically before imaging is obtained. This is a clinical diagnosis, therefore, confirming the diagnosis of tension pneumothorax by obtaining chest radiograph should not delay its treatment.

Needle decompression can be performed either at second intercostal space in the midclavicular line, or fourth or fifth intercostal space in the anterior axillary line. The needle should be inserted above the rib margin in order to avoid intercostal vessel and nerve injuries. Tube thoracostomy can be performed after needle decompression and relief of respiratory compromise. Endotracheal intubation, if needed, should occur after decompression of the chest.

Take-Home Message

Needle decompression is lifesaving for patients with respiratory compromise due to tension pneumothorax and should not wait for imaging studies.

ABP Content Specification

- Plan the management of simple and tension pneumothorax following blunt chest trauma.

Question 7

Part A

A 6-year-old boy is brought to the emergency department by EMS after a motor vehicle collision. The car he was in was rear-ended in a high velocity collision. Paramedics immobilized the patient and reported that immediately after the accident, the boy was not able to move his right arm. Photos from the site show significant destruction to the rear of the car.

In the emergency department, the boy is tearful and looks frightened. He continues to complain about tingling sensation in his right arm. EMS initial examination shows 5/5 power in all four extremities and DTRs are 2+ throughout. There are no sensory deficits and the cranial nerves are intact.

What is the next best step in management?

A. Apply nexus criteria to determine if the C spine can be cleared clinically
B. Obtain plain films of the C-spine including an odontoid view
C. Obtain CT scan of the C-spine
D. Obtain flexion extension images of the C-spine
E. Observe patient in the ED for 6–8 hours prior to discharge

Correct Answer: C

Applying the NEXUS criteria to high mechanism injuries is controversial, particularly in children under 8 years old or who are distracted by fear. A spine MRI is desirable if available, but in its absence, CT imaging can help screen for spine injury. Greater than 8 mm of prevertebral widening at C2 is abnormal if C-spine X-rays are done. In this case, Spinal Injury Without Radiographic Abnormality (SCIWORA) is the main concern because of the report of a neurologic deficit. Most victims of SCIWORA are children under the age of 8 years old. The reason this injury is so prevalent among pediatric patients is due to the ligamentous elasticity of the immature spine and its ability to hyperextend/flex causing injury without osseous deformity.

Part B

CT scan and X-rays are negative and there are no signs of neurological deficit. What is the next appropriate step in management?

A. Apply nexus criteria to determine if the cervical spine can now be cleared clinically
B. Consult neurosurgery and admit the patient for further imaging studies

C. Observe the patient in the ED for 12 hours
D. Discharge the patient home with follow-up to neurosurgeon within 3 days
E. Perform a lumbar puncture

Correct Answer: B

Since this patient had a witnessed neurological deficit (EMS reported no right arm movement after the accident) and persistent tingling, the patient has a presumed spinal cord injury. Without radiological evidence of an injury on CT, the diagnosis of Spinal Cord Injury Without Radiological Abnormality (SCIWORA) can presumptively be made. All children with this diagnosis must be admitted and have a neurosurgical consultation. MRI is the next best option for further imaging of the cervical spine. With the advent of MRI, spinal cord parenchymal signal abnormalities have been detected. Since most injuries traditionally described as SCIWORA are identified on MRI, SCIWORA may be a misnomer in this era. The higher incidence in children is related to the laxity of ligaments, expandability of the intervertebral disk, and anatomical differences noted in the pediatric spine from adult.

SCIWORA should be suspected among patients that present with initial neurological deficits immediately following trauma, even if they resolve. These deficits can manifest again within 1–4 days. Management of SCIWORA should be based on the MRI findings and consultation with a spine specialist. Immobilization of the neck after trauma is critical. In young children, conventional C-collars may cause harm because they often cause flexion. Neutral position is achieved by aligning the external auditory meatus with the shoulders. If necessary, create a bolster for the head with rolled sheets or towels and tape.

Take-Home Message

A large number of children with spinal cord injury have no radiographic abnormality on X-ray or CT scan. The only indication of SCIWORA may be transient paresthesia, numbness, or weakness at the time of or shortly after the injury takes place.

ABP Content Specification

- Know proper cervical spine alignment techniques for children who are supine on a spine board.
- Understand the concept that cervical cord injury can occur in the absence of a radiologic abnormality.

Question 8

Which of the following injuries occur LESS frequently in infants and younger children than in older children and adults?

A. Multisystem involvement from blunt injuries
B. Head trauma
C. Internal injuries of the thorax and abdomen with few external signs of trauma
D. Cervical spine fractures
E. Nonaccidental trauma or abuse

Correct Answer: D

When caring for the acutely injured child, it is important to recognize that age-related anatomic variation predicts what type of injuries they commonly sustain. Because of their smaller body mass and more tightly packed organs, blunt injury in a younger child causes more force to be transmitted widely throughout their body. This often results in multisystem involvement, and must be assumed until proven otherwise. Additionally, younger children have proportionally large heads, less well-myelinated brains, small subarachnoid space, and thinner cranial bones in certain locations. This makes them more susceptible to impact seizures and major head trauma, which is the leading cause of morbidity and mortality in pediatric trauma. In fact, up to 80% of children who died of multisystem trauma have significant head injuries.

Younger children also have less fat and muscle, more elastic connective tissue, and a more compliant skeleton overlying tightly packed abdominal and thoracic structures. This predisposes them to greater internal injuries, often with few signs of external trauma. Some examples are pulmonary contusions without rib fractures, solid abdominal organ damage, and injuries to the heart and other mediastinal structures. Other specific injury patterns in children include pancreatic or duodenal hematomas from impact with bicycle handlebars or folded elbows, small bowel perforation near the ligament of Treitz, and bladder rupture due to the shallow depth of their pelvis.

One injury that occurs less frequently in younger children than in adults is cervical spine injuries. Younger children (less than 8 years old), however, tend to have higher C-spine C1–C3 (supra-axial) injuries, and are more prone to pseudo-subluxation, with up to 40% of children less than 7 years old having anterior displacement of C2 on C3. Generally, around 15 years of age cervical spine injury patterns become similar to adults.

Finally, nonaccidental trauma (NAT) or abuse should be considered in children of all ages, but especially in young children. While accidental trauma predominates in older children, homicide is the most common cause of injury-related death in children less than 1 year old. Historical clues of NAT include a discrepancy between parental history and injury, history that changes with time or from parent to parent, prolonged interval before medical care is sought, repeated traumas treated in the ED, doctor shopping, or an inappropriate response to medical advice. Physical examination clues to NAT include bruises in different stages of healing, healed fractures, perioral injuries, genital or perianal injuries, long bone fractures in children less than 3 years old, ruptured internal organs without major blunt trauma, multiple subdural hematomas without a fresh skull fracture, retinal hemorrhages, bites, cigarette burns, rope marks, or sharply demarcated second and third-degree burns.

Take-Home Message

Know that the anatomical differences of younger pediatric patients predispose them to different patterns of injury than those seen in older children and adults.

APB Content Specification

- Recognize common patterns of injury in children with major trauma with respect to anatomic and physiologic differences by age

Question 9

Which of the following are is MORE likely to occur because of significant trauma in an infant or younger child than in older children and adults?

A. Hypotension as a late finding in shock
B. Cardiac arrest from blood loss
C. Milder rise in intracranial pressure from blunt head injury
D. Maintain normal temperature for a longer period
E. Blunted emotional response

Correct Answer: A

Although the general principles of resuscitation of injured children are similar to those of adults, recognition of differences in cardiorespiratory variables, airway anatomy, response to blood loss, thermoregulation, and the need for specialized equipment is essential for successful resuscitation. Compared to adults, children tend to respond with rapid increases in heart rate and significant peripheral vasoconstriction to compensate for blood loss and intravascular depletion. Thus, they can maintain a near-normal blood pressure despite a 25–30% loss of their blood volume loss, making hypotension an often late and ominous finding in

younger children. In these situations, subtle changes in the heart rate and extremity perfusion may signal impending cardiorespiratory failure, and should be acted on immediately with early crystalloid and blood replacement. Such findings include tachycardia, narrowed pulse pressure (<20 mm Hg), hyper- or hypo-ventilation, skin mottling, hypoglycemia, a decreased level of consciousness, and a decrease in urine output.

Head injury in children often has devastating consequences and accounts for the majority of morbidity and mortality in major trauma. They often have a more pronounced rise in intracranial pressure with resultant "brain edema" and cerebral hyperemia. With their relatively high cerebral blood flow, they also experience more secondary brain injury, highlighting the importance of preventing hypoxia, hypotension, hypoglycemia, and hypothermia. Because of their larger body surface area to volume ratio, hypothermia and insensible fluid loss can occur rapidly. This can lead to coagulopathy and acidosis. It is therefore necessary to monitor the patient's core temperature and provide warming blankets or a radiant warmer, as well as warm IV fluid when necessary.

Take-Home Message

The physiologic response of younger pediatric patients in major trauma differs from those seen in older children and adults. Notably, hypotension is often a late finding in shock, which can be detected by careful attention to other examination findings.

APB Content Specification

- Recognize response to injury in children with major trauma with respect to anatomic and physiologic differences by age.

Question 10

Which of the following is the most common mechanism of injury and cause of death in pediatric trauma?

A. GSW, thoracic trauma
B. MVC, abdominal trauma
C. MVC, head trauma
D. Fall, head trauma
E. Drowning, asphyxiation

Correct Answer: C

The most common cause of death in children of all ages is trauma. Motor vehicle collisions (MVCs) result in more than half of all trauma deaths. Other causes of death are drownings, house fires, homicides (with nonaccidental trauma occurring more frequently in infants, and firearm-related deaths in older children), and falls. Head injury in pediatric patients often has devastating consequences and accounts for the majority of morbidity and mortality in major trauma. In fact, up to 80% of children who die of multisystem trauma have significant head injuries.

The mechanism of injury can predict the type of injury sustained. For example, one would predict that children unrestrained in a motor vehicle accident would primarily suffer injuries to their head, neck, and face, while restrained passengers are more likely to have internal abdominal injuries and lower spine fractures. A smaller child pedestrian hit by a vehicle can sustain almost any injury, while older children because of their size are more likely to have lower extremity fractures. Classically, a handlebar bicycle accident can cause pancreatic, duodenal, or mesenteric hematomas, while a fall from height can cause extremity fractures, or head, neck, and spinal injuries depending on the patient's initial point of impact.

Take-Home Message

By far, the most common cause of morbidity and mortality in pediatric trauma is head injury. Additionally, specific patterns of injury can be predicted from the mechanism of trauma sustained.

ABP Content Specification

- Know the importance of mechanisms of injury in the evaluation of children with major trauma.

Question 11

A 9-year-old boy is brought to the ED by ambulance after he was hit by a car at high speed while chasing his ball in the street. On arrival to the ED, he has a GCS of 6, with a large hematoma over his posterior scalp. He also has a gross deformity of his ankle, which appears dislocated and possibly fractured. He has weak pulses palpable in all extremities. His vital signs are as follows: temperature: 94.8 °F, heart rate 168 beats/minute, respiratory rate 32 breaths/minute, blood pressure 85/66 mm Hg, and oxygen saturation 94% on room air. Which of the following interventions should be performed *LAST*?

A. Orotracheal intubation
B. Placement of two large-bore IVs with infusion of IV fluid
C. Place patient in a cervical collar
D. Warm patient with blankets and warm IV fluid
E. Reduce and splint the affected extremity

Correct Answer: E

The above child has obvious signs of head injury, as well as hemodynamic compromise and hypothermia, all of which must be addressed promptly to prevent a decline in condition and potential cardiopulmonary collapse. Systematic trauma resuscitation should be performed in a systematic manner, to avoid missing potential injuries. This is done by first performing the primary survey, where life-threatening injuries are identified and addressed, followed by the secondary survey, where additional but less urgent injuries are identified. In this patient, the airway and C-spine should be managed emergently, along with volume resuscitation and temperature control. A GCS of 8 or less is an indication to intubate a trauma patient.

While it is important to reduce and splint the patient's ankle to prevent long-term disability, this can be done after other life-threatening injuries are treated, as it is not causing vascular compromise at this time.

Take-Home Message

The first priority in managing children with major trauma is to identify and treat life-threatening injuries as part of the primary survey. Since TBI is the major cause of morbidity and mortality in pediatric trauma, it is also important to limit secondary cerebral injury.

APB Content Specification

- Understand priorities in the management of children with major trauma

Question 12

An 11-year-old girl is brought to the ED by EMS after she was hit at high speed by a vehicle. She was found by bystanders on scene mumbling some incomprehensible words, with a laceration to the back of her scalp. Her left leg is grossly deformed, with part of her tibia exposed. On arrival to the ED, her heart rate is 145 beats/minute and blood pressure 88/62 mm Hg with delayed capillary refill. She has an irregular respiratory pattern with prolonged periods of apnea. Bilateral breath sounds are present. Her pupils are unequal, and there is an obvious open left tibial fracture with blood oozing from the site.

What is the first step in the patient's management?

A. Needle decompression of the right chest
B. Orotracheal intubation
C. Place a tourniquet to her left leg
D. Administer blood products
E. Call trauma/vascular surgeon on call for emergent surgery

Correct Answer: B

Trauma resuscitation should be performed in a stepwise manner to avoid missing potential injuries. Although described in sequence, these steps often occur simultaneously, when multiple providers are involved such as in the emergency department. In these instances, it is important for each team member to verbalize their findings and interventions to a team leader, who can oversee the resuscitation and plan accordingly. Advanced Trauma Life Support (ATLS) protocol comprises of an initial primary survey, where life-threatening injuries are identified and acted upon, followed by the secondary survey, where additional but less immediate findings are addressed. The following are the ABCDEs of the primary survey:

A—Airway and cervical spine stabilization
B—Breathing
C—Circulation and hemorrhage control
D—Disability
E—Exposures

A includes both noninvasive and invasive means of maintaining a patent airway, which is easily assessed by asking the patient to speak or listening to them produce sounds. Included in this first step is cervical spine stabilization, using manual techniques, towel rolls, tape, or collars to immobilize patients at risk for cervical spine injury. Jaw-thrust maneuver should be used to open the airway.

B assesses the patient's breathing and ventilation, usually by visualization of chest rise and auscultation of breath sounds to identify such injuries as tension pneumothorax or large hemothorax. These should be addressed immediately by performing needle decompression and tube thoracostomy.

C assesses the patient's circulatory status and hemorrhage control; special attention to vital signs and signs of peripheral perfusion, such as pulses, capillary refill, and skin color and temperature. Additionally, it is important to control external hemorrhage using direct pressure. A maintained systolic blood pressure does not exclude shock. Compensated shock may be present even when blood pressure is in normal range.

D refers to rapid neurologic and mental status evaluation and predicts their disability. Most commonly this is assessed using the Glasgow Coma Scale or a simpler AVPU (Alert, responds to Voice, responds to Pain, Unresponsive) score in pediatrics.

E refers to events, exposure and complete examination; the patient is fully undressed to assess for hidden injuries; avoid hypothermia and further insult from cold clothes, avoid heat loss; warmed blankets, warmed humidified oxygen, warmed fluids, and warmed blood.

Some trauma surveys include F for fingerstick glucose, as well as "fingers in holes," where rectal examination is performed, and catheters are placed in the bladder and stomach when clinically indicated.

Usually, at the completion of the primary survey, the secondary survey is undertaken, which comprises a thorough head-to-toe examination to identify any injuries that may have been overlooked during the initial assessment.

The initial imaging studies include chest and pelvis X-rays, and Focused Assessment with Sonography in Trauma (FAST) when appropriate. A FAST examination may identify hemorrhage in the abdomen or the pericardial space particularly in unstable patients.

In this patient, who shows signs of severe neurologic injury and respiratory distress with impending airway compromise, the first step in management should be to protect the airway by orotracheal intubation.

Take-Home Message

Injuries and conditions that require immediate lifesaving intervention should be identified and treated during the primary survey. All other conditions are identified and managed during the secondary survey.

APB Content Specification

- Understand the principles of primary versus secondary survey

Question 13

A previously healthy 14-year-old boy involved in a high-speed collision is brought into your emergency department by EMS. They report that the child was the unrestrained front-seat passenger in a car going approximately 65 mph that lost control. The resulting head-on collision caused the child to be ejected from the vehicle. At the scene, GCS was 13, and vital signs were as follows: heart rate 120 beats/minute, respiratory rate 20 breaths/minute, blood pressure 94/78 mm Hg, and oxygen saturation 97% on room air. A 20 ml/kg normal saline bolus was administered by EMS, which improved his HR to 110 and BP to 108/82. While in the ED, he is complaining of severe abdominal pain with progressive abdominal distention, his abdomen has become progressively more distended, and he has required an additional 20 ml/kg NS bolus secondary to another drop in BP in the ED. His heart rate has now increased to 122 beats/minute, and his blood pressure has again decreased to 89/78 mm Hg. What is the best resuscitation strategy at this time?

A. Allow for permissive hypotension and continue observing the patient without intervention
B. Perform DPL to remove blood from abdomen and relieve pressure off of his IVC
C. Type and crossmatch for 10 ml/kg type-specific packed RBC
D. Start on vasopressors
E. Administer additional 20 ml/kg NS bolus and arrange for emergent 10 ml/kg type O packed RBC transfusion

Correct Answer: E

Hemodynamic instability in trauma patients is most commonly secondary to blood loss. The most common sources of substantial bleeding are intrathoracic, intraabdominal, pelvic, thigh (usually from a femur fracture), scalp, and intracranial (in smaller children). The patient in this vignette, who has signs of intraabdominal hemorrhage, can be confirmed by FAST examination, and ultimately to the OR for emergent exploratory laparotomy. This child is in shock and should receive immediate volume resuscitation by administering a 20 ml/kg isotonic crystalloid bolus, such as normal saline or lactated ringer's solution. If they need more than two 20 ml/kg IV crystalloid boluses, they should receive a third while preparing to administer a 10 ml/kg type O packed RBC transfusion. Empiric administration of blood products is suggested when patients are in severe traumatic shock or have multiple injuries with the potential for significant hemorrhage. Vasopressors may be necessary in only limited instances, such as in settings of neurogenic or cardiogenic shock.

Take-Home Message

Transient fluid responders should be thoroughly evaluated for a source of bleeding, and should receive 10 ml/kg packed RBC if IV crystalloid fails to maintain normal perfusion.

APB Content Specification

- Understand the importance of appropriate fluid resuscitation in the management of children with major trauma
- Understand blood product administration in the management of traumatic shock
- Define appropriate fluids and rates for patients in traumatic shock

Question 14

A previously healthy 6-month old boy is brought to the ED by parents after a fall. He is becoming progressively harder to arouse and has vomited multiple times. The mother reports that they picked him up out of his high-chair, but slipped on one of his toys, and dropped him on his head onto a hardwood floor. On examination, his anterior fontanelle is tense, eyes are deviated downward, and pupils are equal but sluggish. He withdraws all his extremities to pain, and he

sounds like he is snoring when breathing. On chest auscultation, you hear course bilateral breath sounds, slightly diminished on the right. His vital signs are as follows: temperature 97.5 °F, heart rate 140 beats/minute, respiratory rate 34 breaths/minute, blood pressure 94/67 mm Hg, and oxygen saturation 86% on room air. How would you manage the patient's respiratory status?

A. Administer Albuterol nebulized treatments
B. Orotracheal intubation
C. Needle decompression of the right chest
D. Reposition the patient's head, suction out his airway, and place an oropharyngeal airway
E. Start Bag-valve-mask ventilation

Correct Answer: D

Airway obstruction is a common occurrence in the pediatric population, and is especially true in trauma. The airway can be compromised anywhere between the lips and the carina. This can occur by direct facial, laryngeal, or tracheal injury; obstruction secondary to the large tongue, blood, secretions, or foreign bodies (teeth, particulate matter); or externally compressed by large neck hematomas or edema caused by burns. This is especially true in the pediatric population, where less luminal narrowing is needed to impact the flow through a smaller airway. For similar reasons, the largest feasible endotracheal tube should be used for intubation.

In addition, if the child's level of consciousness is depressed, the child may not be able to maintain a patent airway or protect his lungs from secretions or aspiration of stomach contents because of a loss of the gag reflex. This is often encountered in severe neurologic injury and should always be considered early in the patient's course, especially when considering inter-facility transfers and transport to the radiology suite.

The classic sign of partial airway partial obstruction is inspiratory stridor, while respiratory effort with no airflow indicates complete airway obstruction. Suspicion should also be raised in patients with sonorous breath sounds, significant facial trauma, blood in their nose or mouth, loose or avulsed teeth, or unilateral breath sounds.

Fortunately, simple techniques can often be performed to relieve airway obstruction. First, the nose and mouth should be inspected for foreign bodies, and these carefully removed. A blind finger sweep should not be performed, as it can push a foreign body further into the airway. Other maneuvers include tilting the patient's mandible forward and neck back, or performing a jaw-thrust when C-spine stabilization is required.

To open the airway, a chin-lift or jaw-thrust maneuvers should be performed. The airway adjuncts such as a nasopharyngeal or oral airway may be necessary if the chin-lift and jaw-thrust maneuvers are not successful in opening the airway. Nasopharyngeal airways are tolerated in semiawake patients with a preserved gag reflex and less likely to cause vomiting, but are contraindicated in severe nasal or maxillofacial trauma, while oropharyngeal airways are only tolerated in unconscious patients who have no gag reflex and can additionally facilitate bag-valve mask ventilation. Suction should be set up prior to the arrival of a patient to the ED whenever possible and is very useful in clearing blood, secretions, or emesis. It is important to suction secretions and clear the airway before any rescue measures. Finally, supplemental oxygen should be provided when necessary prior to bag-valve mask ventilation and after suctioning the mouth and repositioning the airway.

Take-Home Message

Airway obstruction is common in the setting of pediatric trauma, and occurs for multiple reasons. Simple techniques such as airway maneuvers, suctioning, and placement of airway adjuncts may be all that is needed to relieve the obstructed airway.

APB Content Specification

- Recognize airway obstruction in children with major trauma
- Plan the management of a child with an obstructed airway in the setting of major trauma

Question 15

Which of the following is true of cervical spine injury in pediatric trauma patients?

A. Older children are more likely to have higher (supra-axial) C-spine injuries.
B. NEXUS criteria are validated and should be used in patients of all ages.
C. Younger children who are alert and neurologically normal, behaving appropriately for their age can be clinically cleared for their C-spine if they lack spinal tenderness and can freely move their neck.
D. Falls account for the highest number of C-spine injuries in children.
E. C-spine injuries are rarely associated with head injury or multisystem trauma.

Correct Answer: C

Fortunately, Cervical spine injury is rare in children, occurring in <1% of pediatric trauma patients. This is due in part to increased spine mobility and more horizontal facet joints. These injuries, however, have the potential of devastating long-term disability, and must be recognized early and treated appropriately. Independent predictors of C-spine injury are a GCS score <14, GCS eye score of 1, high-speed MVC, and age >2 years old. Concerning physical exam findings include major head or facial trauma, an intubated or unconscious patient, and torticollis or the absence of free range of motion of the neck.

Because of a disproportionately larger head with a higher fulcrum of motion, younger children (<8 years old) tend to have supra-axial (C2 and above) injuries. They are also more prone to pseudo-subluxation (normal mobility of one vertebra on another), with up to 40% of children <7 years old having anterior displacement of C2 on C3. The most common injury mechanism in children of this age group is motor vehicle accidents. In older children >8 years old, C-spine injury is most commonly caused by MVCs or high-impact sports. In this group, subaxial (below C2) vertebral body fractures and spinal cord injury without radiographic abnormality (SCIWORA) are more common. It represents 15–30% of spinal injuries in children and more common in cervical region than thoracolumbar. SCIWORA may be related to the greater elasticity of the vertebral column and supporting structures in children.

In adults, decision rules such as the NEXUS criteria for C-spine imaging, and the Canadian C-spine Rule have been validated to guide imaging decisions in higher-risk patients. However, only 2.5% of patients in the NEXUS cohort were <8 years old, and the Canadian C-spine Rule has not been validated in the pediatric population. In a smaller retrospective study, NEXUS was 100% sensitive in detecting cervical spine injury in children >8 years old but was less reliable in younger children.

According to NEXUS criteria, patients are at low risk if they meet the following criteria:

1. Absence of midline cervical tenderness
2. No evidence of intoxication
3. Normal level of alertness
4. Normal results on neurologic examination
5. Absence of a painful or distracting injury

Several other studies have shown that a neurologically normal and developmentally appropriate child, who is not intubated or unconscious, without focal neurologic deficits, has no torticollis and freely moves his neck, and has no spinal tenderness with palpation, is unlikely to have severe injury.

Take-Home Message

Although rare, higher spinal cord level injuries are more common in children—above C3 in <8 years old. Children have higher incidence of spinal cord injury without bony injury.

APB Content Specification

- Anticipate the risk of cervical spine injury associated with major trauma

Question 16

A 15-year-old previously healthy boy is brought to the ED after a high-impact injury while playing football. He felt a jarring shock shoot down his back, with numbness in his right hands that lasted

for only 3 minutes and resolved. He was wearing his helmet and has been immobilized by a C-collar for transport. On examination, he has midline C-spine tenderness, but is otherwise fully alert and oriented with a GCS of 15, and has normal strength, sensation, and reflexes in all extremities. You obtain a CT of his C-spine which reveals no acute abnormality. What is the next step in his management?

A. Consult Neurosurgery and obtain MRI C-spine
B. Clear cervical spine and send him home without further treatment
C. Clear C-collar, place on steroids and NSAIDs, with outpatient Neurosurgery follow-up
D. Discharge home in C-collar for repeat CT in 1 week
E. Obtain C-spine X-rays to ensure that there is no missed fracture

Correct Answer: A

While younger children (<8 years old) tend to have supra-axial (C2 and above) cervical spine injuries, older children are prone to subaxial (below C2) vertebral body fractures and an entity termed spinal cord injury without radiographic abnormality, or SCIWORA. A large proportion (up to 66% in some studies) of spinal cord injury in pediatric patients show no radiographic abnormalities, including fracture or dislocation. This is due in part to their increased spine mobility and more horizontal facet joints. Almost half of these patients have delayed onset of paralysis (up to 4 days after the injury), making this diagnosis challenging and easy to overlook in the acute setting. Most patients with SCIWORA, however, have transient paresthesia, numbness, or weakness at the time of or shortly after injury, such as in this patient. If initial imaging (X-Ray or CT) shows no evidence of abnormality in this setting, the patient requires cervical spine immobilization and a Trauma surgery or Neurosurgery consultation with advanced imaging by MRI.

Take-Home Message
Many children with spinal cord injury have no radiographic abnormality on X-ray or CT scan. The only indication of SCIWORA may be transient paresthesia, numbness, or weakness at the time of or shortly after the injury takes place.

APB Content Specification
- Understand the concept that cervical cord injury can occur in the absence of a radiologic abnormality

Question 17

A previously healthy 11-year-old girl is brought by EMS after a high-speed MVC. She was the backseat passenger on the driver's side of the car, restrained with a lap belt and shoulder strap. The car was "T-boned" by another car traveling at approximately 55 mph on the passenger side. According to EMS, she did not lose consciousness at the time, but they state that she has become more confused and sleepy. In the ED, she could open her eyes and grab your arm with both hands, but only when you rub her sternum, and tells you "the black cat ate her lunch" when you ask her what happened. What is the patient's GCS score?

A. GCS 7
B. GCS 8
C. GCS 9
D. GCS 10
E. GCS 11

Correct Answer: D

Level of consciousness and basic neurologic status is assessed in the disability portion of the primary survey. Classically, the Glasgow Coma Scale (GCS) is used as a rapid assessment tool. This scale ranges from 3 (unconsciousness and unresponsive) to 15 (fully alert and oriented), and has 3 components: eye opening (graded 1–4), verbal response (graded 1–5, scored 1T if intubated), and motor response (graded 1–6, using best extremity score) (see below). Because infants and younger children have absent or incompletely developed vocabulary, a modified GCS scale (see below), or a simpler AVPU can be used, rated as alert, responds to verbal stimuli,

responds to painful stimuli, or is unresponsive. Patients with specific CT abnormalities, GCS ≤5, or AVPU score of Unresponsive are predicted to have poorer outcomes. In addition to a general level of consciousness, special attention should be paid to pupil size and reaction, where asymmetry or abnormality may signal impending herniation, as well as fontanelle fullness in infants, and gross motor function in children of all ages.

The correct GCS for the patient above is 10, as she opens her eyes to painful stimuli (2), uses comprehensible but inappropriate words (3), and localizes to pain with her upper extremities (5).

Modified Glasgow Coma Scale for infants and children

Area assessed	Infants	Children	Score[a]
Eye opening	Open spontaneously	Open spontaneously	4
	Open in response to verbal stimuli	Open in response to verbal stimuli	3
	Open in response to pain only	Open in response to pain only	2
	No response	No response	1
Verbal response	Coos and babbles	Oriented, appropriate	5
	Irritable cries	Confused	4
	Cries in response to pain	Inappropriate words	3
	Moans in response to pain	Incomprehensible words or nonspecific sounds	2
	No response	No response	1
Motor response[b]	Moves spontaneously and purposefully	Obeys commands	6
	Withdraws to touch	Localizes painful stimulus	5
	Withdraws in response to pain	Withdraws in response to pain	4
	Responds to pain with decorticate posturing (abnormal flexion)	Responds to pain with decorticate posturing (abnormal flexion)	3
	Responds to pain with decerebrate posturing (abnormal extension)	Responds to pain with decerebrate posturing (abnormal extension)	2
	No response	No response	1

Adapted from Davis RJ et al.: Head and spinal cord injury. In Rogers MC, editors. *Textbook of pediatric intensive care*. Williams & Wilkins, 1987; James H, Anas N, Perkin RM. *Brain insults in infants and children*. New York: Grune & Stratton, 1985; and Morray JP et al.: Coma scale for use in brain-injured children. *Crit Care Med* 1984;12:1018

[a]Score ≤12 suggests a severe head injury. Score <8 suggests need for intubation and ventilation. Score ≤6 suggests need for intracranial pressure monitoring

[ba]If the patient is intubated, unconscious, or preverbal, the most important part of this scale is motor response. This section should be carefully evaluated

Take-Home Message

A GCS score ≤8 necessitates prompt management, including stabilization of the airway and breathing, often with endotracheal intubation.

Be familiar with different methods of rapid neurologic assessment as an initial prognostication tool, and means to follow a patient's clinical examination in TBI.

APB Content Specification

- Know methods of rapid assessment of the central nervous system

Question 18

In which of the following patients would ED thoracotomy be most indicated?

A. A 5-year-old girl who was hit by a drunk driver, is now crying, but has large bruises over her entire chest wall.
B. A 16-year-old boy who was shot in the right hemithorax and stopped talking to you with loss of pulse during your initial assessment.

C. A 14-year-old boy who weighs 50 kg with large hemothorax from an MVC, who put out 500 ml of blood on initial chest tube placement, and 100 ml during the next hour.
D. A 6-year-old boy who was the unrestrained passenger in a rollover MVC, with absent breath sounds over his left but not right hemithorax when asked to breathe.
E. A 13-year-old boy who was found unresponsive and pulseless by paramedics after he was stabbed in the chest, back, and arms.

Correct Answer: B

Resuscitative ED thoracotomy (EDT) is a procedure that should be reserved for certain rare but specific situations. It is most effective for injuries of the heart, which can be repaired. Patients with knife stab wounds more likely to have a favorable outcome than those with gunshot wounds.

The clinical scenario with the most potential for favorable outcome is in penetrating thoracic trauma, with witnessed recent loss of pulses or respirations (prehospital, or in the ED itself).

EDT should be considered in penetrating or blunt thoracic injury with unwitnessed cardiac arrest, unresponsiveness with extreme hemodynamic instability despite other resuscitative efforts, or massive hemothorax with rapid bleeding (>15 mL/kg initial or >4 mL/kg/hour chest tube output). The main goals of EDT are to relieve cardiac tamponade by performing a pericardiotomy, control hemorrhage of cardiac or great vessel wounds, and provide direct cardiac compressions, and potentially cross-clamp the descending thoracic aorta. The incision landmark should be at the fourth or fifth intercostal margin, just below the nipple. It is a very invasive procedure and can have significant morbidity or mortality.

Cardiac tamponade occurs after a penetrating wound to the heart, with rupture of the myocardium. The presentation includes hypotension, distended neck veins, and distant heart sounds (Beck's Triad). These findings are most often not seen all at once. Another finding is pulsus paradoxus, which occurs when there is an unusually large decrease in systolic blood pressure greater than 10 mm Hg during inspiration. One should suspect cardiac tamponade if the drop is greater than 20 mm Hg. It occurs due to either cardiac tamponade which restricts venous filling or an increased intrathoracic pressure which restricts venous return. An ultrasound-guided pericardiocentesis may be helpful to decrease the intrapericardial pressure and improve cardiac output. A FAST examination may provide rapid assessment of cardiac function and integrity of the pericardial space, and help to identify fluid collection and tamponade. This may identify an amount as little as 50 ml.

Take-Home Message

ED thoracotomy is most likely to be effective in a patient with penetrating chest trauma who has recent loss of pulse (just prior to, or in the ED). Consider mechanism of injury and timing of vital signs lost to guide decision to perform EDT.

APB Content Specification

- Know the indications for thoracotomy in the emergency department

Question 19

A previously healthy 16-year-old girl is brought to the ED by the ambulance after she was involved in a motor vehicle accident. She states that she was the front seat passenger, wearing a lap belt and shoulder strap, when her friend driving "too fast" hydroplaned on the highway. The auto she was riding in hit the back of another car, causing the airbags to go off and intrusion into the front of their vehicle. She complains of significant pain in her groin and the right side of her back. She has been unable to bear weight on her legs since the accident. Her vital signs are as follows: temperature 97.7 °F (36.5C), heart rate 112 beats/minute, respiratory rate 18 breaths/minute, blood pressure 126/74 mm Hg, and oxygen saturation 98% on room air. On examination, her pelvis is stable, but she cries in pain when you roll her off the backboard, and again when you try to extend her right hip. Chest X-ray is unremarkable and

Pelvis X-ray shows a right-sided inferior pubic ramus fracture. You order laboratory testing and are considering further imaging when her UA comes back and reveals the following:

- Urinalysis
- Specific gravity: 1.016
- pH: 5.0
- Protein: 1+
- Glucose: negative
- Blood: trace
- Ketones: negative
- Nitrite: negative
- Leukocyte esterase: negative
- WBC: 4/HPF
- RBC: 88/HPF
- UA: bacteria: Few/HPF
- UroBili: negative

What is the best next step in management?

A. Obtain CT scan of abdomen and pelvis with IV contrast
B. Call Trauma Surgery to take her immediately to the OR
C. Perform a DPL
D. Obtain emergent retrograde urethrogram
E. Call Interventional Radiology to take her to the IR suite for angiographic embolization

Correct Answer: A

Genitourinary (GU) tract injury should be considered in patients who sustain multisystem trauma, pelvic fractures (especially anterior ring fractures), or injury to the back, flank, abdomen, or groin. Physical examination guides much of the management, with special attention to vital signs, tenderness or ecchymosis of the flank or groin, or evidence of lower GU tract injury such as blood at the urethral meatus or scrotal/labial hematomas or lacerations. Hemodynamically unstable patients should be taken immediately to the OR for exploratory laparotomy as they may have concomitant abdominal trauma (answer choice B), or to Intervention Radiologist for angiographic embolization of bleeding vessels if they have isolated pelvic trauma (answer choice E). In patients who are hemodynamically stable, further imaging with CT scan of the abdomen and pelvis should be obtained if there is a mechanism of injury or physical examination findings suggesting GU trauma, pelvic ring fractures, or hematuria. Most centers agree that children with more than 50 RBC/high powered field on microscopy or gross hematuria should undergo a CT scan. Generally, children with less than 50 red blood cells per high-powered field considered to have a low likelihood of significant renal injury. Moreover, the degree of hematuria does not correlate with the severity of renal or GU tract injury. It is important to note, however, that a normal physical examination and normal urinalysis portends a negative predictive value of 100% for GU injury.

A urethral injury is suspected if there is high-riding prostate, meatal blood, perineal ecchymosis, scrotal hematoma, pelvic fracture, gross hematuria or inability to void. In such situations, perform retrograde urethrography before placing a Foley catheter. If there is a difficulty in passing a Foley catheter, it should raise concern for a urethral injury.

Take-Home Message

Hematuria (>50 RBCs/HPF) may suggest genitourinary tract injury in hemodynamically stable children with blunt trauma and warrants further imaging studies.

APB Content Specification

- Be able to interpret the results of urinalysis

Question 20

A 14-year-old boy is brought to the ED after a high-speed motor vehicle collision. He was a restrained front seat passenger. He hit the top of his head against the roof and complained of neck pain at the site of the accident. He was placed in a cervical collar. He denies any weakness, numbness, or paresthesia in his extremities. The physical examination demonstrates tenderness at C1. An AP X-ray of the cervical spine shows lateral

offset of the lateral mass of C1 on C2. Which one of these statements is true about his condition?

A. This fracture rarely causes immediate neurologic impairment because the fracture does not physically impinge on the spinal cord.
B. An increased AP diameter of the cervical spinal canal is associated with spinal cord injury.
C. Basilar skull fracture presents with severe neck pain.
D. If there is a decreased distance between lateral masses of C1 and odontoid process, it should be considered as unstable.
E. Since this fracture does not affect the spinal cord, it need not be immobilized.

Correct Answer: A

A Jefferson fracture is a burst fracture of the ring of C1 because of axial load. The axial force compresses the ring of C1 between occipital condyles of the skull and the lateral masses of C2. The outward burst of C1 gives the characteristic radiologic finding of the lateral offset of the lateral mass of C1 of more than 1 mm from the vertebral body of C2 in the anteroposterior view of cervical spine X-ray. This fracture does not cause immediate neurologic impairment because the fracture does not physically impinge on the spinal cord. But it can be unstable, and therefore must be immobilized. If there is an increased distance between the lateral masses of C1 and the odontoid process, it should be considered unstable. This happens when the transverse ligament is injured. The Jefferson fracture may be associated with other cervical spine fractures, most frequently involving C2.

Basilar skull fracture involves a fracture through the petrous portion of temporal bone. Ecchymosis in the postauricular region may develop in this injury but there is no neck pain unless there is associated cervical spine injury. The characteristic presentation includes battle's sign, raccoon eyes, hemotympanum, and CSF discharge from the ears or nose. Facial nerve is commonly injured with basilar skull fracture. The test of choice is head CT scan.

Take-Home Message

A Jefferson fracture, or burst fracture of C1, occurs secondary to axial loading. With disruption of the transverse ligament, it can be unstable, and is radiographically identified with displacement of the lateral masses of C1.

ABP Content Specification

- Understand the mechanism of injury of a Jefferson fracture.
- Differentiate between neurologically stable and unstable cervical spine injuries.

Question 21

A 14-year-old girl was thrown to the ground while horseback riding. She is complaining of neck pain and weakness in both the upper extremities. She is able to move her lower extremities. She also has paresthesia in all her extremities. Her vitals are as follows: heart rate 55 beats/minute, respiratory rate 22 mm Hg, blood pressure 80/50 mm Hg, and oxygen saturation 95%. What is your diagnosis?

A. Brown–Sequard syndrome
B. Anterior spinal cord syndrome
C. Central cord syndrome
D. Complete cord syndrome
E. Cauda Equina syndrome

Correct Answer: C

Traumatic central cord syndrome is usually caused by a forced hyperextension injury during which the ligamentum flavum is thought to buckle, resulting in increased pressure on the central cord. This is common incomplete spinal cord syndrome which involves the central portion of the spinal cord. The characteristic physical finding of central cord syndrome is bilateral motor paresis or weakness greater in the upper extremities than in the lower extremities. The paresis is usually greater distally than proximally and there is variable sensory involvement. This pattern occurs because the most central portions

of the spinal tracts contain fibers from the upper extremities and peripheral positioning of the lower extremity axons in the spinal cord.

The Brown–Séquard syndrome is a rare spinal injury that results in hemi-section of the spinal cord that results in crossed sensory and motor deficit. It is usually caused by penetrating trauma which is characterized by ipsilateral loss of motor function (lateral corticospinal tract) with contralateral loss of pain and temperature (spinothalamic tract).

Complete cord syndrome-transection of the spinal cord results in complete loss of motor, sensory, and autonomic function below the level of the lesion. The anterior spinal cord syndrome, which involves injury to the spinothalamic tract, is characterized by bilateral loss of motor, pain, and temperature sensation with preservation of vibration and proprioception below level of cord involvement.

Cauda equina syndrome is a pure lower motor neuron injury, not a true spinal cord syndrome. Since the cauda equina is composed entirely of lumbar, sacral, and coccygeal nerve roots, it causes peripheral nerve injuries. The only neurological structures in this region include the lumbar and sacral roots. The deficits are usually asymmetric and unilateral and they affect a single extremity. The physical findings are absent bulbocavernosus reflex, absent deep tendon reflexes, flaccid urinary bladder, and reduced lower-extremity muscle tone. The most sensitive finding is urinary retention.

Take-Home Message

The characteristic physical finding of central cord syndrome is bilateral motor paresis or weakness greater in the upper extremities than in the lower extremities. Brown–Sequard syndrome is marked by crossed symptoms and cauda equina syndrome with lower extremity loss of function and bladder and bowel retention or incontinence.

ABP Content Specification

- Recognize signs and symptoms of spinal cord injury syndromes (anterior, central, complete, posterior, Brown–Sequard) in children.
- Recognize the signs and symptoms of findings suggestive of cervical spine injury trauma.

Question 22

A 14-year-old previously healthy patient is being evaluated in the ED after a fall from a fire escape. She is alert, slightly flushed and complaining of pain in her head, neck, and lower legs. Her initial vital signs are as follows: temperature 98.0 °F, heart rate 65 beats/minute, respiratory rate 20 breaths/minute, blood pressure 80/50 mm Hg, and oxygen saturation 99%. Your FAST exam is negative. You administer a liter of normal saline as a bolus, and are considering imaging her neck. Her blood pressure does not improve after the bolus. What is the next appropriate step in managing her blood pressure?

A. Additional normal saline bolus
B. Dopamine
C. Dobutamine
D. Epinephrine
E. Norepinephrine

Correct Answer: E

This scenario describes a child presenting with neurogenic shock after blunt cervical spinal cord trauma. Neurogenic shock is a clinical syndrome characterized by loss of neurologic function and autonomic tone below the level of an acute spinal cord lesion. It is due to unopposed vagal stimulation after disruption of descending sympathetic pathways in the upper spinal cord.

The presentation is flaccid paralysis with loss of sensation, deep tendon reflexes, and urinary bladder continence, along with bradycardia, hypotension, hypothermia, and intestinal ileus due to the loss of sympathetic input to the vascular system. Patients have a lack of reflex tachycardic response to the hypovolemia due to disruption of autonomic ganglia. They also demonstrate warm flushed skin in the setting of hypotension due to loss of vasomotor tone. These patients may need fluid resuscitation, but more importantly they require alpha agonist support using medications such as norepinephrine and phenylephrine to maintain adequate perfusion and avoid fluid overload.

Take-Home Message
The combination of hypotension and bradycardia is suggestive of neurogenic shock; however hemorrhagic shock may coexist, particularly in patients with other injuries.

ABP Content Specification
- Know the role of pharmacologic agents in the management of spinal cord injury.

Question 23

A 7-year-old girl was struck by a car. She has chest tenderness on exam and multiple abrasions, but otherwise appears well. Her initial respiratory rate and oxygen saturation were within normal limits. Initial X-rays are normal. Two hours after arrival to the ED, she is noticed to have tachypnea and her oxygen saturation on room air is 93%. You have placed the child on a nonrebreather. Air entry is equal in lung fields bilaterally. What is the most sensitive test to diagnose the child's condition?

A. Chest X-rays
B. Chest CT scan
C. Lung Ultrasound
D. Thoracocentesis
E. Transesophageal echocardiography

Correct Answer: B

The patient in this vignette exhibits the signs and symptoms of pulmonary contusion. This is the most common thoracic injury in children. Although both penetrating and blunt thoracic trauma can cause pulmonary contusion, it is more common after a blunt trauma. As in any contusion, the capillary network becomes damaged, leaking fluid into the surrounding tissues. Blunt force may lead to alveolar edema and hemorrhage. A ventilation-perfusion mismatch occurs because of the extravasation of fluid interfering with oxygenation. The hypoxemia results in increased A–a gradient. As the edema and swelling worsens, the patient's respiratory status also deteriorates. A pulmonary contusion may initially not be apparent on the chest radiograph. It develops over 24 hours. Plain radiograph may also underestimate the size of the contusion. In addition, a supine radiograph obtained during resuscitation may not be sensitive to identify significant thoracic injuries and may miss anterior pneumothorax. A chest CT scan is more sensitive in detecting pulmonary contusion. Parenchymal injuries can be noted when a few cuts of the thoracic cavity are imaged while obtaining an abdominal CT scan.

Take-Home Message
Clinically significant pulmonary contusion may not be initially apparent and becomes apparent within 24 hours of injury.

ABP Content Specification
- Recognize the signs and symptoms of pulmonary contusion following blunt chest trauma.

Question 24

When managing a patient with pulmonary contusion, which of the following is true?

A. Children with positive CT scan and negative chest X-ray are likely to require prolonged hospital stay.
B. Mechanical ventilation with positive pressure is the treatment of choice in moderate to severe pulmonary contusion.
C. Children with positive CT scan and positive chest X-ray are less likely to require prolonged hospital stay.
D. Patients with moderate to severe contusions need fluid resuscitation.
E. Patients with mild contusions can be discharged home from the ED.

Correct Answer: B

Children with positive CT scan and positive chest X-ray are more likely to require prolonged hospital stay, an intensive care unit admission

and endotracheal intubation compared to children with positive CT scan and negative chest X-ray.

Tachypnea, abnormal breath sounds, external thoracic wall contusion, and fracture of the bony thorax are absent in more than 50% of the patients with pulmonary contusion. Even mild contusions require close hospital observation for worsening respiratory status and supportive care. Patients with moderate to severe contusions often need endotracheal intubation and mechanical ventilation with positive pressure for their worsening respiratory status. Fluid restriction can be helpful to minimize the clinical sequela of pulmonary edema.

Pulmonary contusion often occurs with flail chest. Flail chest occurs when several fractured rib segments paradoxically oppose the movement of the rest of the chest wall. It occurs with at least two fractured segments in each rib, involving at least three adjacent ribs. Typically, a paradoxical chest wall movement is described where the flail segment moves inward during inspiration and outward during expiration.

Since significant force is required to cause the contusion, a careful evaluation should be made to evaluate for the presence of additional injuries. The management consists mainly of supportive care.

Take-Home Message

A high index of suspicion must be maintained for pulmonary contusions in blunt chest trauma. The patient's clinical status can rapidly worsen, and may require positive pressure ventilation.

ABP Content Specification

- Recognize the signs and symptoms of pulmonary contusion following blunt chest trauma
- Plan the management of pulmonary contusion following blunt chest trauma.

Question 25

A 16-year-old girl is brought in to the ED after a bookstand fell on her chest. She has contusions on her chest and is having difficulty breathing. She is treated for a tension pneumothorax and after needle decompression a chest tube is placed immediately. What specific finding will indicate bronchial rupture in this patient?

A. Hemothorax
B. Subcutaneous emphysema
C. An active chest tube air leak
D. Pneumomediastinum
E. Hemoptysis

Correct Answer: C

Injuries to the airways are not common. These injuries may not be recognized on initial evaluation, and a delayed diagnosis is common. Mechanism of injury (fall, crush, and direct blow) provides an important clue in diagnosing tracheobronchial injuries. Clinical signs include hemoptysis, cyanosis, tachypnea, subcutaneous emphysema, and pneumomediastinum. If pneumothorax is present with these findings, a bronchial rupture is suspected. Air continuously leaks through the rupture and flows into the surrounding area. A continued air leak after insertion of a thoracostomy tube is very specific for bronchial tear.

Take-Home Message

An active air leak from a chest tube placed for a pneumothorax is an indication of a tracheobronchial rupture. Also suspect tracheal or proximal bronchus injury if pneumothorax is refractory to chest drainage.

ABP Content Specification

- Recognize the complications of tracheobronchial rupture following blunt chest trauma.
- Recognize common patterns and mechanisms of injury in children with blunt thoracic trauma.

Question 26

A 15-year-old boy riding a bike was hit on his left side by a car. He is complaining of pain in his left flank and chest. He is also complaining of pain in his left shoulder and shortness of breath.

He denies any loss of consciousness or extremity pain. Physical examination shows bruising on the left flank and a scaphoid abdomen. Chest X-ray shows bowel loops in the left hemithorax. Which of the statements are correct regarding diaphragmatic injury in children?

A. 80% of diaphragmatic injury happens on the left side and 20% on the right side
B. Right sided diaphragmatic injury and herniation are easy to diagnose because the herniated organs are solid.
C. Left sided diaphragmatic injuries are associated with a higher mortality rate than right sided injuries.
D. In right sided diaphragmatic tears, the tip of the nasogastric tube may be seen looping in the chest.
E. A ruptured diaphragm is readily seen on CT scan.

Correct Answer: A

Diaphragmatic injuries in blunt trauma occur because the crushing force produces a sudden increase in the intrathoracic and intraabdominal pressure against the fixed diaphragm. Children wearing lap belts are at risk for the development of diaphragmatic herniation.

Approximately, 80% of diaphragmatic injuries occur on the left side and 20% on the right side. The left diaphragm is relatively unprotected, whereas liver protects the right side. Right-sided diaphragmatic injury and herniation are more difficult to diagnose because the herniated organs are solid. Right sided diaphragmatic injuries are associated with increased mortality rate compared to those on the left. In left-sided diaphragmatic tears, the tip of the nasogastric tube may be seen looping in the chest. A high index of suspicion must be maintained for diaphragmatic rupture based on mechanism since it is not readily seen on CT scan, and can be delayed from time of injury. Among the solid organ injuries, spleen is most commonly injured followed by the liver. Liver is the most common cause of significant and fatal hemorrhage in children.

Initial management includes placement of a nasogastric tube to decompress the stomach. This is identified in the lower left hemithorax. Bag mask ventilation should be avoided. All diaphragmatic injuries require surgical repair.

Take-Home Message

Diaphragmatic injuries are often difficult to diagnose, and may have a delayed presentation. A high index of suspicion must be maintained based on mechanism of injury. The majority are left-sided due to relatively less protection from solid organs.

ABP Content Specification

- Recognize the complications of diaphragm injury following blunt chest trauma.
- Recognize common patterns and mechanisms of injury in children with blunt thoracic trauma.

Question 27

A 6-year-old girl is involved in a high-speed motor vehicle collision. She was wearing a seatbelt, but was not restrained on a booster seat. The airbag was deployed. She is complaining of abdominal pain and back pain. On examination, you see a transverse band of ecchymosis across the abdomen. What kind of injury is likely to be encountered in this patient?

A. Thoracic spine fracture
B. Lumbar spine fracture
C. Cervical spine fracture
D. Sacroiliac joint separation
E. Sacral fracture

Correct Answer: B

A single lap belt restraint can cause chance fracture of the lumbar spine. Children who are too small for adult seat belts or restrained only by lap belts in motor vehicles involved in rapid deceleration crashes are at risk for a "Chance fracture," which is a compression or flexion-

distraction fracture of the lumbar spine. Patients with Chance fractures have associated intraabdominal injuries and hollow viscus injuries.

The "seat belt syndrome" includes the combination of a transverse bruise on the abdomen, Chance fracture, visceral trauma, and, rarely, abdominal aortic injury. Other injuries seen are duodenal perforation, mesenteric disruption, transection of small bowel, and bladder rupture. A normal abdominal CT scan does not completely rule out visceral trauma. Patients with persistent pain or tenderness despite a negative CT should be hospitalized for observation and repeated examination and abdominal imaging.

Take-Home Message

Seat belt injuries are associated with various injuries, including those to intra-abdominal organs and thoracolumbar spine. Further evaluation is recommended for significant "seat belt sign" or abdominal tenderness following blunt abdominal trauma.

ABP Content Specification

- Understand the types and mechanisms of thoracolumbar spine injuries.
- Chance fracture with visceral perforation.
- Understand neuroanatomic clinical correlation in thoracolumbar spine injuries.
- Recognize injuries commonly found in conjunction with thoracolumbar spine injuries.

Question 28

An 18-year-old boy was involved in a high speed MVC. He is complaining of pain in his back and inability to move his legs. Physical examination shows ecchymosis and tenderness to his spine at T6 and T7 and paraplegia. His chest X-ray shows a widened mediastinum and normal vertebra at T6 and T7 without any fracture. What is the gold standard test to diagnose the patient's condition?

A. Thoracic CT scan
B. Aortography
C. Transesophageal echocardiogram
D. Thoracocentesis
E. MRI spine

Correct Answer: B

The patient in this scenario should be worked up for traumatic rupture of the aorta (TRA) secondary to blunt trauma to the chest. Patients may present with differences in pulses between the arms and legs, thoracic ecchymosis, thoracic and back tenderness, paraplegia, and anuria. Because of the paraplegia and anuria, patients are often initially diagnosed with a presumptive spinal cord injury. A chest X-ray can show a widened mediastinum, tracheal deviation, and loss of the aortic knob.

The gold standard for diagnosing TRA is aortography. Thoracic CT is only 55–65% accurate. Transesophageal echocardiogram is only about 63% sensitive. Life threatening intracranial, thoracic, or intraabdominal injuries must be evaluated and stabilized prior to aortography.

Take-Home Message

Traumatic rupture of the aorta may present with hypotension. Decreased femoral pulses, thoracic ecchymosis, paraplegia, and anuria. The gold standard for diagnosis is aortography (angiography).

ABP Content Specification

- Recognize the signs and symptoms of great vessel trauma following blunt chest trauma.
- Know indications for and interpret findings of computed tomography following blunt abdominal trauma.

Question 29

A 13-year-old boy was assaulted earlier and brought in by EMS complaining of pain in his lower abdomen. He says he was kicked on his belly, then voided grossly bloody urine and is now finding it difficult to urinate. On examination, he is in pain. His vital signs are as follows: temperature 99 °F, heart rate 100 beats/minute, respiratory rate 20 breaths/minute, blood pressure 140/70 mm Hg, and oxygen saturations 100% on room air. He is tender and guarding in the suprapubic area, but the abdomen is soft else-

where. He has a normal appearing penis and nontender scrotum. What is your next step in management after pain medication, IV placement, and a blood draw for trauma labs?

A. CT abdomen and pelvis
B. CT abdomen and pelvis with CT cystogram
C. STAT surgery consultation
D. CT abdomen/pelvis with IV pyelogram
E. CT abdomen/pelvis with contrast

Correct Answer: B

Bladder injuries are uncommon injuries and occur in 1.6% of blunt abdominal injuries. The bladder is in the lower abdomen of children but descends further into the pelvis in adolescents. Injuries are more common when there is either blunt abdominal trauma to a distended bladder or with pelvic fractures. Blunt abdominal trauma can rupture the dome of the bladder (located superiorly) while bony spicules from a pelvic fracture can shear the anterolateral wall of the bladder. Features concerning for a bladder rupture in the setting of trauma are lower abdominal pain, peritonitis, inability to void or painful micturition, gross or microscopic hematuria, and a high riding prostate.

In this patient who has trauma to his abdomen now complaining of suprapubic pain, gross hematuria, guarding, and difficulty voiding, a bladder rupture should be considered. The next step is a CT abdomen and pelvis with a cystogram. The CT abdomen and pelvis are required to evaluate the kidneys but will not be able to identify bladder rupture as there is no differentiation between blood and urine. The CT cystogram can identify bladder injuries and requires dilute contrast to be infused into the bladder though a Foley catheter. Approximately 300 ml is required to distend the bladder, to avoid missing injuries. Bladder rupture is likely if contrast extravasates adjacent to the bladder in the pelvis.

CT cystogram is preferred over plain film cystograms, but in resource-limited settings, plain film cystograms can also identify bladder ruptures.

Take-Home Message

Gross hematuria in patients with blunt trauma suggest bladder injury and should warrant cystography, which is the best diagnostic test to evaluate for blunt traumatic bladder injury.

ABP Content Specification

- Plan the management of a patient with bladder trauma.

Question 30

A 16-year-old boy states he was walking in the park when he was assaulted with a knife. He has pain in the left lateral neck at level of the thyroid cartilage and it hurts to swallow. There is a small amount of blood oozing from the wound. The platysma appears to be breached. His vital signs are as follows: temperature 99 °F, heart rate is 88 beats/minute, respiratory rate 16 breaths/minute, blood pressure 120/80 mm Hg, and oxygen saturation 100%. He is alert and well appearing, has normal carotid pulses, no expanding hematoma, and good air entry bilaterally in the chest. There is no crepitus over the neck and chest. He has a normal neurological exam. A chest and soft tissue neck X-ray is completed and shows no abnormality.

Your next step in his management is

A. Admit the patient to the surgical service
B. Discharge the patient with surgical clinic follow-up
C. Close the neck wound by approximating the platysma, followed by the other wound layers
D. Explore the neck wound at the bedside to estimate depth and extent of damaged structures
E. Perform a contrast enhanced CT neck and chest with angiography (CTA)

Correct Answer: E

Penetrating neck injuries in the neck may appear trivial at the surface but have devastating injuries given the proximity of vital vascular, pul-

monary, neurological, and gastrointestinal structures present. Neck injuries are classically divided into three zones, depending on injury location. Zone 1 includes the space from clavicle and sternal notch to inferior border of the cricoid cartilage. Zone 2 is from the inferior border of the cricoid cartilage to the angle of the mandible and Zone 3 injuries are between the angle of the mandible and base of the skull. Zone 2 injuries are the most common.

Patients that are unstable require immediate resuscitation and the ABCs are priority, including the need for securing the airway, taking over ventilation, and fluid resuscitation. Disruption of the platysma requires surgical and diagnostic evaluation as it signifies significant penetration into neck tissue. However, even stable patients with any of the below signs and symptoms will require prompt imaging and surgical evaluation.

- Active external bleeding
- Neck bruit or thrill
- Dysphagia
- Hoarseness
- Subcutaneous emphysema
- Large, expansile or pulsatile hematoma
- Oropharyngeal bleeding/hemoptysis
- Sucking neck wound
- Neurological deficit

Hard signs for aerodigestive and neurovascular injury include airway obstruction, decreased or absent radial pulse, expanding hematoma, or vascular bruit or thrill. Soft signs include dysphagia, dyspnea, hematemesis, mediastinal emphysema, nonexpanding hematoma, or subcutaneous emphysema. A bubbling wound in neck trauma may indicate an injury to larynx or trachea.

Contrast enhanced CT scan of the neck with angiography (CTA) is vital in injuries that require diagnostic evaluation. In the scenario of the patient with a zone 2 neck injury with a stabbing wound and hoarseness, evaluation with CTA is required prior to admission or discharge. Neither closure of the platysma nor surgical exploration should be performed at the bedside by the emergency physician.

Take-Home Message

All injuries that penetrate the platysma require surgical exploration. With signs of vascular or aerodigestive injury, CTA of the neck should be obtained.

ABP Content Specification

- Plan the evaluation and management of penetrating injury to the neck differentiating by symptoms and location.
- Recognize potential injuries associated with penetrating trauma to the neck.

Question 31

A 7-year-old boy fell while hiking upstate with his family yesterday evening and sustained a 3 cm laceration to his posterior elbow. The campsite nurse cleaned his wound and clean gauze was placed over the wound. They arrived home this morning and wanted his wound checked because it has continued to ooze blood. He has no fever and no other complaints. On examination, his posterior left elbow has a 3 cm, gaping, linear, and deep laceration that appears clean but continues to have minimal oozing. There is no erythema, foreign body, swelling, necrotic/devitalized tissue, or pus discharging from the site. It has now been 16 hours since the laceration occurred.

The mother would like the wound closed. You choose to

A. Clean the wound and repair it with interrupted sutures prior to discharge
B. Leave the wound open and let it heal by secondary intention
C. Debride the wound and begin oral antibiotic coverage
D. Use tissue adhesive to close the wound
E. Use a stapling device to approximate the wound loosely

Correct Answer: A

This patient has a gaping, large laceration over a joint that is unlikely to heal quickly and more

likely to continue to ooze blood, become infected or have poor cosmetic outcome if allowed to heal without primary closure, given its location and use of the elbow.

A stapling device is used more commonly in the scalp as it has poorer cosmetic, while tissue adhesive is less commonly used on joint injuries because of the tension over the wound.

In healthy individuals, clean lacerations involving well-vascularized tissue can be closed successfully within 18 hours. These older lacerations can be repaired with loose, single interrupted sutures and this decision should be made for each individual case. A Cochrane review looking at adverse effects of employing primary closure beyond 6 hours was unable to reach a conclusion because of insufficient evidence.

Take-Home Message

There is little evidence for an optimal interval or golden period in laceration repair. The age of the laceration should not be the only factor for repair of laceration beyond 6 hours.

ABP Content Specification

- Understand the physiology of wound healing.
- Understand the importance of wound exploration.
- Know the indications for primary, secondary, and delayed primary closure of wounds.
- Understand the role of irrigation and debridement in wound management.

Suggested Reading

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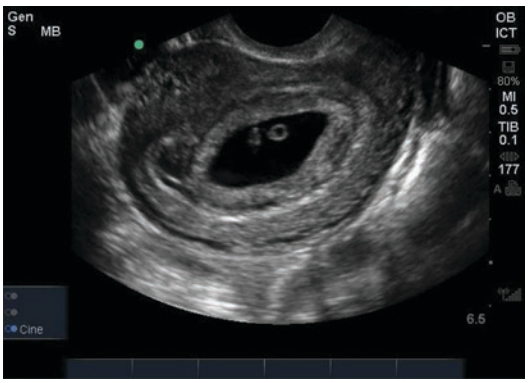
Emergency Obstetric Ultrasound

22

Christine Butts

Question 1

A 14-year-old girl presents to the Emergency Department with her mother, complaining of a syncopal episode today during school. She states that she became light headed when she stood up from sitting. She denies any other symptoms prior to the syncope and states she feels fine now. She has no past medical history and takes no medications. Vital signs obtained at triage are as follows: temperature 99.6 °F, heart rate 115 beats/minute, respiratory rate 20 breaths/minute, and blood pressure 98/60 mm Hg. She is well appearing and in no distress. Her physical examination is otherwise unremarkable with the exception of mild tachycardia and mild abdominal tenderness but no rebound tenderness. A urine pregnancy test is positive and a qualitative serum beta-human chorionic gonadotropin (beta-hCG) returns at 3000 mIU/mL. An endovaginal ultrasound is performed at the bedside and is shown below.



Which of the following is correct?

A. Transabdominal ultrasound is preferred to endovaginal ultrasound in early pregnancy evaluation due to its superior resolution.
B. A transabdominal ultrasound should be performed with an empty bladder to avoid artifact that may obscure the adnexa.
C. An endovaginal ultrasound should be performed with a full bladder to provide an acoustic window for visualization of the adnexa.
D. The ovaries can usually be identified with sonography lateral and posterior to the uterus, typically adjacent to the internal iliac artery and vein.
E. The posterior cul-de-sac should be evaluated for the presence of free fluid and can be found anterior to the uterus.

Correct Answer: D

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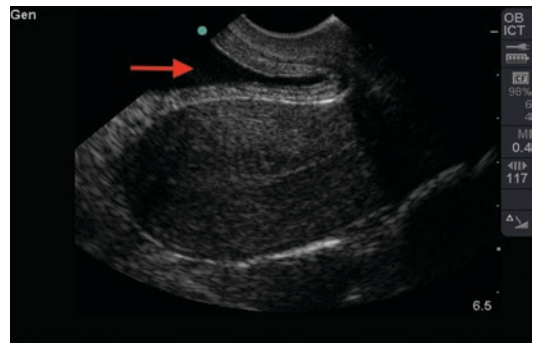
M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_22

Bedside ultrasound is a valuable tool in the evaluation of patients for ectopic pregnancy. Endovaginal ultrasound is performed with a high frequency endocavitary transducer and yields increased resolution over the lower frequency transabdominal ultrasound. For this reason, endovaginal ultrasound is typically more sensitive for detecting the findings of normal early pregnancy versus ectopic pregnancy. Due to its increased resolution, endovaginal ultrasound is capable of identifying signs of early pregnancy at roughly 5 weeks gestation, whereas transabdominal ultrasound will identify signs of early pregnancy at around 7 weeks gestation. Transabdominal ultrasound can be a helpful adjunct to endovaginal ultrasound, particularly to evaluate for the presence of intraperitoneal free fluid. This is due to its increased depth of penetration, and thus, broader image.

Transabdominal ultrasound should be performed when the patient has a full bladder, so that the bladder may serve as an "acoustic window" to enhance the physician's view of the pelvis. Ultrasound waves are well transmitted through fluid filled structures and give an enhanced view of the adnexa. Conversely, endovaginal ultrasound should be performed when the patient has an empty bladder, so that the uterus is not pushed away from the field of view by the distended bladder.

To perform an endovaginal ultrasound, the transducer is typically inserted initially in a sagittal plane, with the indicator pointing up toward the ceiling. The transducer is inserted into the vagina slowly, until the uterus is visualized. The transducer should be angled slightly up and down until the entire uterus, from fundus to cervix is visualized. Slight retraction of the transducer within the vagina may be necessary to visualize the cervix. The cul-de-sac can usually be visualized in this orientation posterior or deep to the uterus. The transducer should then be angled slowly from right to left to fully visualize the cornual areas of the uterus and to locate the ovaries. The ovaries are seen as rounded, hypoechoic (gray) objects, typically with anechoic (black) rounded follicles within. They are typically described as having a "chocolate chip cookie" appearance. They will usually be found lateral and slightly posterior to the uterus. Identifying the pulsatile internal iliac artery with its accompanying vein can be helpful, as the ovaries are typically found adjacent to these structures.

Once the uterus and adnexa are evaluated in the sagittal plane, the transducer should be rotated toward the patient's right so that the pelvis can be evaluated in the transverse plane. The uterus should be identified and again scanned from fundus to cervix by angling the transducer up and down. Slightly pointing the transducer toward the right and left will allow the sonographer to scan the adnexa.



Transvaginal ultrasound of a normal uterus in the sagittal plane. The bladder can be seen at the upper left of the image (arrow), anterior to the uterine fundus

Take-Home Message

Both transabdominal and transvaginal ultrasound area useful in evaluation of patients with suspected pregnancy but transvaginal ultrasound is more sensitive for early pregnancy.

ABP Ultrasound Evaluation of Potential Ectopic Pregnancy

- Know the anatomy and pathophysiology relevant to ultrasound evaluation of potential ectopic pregnancy.
- Plan the key steps and know the potential pitfalls in performing ultrasound evaluation of potential ectopic pregnancy.

Question 2

Which is correct regarding the above ultrasound image in this patient?

A. A finding of a gestational sac is a definitive sign of an intrauterine pregnancy.
B. The double decidual sign is an indicator of an early ectopic pregnancy.
C. Visualization of a fetal pole within the uterus in a patient who is not taking follicle stimulating medications virtually rules out an ectopic pregnancy.
D. A yolk sac will typically first be seen on endovaginal ultrasound at approximately 9 weeks gestation.
E. The discriminatory zone should be strictly used to rule in or out the diagnosis of ectopic pregnancy.

Correct Answer: C

The goal of a bedside ultrasound is to identify findings consistent with an intra-uterine pregnancy (IUP). The presence of a yolk sac or fetal pole within the uterus is considered a definitive sign of early IUP. Although it is helpful to directly visualize an ectopic pregnancy, visualizing signs of an intrauterine pregnancy virtually rules out ectopic pregnancy in almost all patients. Patients who are taking follicle stimulating medications should be considered for the presence of a heterotopic pregnancy, or simultaneous intrauterine and ectopic pregnancy.

Knowledge of a patient's last menstrual period and qualitative beta-hCG level can be helpful in determining the expected sonographic findings. See the chart below for an approximate correlation of gestational age, beta-hCG level, and sonographic findings.

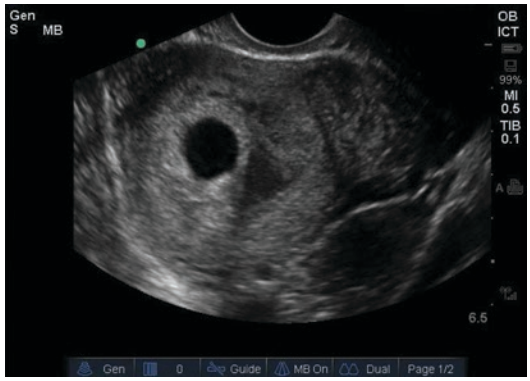
An empty gestational sac alone should not be considered to be an indicator of early intrauterine pregnancy, as distinguishing the gestational sac of a normal early pregnancy and the pseudogestational sac of ectopic pregnancy can be difficult for even an experienced sonographer. Similarly, although a double decidual sign is considered to be the earliest sign of an intrauterine pregnancy, it can be difficult to distinguish from a pseudogestational sac; it should therefore not be relied upon by the emergency physician at the bedside to rule in an intrauterine pregnancy. A double decidual sign is defined by a concentric ring surrounding the gestational sac.

The findings of a yolk sac, fetal pole, or fetus with cardiac activity within the uterus are considered definitive findings of an intrauterine pregnancy and should be sought in evaluating patients with suspected ectopic pregnancy. Identifying one of these findings rules out an ectopic pregnancy in patients who are not taking follicle-stimulating medications.

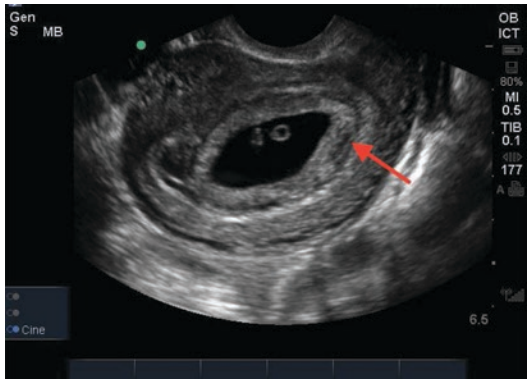
Although a correlation with beta-hCG is useful in evaluating the sonographic findings, recent literature has raised questions on the traditional concept of a "discriminatory zone" to rule in or out an ectopic pregnancy. The concept of the discriminatory zone utilizes the idea that once the serum beta-hCG level reaches a certain point, evidence of a pregnancy should be visible. If it is not, then an ectopic pregnancy or nonviable pregnancy is assumed. The level at which this assumption can be made has fluctuated and has not been consistent across the literature, but values around 1500 mIU/mL are often used. Current recommendations state that when the adnexa appear normal and there is no significant free fluid, a single beta-hCG should not be used to make decisions regarding the viability of a pregnancy. Rather, a single beta-hCG level should be interpreted in context of the clinical presentation. In most cases, this level should be repeated in 48 hours to determine whether it is rising appropriately.

Gestational age	Beta-hCG (mIU/mL)	TV ultrasound	TA ultrasound
5 weeks	1000-2000	Gestational sac	N/A
5–6 weeks	>2000	Yolk sac	Gestational sac
6 weeks	10,000–20,000	Embryo with heartbeat	Yolk sac
7 weeks	>20,000	Embryo with head and torso	Embryo with heartbeat

John MA, Mateer J, Blaivas M. *Emergency ultrasound*. New York: McGraw Hill; 2008.



Transvaginal ultrasound demonstrating an empty gestational sac



Transvaginal ultrasound demonstrating an intrauterine gestational sac containing a fetal pole. This finding is consistent with an intrauterine pregnancy. Also demonstrated in this image is the double decidual sign (arrow)

Take-Home Message

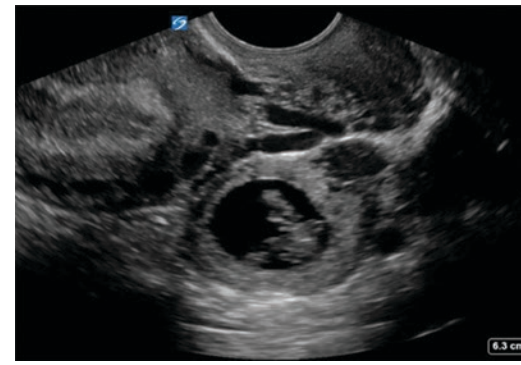
The finding of a gestational sac or double decidual sign in the uterus is not definitive signs of an intrauterine pregnancy. The finding of a yolk sac or fetal pole within the endometrium of the uterus is definitive signs of an intrauterine pregnancy and reassuring for ruling out an ectopic pregnancy.

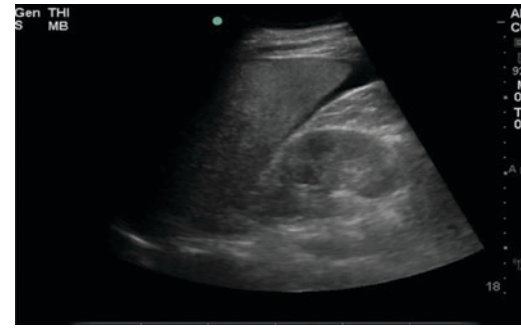
ABP Ultrasound Evaluation of Potential Ectopic Pregnancy

- Know the indications and contraindications for ultrasound evaluation of potential ectopic pregnancy.
- Plan the key steps and know the potential pitfalls in performing ultrasound evaluation of potential ectopic pregnancy.
- Recognize the complications associated with ultrasound evaluation of potential ectopic pregnancy.

Question 3

A 16-year-old female presents to the Emergency Department with severe lower abdominal pain. She reports the symptoms began abruptly this morning and were associated with lightheadedness. She denies any past medical history or medications. She is in significant distress, clutching her abdomen. Her vital signs are as follows: temperature 99.0 °F, heart rate 120 beats/minute, respiratory rate 20 breaths/minute, and blood pressure 80/50 mm Hg. Her physical examination is significant for diffuse abdominal tenderness and rebound tenderness. A bedside ultrasound is performed and is shown below.





Which of the following is correct regarding ultrasound in the evaluation of early pregnancy?

A. The most commonly seen finding in ectopic pregnancy is the presence of a "tubal ring."
B. The presence of free fluid in the hepatorenal space in a patient with positive pregnancy test and an empty uterus is highly suggestive of an ectopic pregnancy.
C. Free fluid within the cul-de-sac is never a normal finding.
D. The finding of a "tubal ring" confers a low likelihood of ectopic pregnancy.
E. Differentiation of a normal ovary from the complex mass of ectopic pregnancy is straightforward and can easily be performed by the bedside sonographer.

Correct Answer: B

In the absence of findings of an intrauterine pregnancy described above, the adnexa should be scanned for direct evidence of ectopic pregnancy. Specifically, the findings of pelvic and intra-abdominal free fluid, tubal ring, and complex adnexal mass should be sought.

The presence of greater than a physiologic amount of pelvic free fluid in the cul-de-sac should be considered very suspicious in a patient with a positive pregnancy test and lack of evidence of an intrauterine pregnancy. Free fluid is typically first seen in the cul-de-sac of the pelvis, posterior to the uterus, as an anechoic (black) or hypoechoic (dark gray) collection. A small amount, or physiologic amount, is usually described as being confined to the cul-de-sac and covering less than one-third of the inferior posterior uterus. The larger the collection of free fluid, the more abnormal the finding, and the more likely the diagnosis of ectopic pregnancy. When large amounts of free fluid are seen within the pelvis, the transabdominal transducer should be used to evaluate the hepatorenal space for the presence of free fluid within the peritoneum (see below). This finding is highly suggestive of an ectopic pregnancy when the pregnancy test is positive and no intrauterine pregnancy is seen.

A tubal ring is a subtle finding that is nearly diagnostic for ectopic pregnancy. It is described as a rounded, hyperechoic (light gray), thick-walled ring in the adnexa with a hypoechoic (light gray) or anechoic (black) center (see below). It can be a subtle finding and can be easily overlooked by an inexperienced sonographer.

A complex mass is the most commonly seen finding in ectopic pregnancy and is described as a mixture of solid and cystic components in the adnexa. Its appearance can vary depending on its makeup. This can also be a subtle finding and can easily be confused with normal adnexa or bowel contents.

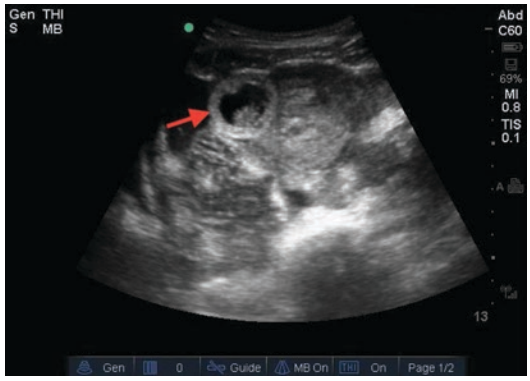
When evaluating for findings of ectopic pregnancy, the emergency physician should have a high degree of suspicion when the pregnancy test is positive and there is an empty uterus. The finding of either pelvic or intraperitoneal free fluid should raise this suspicion. At this point, if the stability of the patient allows, a formal radiologist interpreted ultrasound should be performed to evaluate for the more subtle findings of tubal ring and complex adnexal mass.

Take-Home Message

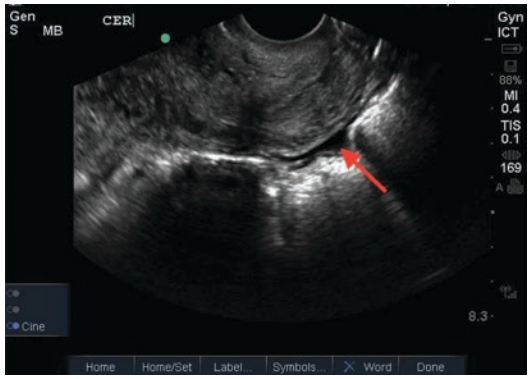
There are several findings suggestive of an ectopic pregnancy. However, a finding of a positive pregnancy test with either free fluid in the abdomen or an empty uterus is concerning for possible ectopic pregnancy.

ABP Ultrasound Evaluation of Potential Ectopic Pregnancy

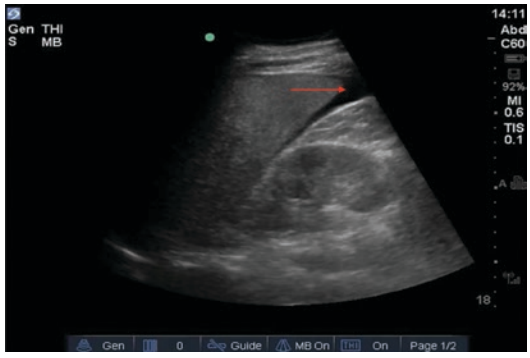
- Know the indications and contraindications for ultrasound evaluation of potential ectopic pregnancy.
- Plan the key steps and know the potential pitfalls in performing ultrasound evaluation of potential ectopic pregnancy.



Arrow indicates tubal ring seen adjacent to an empty uterus on transabdominal ultrasound of the pelvis. Free fluid is seen to the left of the tubal ring



Transvaginal ultrasound image of a small amount of free fluid within the cul-de-sac, posterior to the cervix. Free fluid is considered small, or physiologic, in this region when it extends to less than one-third of the height of the uterus



Transabdominal ultrasound of the right upper quadrant showing anechoic (black) free fluid (arrow) within the hepatorenal space

Suggested Reading

Question 1

Fox JC, Lambert MJ. Emergency ultrasound. New York: McGraw Hill; 2008. p. 353–72.
Matsuno WC. Pediatric emergency medicine. New York: McGraw Hill; 2009.
Reardon RF, Joing SA. Emergency ultrasound. New York: McGraw Hill; 2008. p. 279–318.
Rodriguez AM, Okada PJ, Sheffield JS. Pediatric emergency medicine. New York: McGraw Hill; 2009.

Question 2

Doubilet PM, et al. Criteria for diagnosing early pregnancy. NEJM. 2013;369:1443–51.
Matsuno WC. Pediatric emergency medicine. New York: McGraw Hill; 2009.
Reardon RF, Joing SA. Emergency ultrasound. New York: McGraw Hill; 2008. p. 279–318.
Rodriguez AM, Okada PJ, Sheffield JS. Pediatric emergency medicine. New York: McGraw Hill; 2009.

Question 3

Matsuno WC. Pediatric emergency medicine. New York: McGraw Hill; 2009.
Reardon RF, Joing SA. Emergency ultrasound. New York: McGraw Hill; 2008. p. 279–318.

Emergency Cardiac Ultrasound

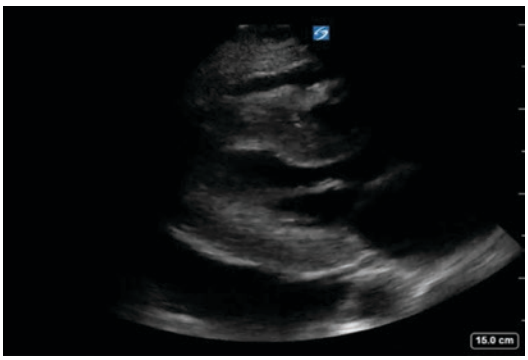
23

Christine Butts and Scott Mackey

Question 1

A 16-year-old boy presents to the emergency department because of chest pain. He states that he had "a cold" about a week ago, but that seemed to clear up. This morning he developed sharp stabbing chest pains that are worsened with movement, and improves while leaning forward. He denies shortness of breath or any other complaints. On arrival vital signs are as follows: temperature 98.0 °F, heart rate 79 beats/minute, respirator rate 16 breaths/minute, blood pressure 123/73 mm Hg, and oxygen saturation 100% on room air. Breath sounds are clear and equal throughout. Heart sounds are regular, with no murmurs, rubs, and gallops. His EKG shows diffuse ST elevation throughout.

An ultrasound of his heart is performed and is shown below. Which of the following is correct regarding this image?



A. It is impossible to assess the right ventricle from this view.
B. A pericardial effusion is present, but there are no indications of pericardial tamponade.
C. A pleural effusion is present.
D. A transesophageal echocardiogram (TEE) would be more sensitive for making the diagnosis in this patient.
E. All of the clinical signs of tamponade have to be present before the diagnosis can be suspected.

Correct Answer: B

This image shows a parasternal long axis view of the heart. This view, obtained by placing the transducer to the left of the patient's sternum with the indicator pointing towards the patient's left shoulder, yields an image that primarily evaluates

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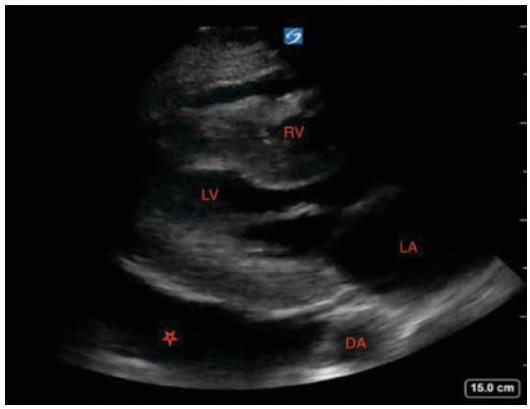
M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_23

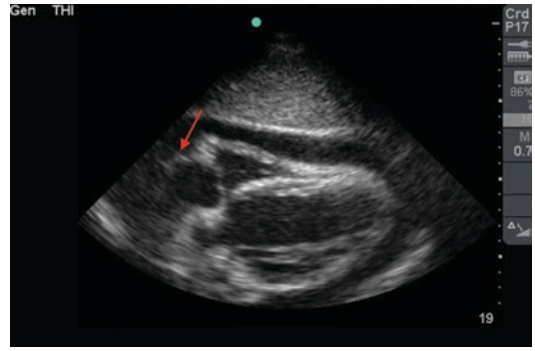
the left side of the heart. However, a small portion of the right ventricle is visible as well. A pericardial effusion is seen surrounding the heart (see image below). The descending aorta provides an important landmark in evaluating this image. Fluid collections anterior to the aorta are pericardial, versus fluid collections that are deep to (or posterior to) the aorta are pleural.



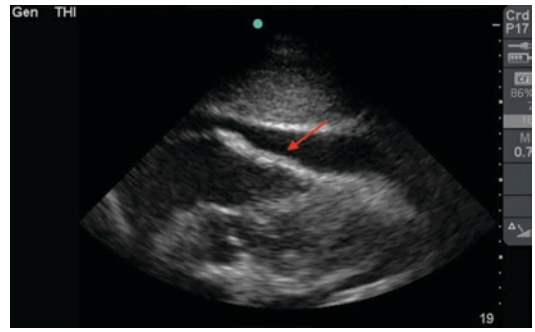
Annotated parasternal long axis view of the heart: RV (right ventricle), LV (left ventricle), LA (left atrium), DA (descending aorta), Star (pericardial effusion)

The patient's presentation of sharp, positional chest pain following a viral illness suggests pericarditis. EKG findings of diffuse ST segment elevation give further weight to this diagnosis. Determining the presence of an effusion is key in order to risk-stratify these patients. Additionally, once an effusion is identified, an assessment for factors suggesting cardiac tamponade is critical.

Beck triad of hypotension, muffled heart tones, and distended neck veins is often cited as the classical presentation of cardiac tamponade. However, these findings can be difficult to identify and may be variably present and a noisy room or obese patient may cause difficulty in assessing for these signs. Ultrasound provides an opportunity not only for the diagnosis of an effusion but also for signs of tamponade. One of the earliest signs that the pressure in the pericardial sac is building is a compressive effect on the right side of the heart. The right side of the heart is a lower pressure system when compared to the left and is the first to be affected by mounting pressure caused by a developing effusion. The right atrium is typically affected first, and the sonographer may note that the right atrium will appear to collapse or bow inward during systole. As the pressure increases, the right ventricle will be next affected and may be seen to collapse inward during diastole. Once diastolic filling of the right side of the heart is compromised, the examiner may note distention of the inferior vena cava as well. Any of these echocardiographic signs, even in the face of a normal blood pressure, should be concerning for impending tamponade.



This image, taken from a subxiphoid approach, shows bowing of the right atrium (arrow). Note that the tricuspid valve is closed, indicating that this is occurring during systole



This image, taken from a subxiphoid approach, shows bowing of the right ventricle. Note that the tricuspid valve, indicating that this is occurring during diastole

In this case, although there is a pericardial effusion present, there is no evidence of bowing of the right atrium or ventricle. Additionally, the patient's blood pressure is within normal limits. Choice A is incorrect due to the fact that, as noted above, the right ventricle can be seen in part in this image. Choice C is incorrect as the location of the descending aorta confirms this fluid collection as pericardial, not pleural. Choice D is incor-

rect as transesophageal echocardiogram is time consuming, requires sedation, and is not more sensitive in making the diagnosis of pericardial effusion and tamponade. Finally, choice E is incorrect as when a pericardial effusion is present, there should be concern for tamponade or impending tamponade, even when all of the clinical signs are not obviously present.

Take-Home Message

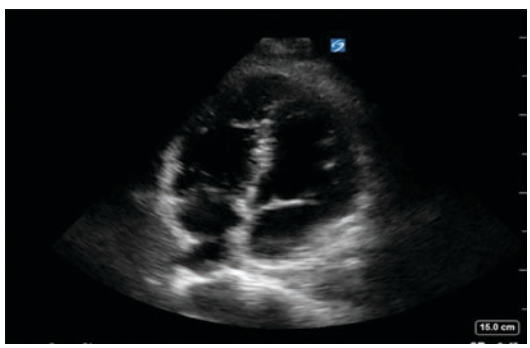
Ultrasound can be used to rapidly assess for the presence of a pericardial effusion and for signs of tamponade or impending tamponade.

ABP Content Specification

- Recognize cardiac tamponade based on clinical and laboratory manifestations. Recognize normal cardiac anatomy on echocardiography.

Question 2

A 12-year-old girl is brought into the ED by her mother with complaints that she is tiring easily. She notes that the patient has not been able to participate in gym class due to extreme fatigue. She has also noted that her daughter gets out of breath walking even short distances. Her vital signs are as follows: heart rate 110 beats/minute, respiratory rate 18 breaths/minute, blood pressure 100/60 mm Hg, and oxygen saturation 95% on room air. She is afebrile. Her examination is significant for tachycardia with an S3 and fine rales noted at both lung bases. A bedside echocardiogram is performed and is shown below. Which of the following is correct regarding this image and case?



A. This view of the heart is ideal for evaluating the flow across the mitral and tricuspid valves, as the direction of flow is parallel to the Doppler gate.
B. Assessing left ventricular contractility requires advanced Doppler calculations and is difficult to assess at the bedside.
C. This view of the heart is not adequate to assess right ventricular chamber size in comparison to the left.
D. Pericardial effusions cannot be assessed from this view.
E. The pressure gradient across a valve can be directly measured utilizing Doppler flow.

Correct Answer: A

Interpreting an echocardiogram at the bedside can be overwhelming. The amount of information measured and obtained can be enormous. However, evaluation of a few basic things is well within the scope of PEM physician. Ejection fraction refers to the volume of blood ejected from the left ventricle. It is calculated by measuring the end diastolic volume and the end systolic volume. These calculations can be cumbersome and intimidating. In contrast, the contractility, or muscular function, of the left ventricle, can be assessed quickly at the bedside by focusing on a few key factors. Specifically, the myocardium should be examined to determine if it is thickening during systole. The chamber size of the left ventricle should also decrease by one third in systole. By quickly assessing these two factors, the physician can rapidly determine if the contractility of the left ventricle is normal, decreased, or severely decreased. Taking a video clip of the heart and viewing it in slow motion can help if it is difficult to assess the contractility in real time. Often, with practice and experience, bedside sonographers can be as successful in this determination as cardiologists.

Additionally, other quick information can be obtained from a few views of the heart. The presence of a pericardial effusion can be noted on any view. Once left ventricular contractility has been assessed, the right heart should be examined for evidence of enlargement, or strain. The right heart should be smaller than the left ventricle, at a ratio of less than 0.60. The apical four-chamber

view, seen in this patient, is ideal for evaluating the two ventricles side by side.

Doppler flow is a complex subject, outside of the scope of this chapter. However, a basic knowledge of the concepts of Doppler can greatly aid the clinician that is attempting to interpret the pediatric heart. Doppler assesses the shift in frequency of an object as it moves in the body. By assessing this shift, the ultrasound is able to determine many factors, including the speed and direction of motion of the object. This information is obtained by placing the Doppler "gate" across the area of interest, such as across a valve. In order to obtain the strongest signal, with the least amount of interference, the gate should be positioned as parallel to the direction of flow as possible. An apical four-chamber view is ideal for this purpose when examining the flow across the mitral and tricuspid valves, as well as the aortic valve (see below).

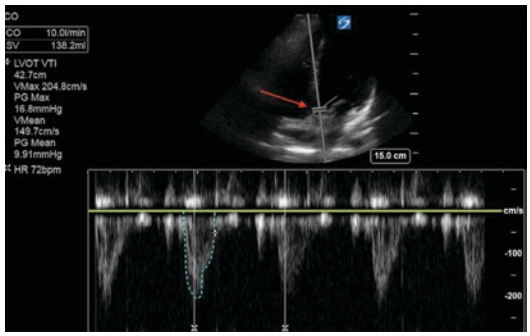


Image demonstrating the placement of the Doppler gate (arrow) parallel to the direction of flow in this apical view. Blood is flowing either from the bottom of the image towards the top (across the mitral and tricuspid valves) or from the top to the bottom (across the aortic valve)

Doppler can determine the velocity of motion of an object, but cannot directly determine the pressure gradient. Pressure gradient can be indirectly assessed once the velocity is determined.

When considering the above answers, option B is incorrect as a basic assessment of left ventricular contractility can be determined with a visual assessment. More complex measurements can be obtained to calculate the ejection fraction. Option C is incorrect as the apical four-chamber view is actually ideal to evaluate the right ventricular size in comparison to the left ventricular size. Option D is incorrect as a pericardial effusion can be seen on any cardiac view. Option E is incorrect as the Doppler function can calculate the velocity across an area, but can only assess the pressure gradient indirectly. Option A is the correct answer as the apical four chamber view allows the examiner to line up the Doppler gate as near to parallel to the direction of flow as possible.

Take-Home Message

Although echocardiography can be complicated, knowledge of basic anatomy, principles of echocardiography, and physics can enable the bedside sonographer to obtain a large amount of information.

ABP Content Specification

- Understand the principles of echocardiography.
- Understand the physics of echocardiography.
- Recognize normal cardiac anatomy on echocardiography.
- Know how Doppler-derived velocity measurements compare to direct-pressure gradient determinations.
- Assess systolic and diastolic function utilizing echocardiography.

Question 3

A mother brings her 8-week-old infant to the emergency department with concern for a change to his skin color. She reports he was born full term and had no complications at delivery. He has been slightly underweight at his office visits and she notes that he doesn't eat as much as he should. A physical exam shows an infant in no acute distress. A harsh systolic murmur is noted at the left upper sternal border and the lungs are clear.

Which of the following is correct concerning echocardiography for this patient?

A. Transesophageal echocardiography is the preferred initial method to examine a patient for suspected congenital heart disease.
B. Pediatric echocardiography is technically difficult when compared to adults due to differences in anatomy.

C. Doppler measurements are key in making the diagnosis of congenital heart disease.
D. Congenital heart disease is usually obvious on transthoracic echocardiography.
E. Congenital abnormalities are best noted on the apical view of the heart.

Correct Answer: C

Echocardiography is crucial in making the diagnosis of congenital heart disease (CHD). When the diagnosis is suspected by the clinical history or physical exam, a transthoracic echocardiogram should be performed first. Transthoracic echo (TTE) carries very little risk for even infants and can demonstrate a number of abnormalities. Transesophageal echocardiography (TEE) has its place in the evaluation of CHD, particularly when the initial echocardiogram is nondiagnostic, but carries inherent risks. Children must be sedated for TEE and this test should be considered as a second line diagnostic modality. It can also be used intraoperatively or in the cardiac catheterization lab to gain further information. Although many defects of CHD, such as a ventriculoseptal defect, can be visualized directly on TTE, findings may be subtle. At times, the sonographer may be looking for indirect evidence of a CHD. For example, right ventricular hypertrophy can be suggestive of the pulmonary stenosis of Tetralogy of Fallot. Additionally, the use of Doppler is crucial in looking for flow abnormalities. Blood flow within the pediatric heart should be predictable and the finding of turbulent flow or regurgitation across a valve should cause the examiner to be suspicious of an underlying CHD. For example, turbulent flow visualized within the right ventricle can suggest the presence of abnormal flow patterns, such as with the overriding aorta seen in Tetralogy of Fallot.

Pediatric patients may require slightly different technique than adults, but the TTE is not inherently more difficult. Pediatric echocardiography may actually be technically less challenging secondary to the absence of habitus complications that plague adult echocardiography.

Choice A is incorrect as transesophageal echocardiography should be reserved for cases in which the initial transthoracic echocardiogram is inconclusive or does not yield a diagnosis. It should not be the initial modality of evaluation. Choice B is incorrect as pediatric echocardiography is not more technically difficult than in adults. Choice D is incorrect as CHD may not be immediately obvious on echocardiography. Application of other techniques, such as Doppler or assessing for secondary findings (such as hypertrophy), will often suggest or prove the correct diagnosis. Choice E is incorrect as, depending on the nature of the defect, multiple views are likely needed to confirm the diagnosis. Choice C is correct as Doppler flow is essential in looking for regurgitant or turbulent flow that suggests a defect. Additionally, the use of Doppler flow allows for calculation of the velocity of flow and in turn, the pressure gradient across valves. This information is critical in identifying the presence of a lesion as well as in classifying its severity and need for intervention.

Take-Home Message

A large amount of information can be gained with transthoracic echocardiography in the evaluation of children with suspected congenital heart disease.

ABP Content Specification

- Know the indications and limitations of fetal echocardiography on the diagnosis of CHD. Know the indications for, risks of, and limitations of transesophageal, stress, and fetal echocardiography.
- Understand the principles of echocardiography.

Suggested Reading

Question 1

Jacob S, et al. Pericardial effusion impending tamponade: a look beyond Beck's triad. Am J Emerg Med. 2009;27(2):216–9.

Goodman A, et al. The role of bedside ultrasound in the diagnosis of pericardial effusion and cardiac tamponade. J Emerg Trauma Shock. 2012;5(1):72.

Question 2

Harris P, Kuppurao L. Quantitative Doppler echocardiography. BJA Educ. 2016;16(2):46–52.

Pershad J, et al. Bedside limited echocardiography by the emergency physician is accurate during evaluation of the critically ill patient. Pediatrics. 2004;114(6):e667–71.

Ciccone TJ, Grossman SA. Cardiac ultrasound. Emerg Med Clin North Am. 2004;22(3):621–40.

Question 3

Ayres NA, et al. Indications and guidelines for performance of transesophageal echocardiography in the patient with pediatric acquired or congenital heart disease: a report from the Task Force of the Pediatric Council of the American Society of Echocardiography. J Am Soc Echocardiogr. 2005;18(1):91–8.

Lai WW, et al. Guidelines and standards for performance of a pediatric echocardiogram: a report from the Task Force of the Pediatric Council of the American Society of Echocardiography. J Am Soc Echocardiogr. 2006;19(12):1413–30.

Emergency Ultrasound in Trauma

24

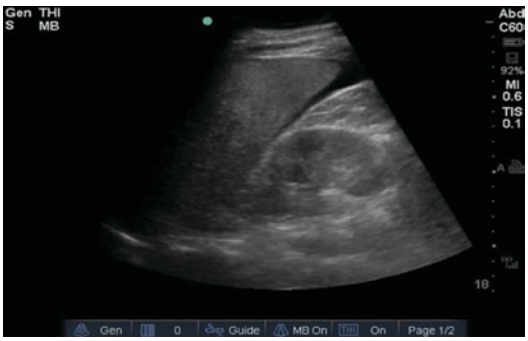
Christine Butts and Elizabeth Clement

Question 1

A 15-year-old boy presents to the emergency department (ED) by emergency medical services (EMS) following an all-terrain vehicle (ATV) accident. EMS reports that the patient was riding at a high speed when he hit a bump and flipped the ATV, causing it to land on top of the patient. The patient denies any loss of consciousness but is complaining of abdominal pain.

His initial vital signs are as follows: temperature 98.9 °F, heart rate 126 beats/minute, respiratory rate 18 breaths/minute, and blood pressure 86/58 mm Hg. He is pale and in moderate distress. His airway is patent, trachea is midline, and he has equal bilateral breath sounds. His abdomen is diffusely tender with guarding and rebound tenderness is also present. His pelvis is stable.

A transabdominal bedside FAST ultrasound is performed at the bedside and is shown below.



Which of the following is most correct?

A. The ultrasound image shows no abnormality, so you should continue to search for a cause of his hemodynamic instability.
B. The patient has sustained a liver injury. He should be admitted to the trauma ICU and monitored for signs of further decompensation.
C. The patient has sustained a renal injury and will need emergent laparotomy.
D. This patient should be taken directly to the OR for exploratory laparotomy for intervention of his intra-abdominal trauma.
E. It is unclear what injury this patient has sustained, so he will need a CT scan for further evaluation.

Correct Answer: D

Bedside ultrasound has become an integral part of the evaluation of the hypotensive blunt

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_24

trauma patients. These patients may have hemorrhage from a number of sources or may have other reasons of shock as well, such as cardiac tamponade. Although the examiner may be able to quickly assess some areas with standard technology (for example, a pelvic X-ray may quickly identify a fracture as a possible source), the abdomen is more difficult to assess. Traditionally, diagnostic peritoneal lavage (DPL) was used to assess for bleeding within the peritoneal space in these unstable patients. However, this test has its drawbacks, as it must be performed by a skilled provider, may be contraindicated in some patients (such as pregnant women). DPL carries an inherent risk of iatrogenic injury to the patient and is not easily repeatable.

The FAST (Focused Assessment with Sonography in Trauma) examination is designed to overcome these barriers by using the relatively low-risk modality of ultrasound to examine the peritoneal space. The examination relies on the principle that free fluid within the peritoneal space will accumulate in the dependent areas in a supine patient. These standard dependent areas are the hepatorenal recess (Morison's pouch), the splenorenal recess and the suprapubic view.

The pericardium can also be quickly assessed for the presence of effusion that may indicate pericardial tamponade. Therefore, FAST examination evaluates the presence or absence of free fluid in four anatomic locations: the hepatorenal space (Morrison's pouch), the splenorenal space, the suprapubic region (around the bladder), and the pericardium. The free fluid appears anechoic (dark or black) on ultrasound. Since FAST is noninvasive, this allows the operator to perform an examination simultaneously during the resuscitation.

The FAST examination is most sensitive in patients who are hemodynamically unstable. In these patients, sensitivities in the 90% range have been noted. Identifying the presence of intraperitoneal fluid in these patients narrows down the source of their shock and quickly directs management, as these patients should be taken to the OR for surgical management of their injuries. Delaying operative intervention by obtaining a CT scan or other testing may add some information about the nature of the patient's injuries, but will not be helpful in stopping the hemorrhage.

Although the FAST is relatively sensitive in this group of patients in identifying the presence of free fluid and hemorrhage, it does not indicate the location of the injury. The location of the free fluid should not be considered a marker of the location of injury, as fluid may move within the compartments of the peritoneum as the patient shifts.

It should also be noted that the use of the FAST examination in pediatric patients has been controversial, as there are a few key differences in pediatric versus adult trauma patients. Pediatric patients are less likely to have free fluid in the peritoneum than adults, possibly making the FAST less sensitive in stable patients. Additionally, pediatric patients are more likely to manage nonoperatively than adults, making the finding of free fluid on FAST in a pediatric patient less important.

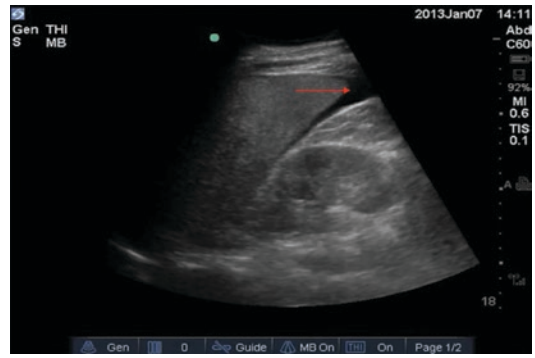


Image of the hepatorenal space indicating free fluid, as indicated by the arrow.

In the image shown with the question given earlier, the right upper quadrant can be seen, with the liver on the left side of the image and the kidney to the right. In between the liver and kidney (in the hepatorenal recess or Morrison's pouch), a "stripe" of anechoic (black) fluid can be seen, indicating a positive scan. As this patient is unstable being hypotensive and tachycardic, this finding should prompt surgical management with an exploratory laparotomy.

Choice A is incorrect, as the image of the right upper quadrant clearly demonstrates the abnormal finding of free fluid. Choices B and C are incorrect as FAST does not identify the source of free fluid or the specific injury. Choice E is

incorrect, as although FAST cannot identify the source of an injury as well as CT scan, this patient is not stable enough to undergo further imaging at this time. Choice D is correct, as the finding of free fluid in an unstable patient should warrant operative intervention.

Take-Home Message

The FAST examination is valuable in identifying a source of hemorrhage in the evaluation of hypotensive patients following blunt trauma. Although a finding of free fluid is helpful in the management by indicating a need for surgical exploration, the location of the free fluid does not indicate the source of injury. An unstable patient with a positive FAST examination should be taken to the OR for laparotomy.

ABP Content Specification

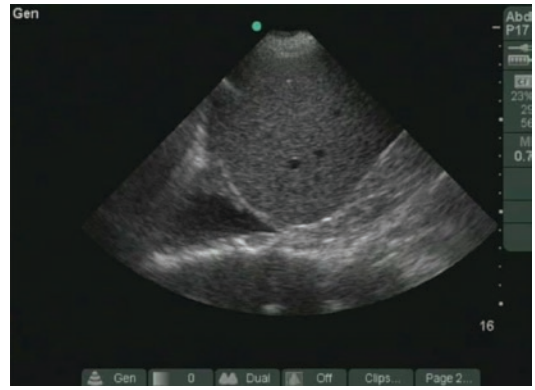
- Understand the role of ultrasound in the management of a major trauma victim.
- Know the indications and contraindications for focused access with sonography for trauma (FAST).
- Know the anatomy and pathophysiology relevant to focused access with sonography for trauma (FAST).
- Plan the key steps and know the potential pitfalls in performing focused access with sonography for trauma (FAST).

Question 2

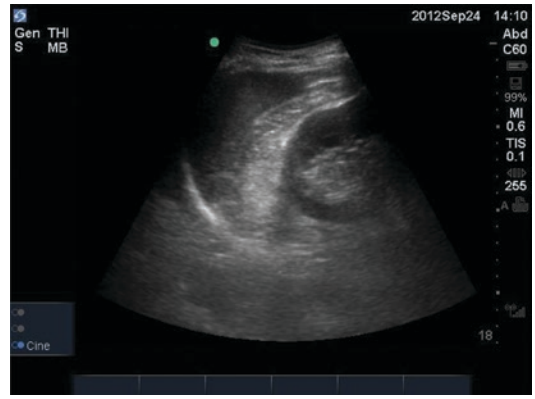
A 13-year-old boy is brought to the ED by his parent for evaluation after he was struck by a car while riding his bicycle. The patient is ambulatory at the time of arrival, but is complaining of shortness of breath. His initial vital signs are as follows: temperature 98.4 °F, heart rate 109 beats/minute, respiratory rate 36 breaths/minute, blood pressure 98/62 mm Hg, and oxygen saturation 97%. He is alert, but in moderate respiratory distress with increased work of breathing. Crepitus is noted to the right lateral ribs. His abdomen is soft and nontender.

During the initial evaluation of the patient, a bedside ultrasound is obtained. The relevant images are presented below.

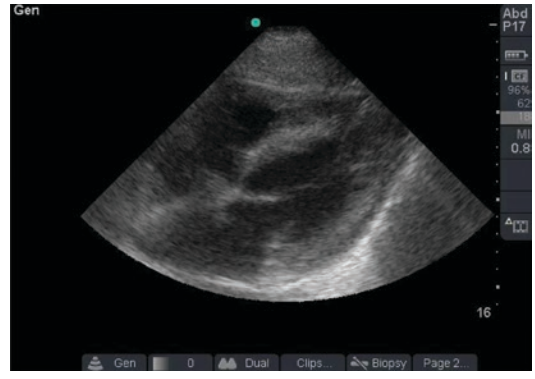
R Flank



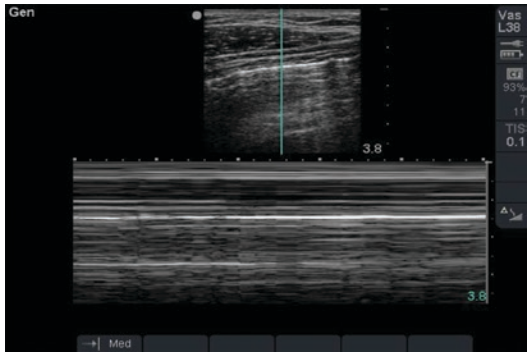
L Flank



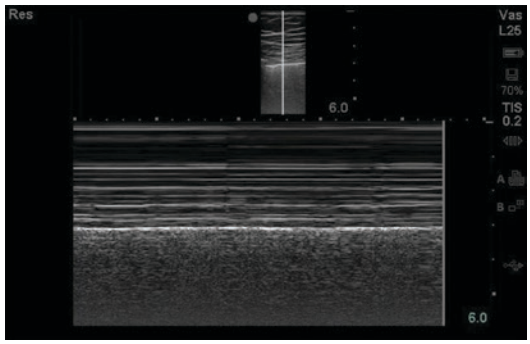
Subxiphoid cardiac view



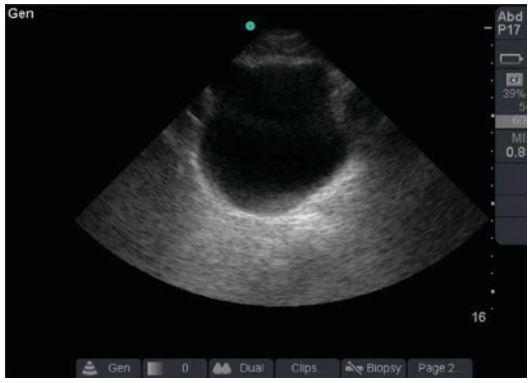
R lung



Left lung



Suprapubic view



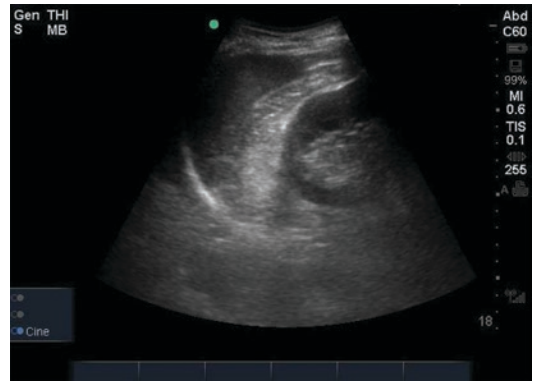
Which of the following is most correct regarding the provided images of this patient's eFAST scan?

A. The patient is likely in shock due to a pericardial tamponade.
B. The etiology of the patient's respiratory distress is a right-sided pneumothorax.
C. The etiology of the patient's respiratory distress is a right-sided hemothorax.
D. The suprapubic view identifies the cause of the patient's symptoms.
E. Both B and C are correct.

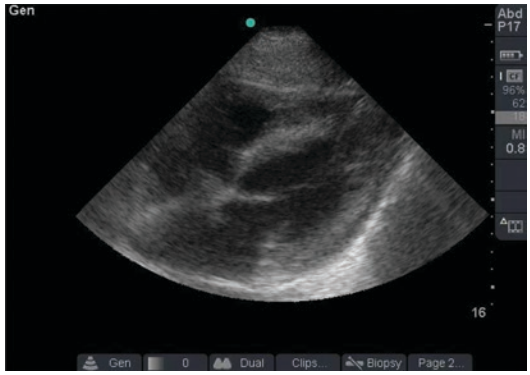
Correct Answer: E

The eFAST (extended focused assessment with sonography in trauma) examination has been expanded beyond the normal four-view FAST series to include the evaluation of the thoracic cavity for both hemothorax and pneumothorax.

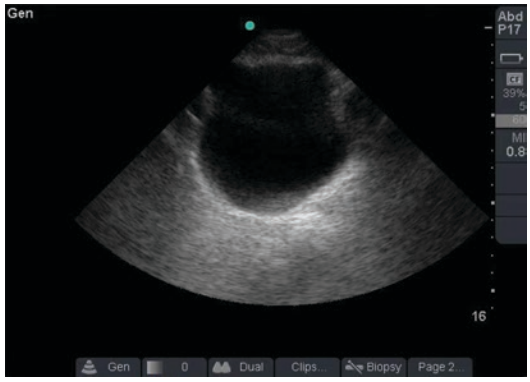
The images of this patient's FAST include multiple images. The image of the left flank and left upper quadrant demonstrates a view of the spleen, left kidney, and diaphragm. No free fluid or hemothorax is seen in this image.



The subxiphoid image of the heart demonstrates the heart deep to the left lobe of the liver. The pericardium is seen as the bright white outline surrounding the heart and no fluid is seen in the pericardial sac.



And image of the pelvis is also demonstrated, with the bladder seen as an anechoic (black) structure. No fluid is seen surrounding the pelvis, indicating a negative view.



The remainder of the images are discussed below.

To scan for hemothorax, the curvilinear transducer is placed in the mid to posterior–axillary line with the marker pointed cephalad. The diaphragm is seen as a hyperechoic (bright white) linear structure near the left side of the screen. Just to the left of the diaphragm on the screen is a triangular region of the costophrenic angle. An anechoic or hypoechoic collection can be seen in this area. In the setting of trauma, this would most likely be a hemothorax. Ultrasound is highly sensitive for detecting fluid collections within this gravity-dependent space.

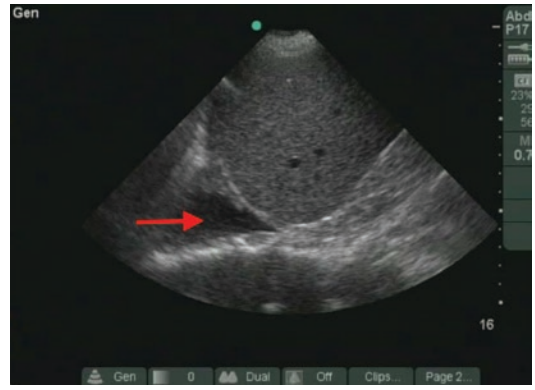


Image demonstrating an anechoic (black) fluid collection in the right costophrenic recess (arrow).

Ultrasound can also be used to evaluate for pneumothorax. Supine chest X-ray has poor sensitivity in detecting even moderate-sized pneumothorax and ultrasound is consistently found to be superior in these patients. To scan for pneumothorax, the high-frequency linear transducer should be used. The target area to scan is the mid-clavicular line in the upper chest with the transducer marker-oriented cephalad. The ribs will be seen as bright white oval structures. Just deep to the rib, a bright white linear structure is noted. In a normal examination, a sliding motion is seen, which corresponds to the parietal and visceral pleura sliding back and forth across each other as the patient inspires and expires. Loss of this "slide sign" is noted in the setting of pneumothorax as the visceral pleura drops out of the field of view.

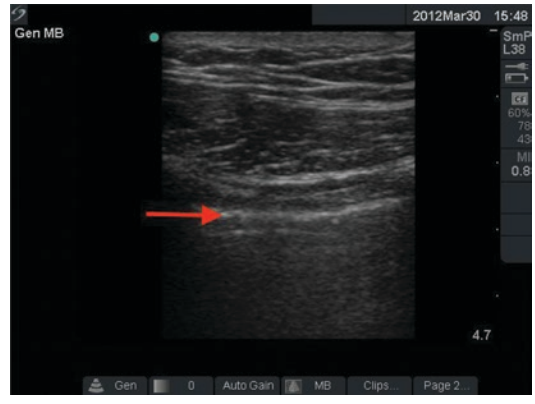
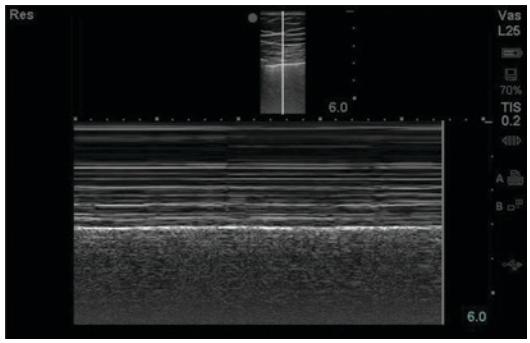


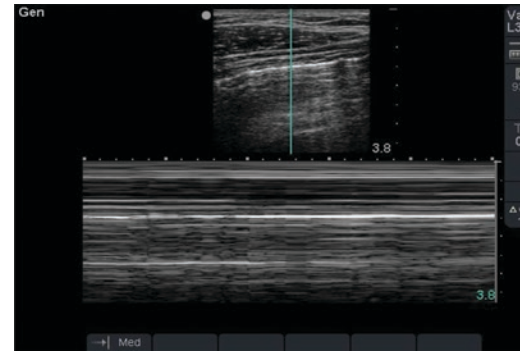
Image depicting the pleura (arrow). When seen in real time, this hyperechoic line can be seen to slide back and forth, indicating absence of pneumothorax.

Further confirmation of this finding can be obtained by using M-Mode. This will produce a graph of motion toward and away from the transducer over time. The resulting graph in a normal scan has been described as the "seashore sign" as it can be compared to the image of a beach on a postcard. The upper portion of the graph reveals a series of horizontal lines that corresponds to the nonmoving soft tissues of the chest wall. These lines are considered to be the "waves" of the ocean. Just below the soft tissue lines, a bright white line is noted, which corresponds to the pleura that is moving parallel to the transducer rather than toward and away from it. Finally, deep to the pleural line, a region of disconnected dots is noted. This region is considered to be the "sandy beach." This region of the graph depicts the chaotic motion of the air molecules in the lung.



M-mode image of a normal, sliding pleura. Note the more solid lines at the top of the image, giving way to the hazier area (or sandy beach) at the inferior aspect of the image.

In the setting of a pneumothorax, the M-mode thoracic scan will lose this normal organization. As the visceral pleura and the lung parenchyma drop out of view, a resultant set of artifactual horizontal lines replaces the "sandy beach." The abnormal scan has been titled "the barcode sign" and is consistent with presence of a pneumothorax.



M-mode image depicting the "barcode sign." Note in this image that the solid, horizontal lines are seen from the top of the image to the bottom, indicating a lack of movement over the entire image, as would be seen in a pneumothorax.

Choice A can be eliminated as there is no evidence of pericardial effusion noted on the subxiphoid view of the heart. Choice D is also incorrect. The subxiphoid image is within normal limits. The best answer in this case is Choice E. Both a hypoechoic collection consistent with a hemothorax (Choice C) and an abnormal "barcode sign" (Choice B) are included in the patient's eFAST images.

Take-Home Message

Extending the basic FAST examination to include the extended focused assessment with sonography for trauma (E-FAST) views of the pleura and thoracic cavity can assist in identifying pneumothorax and hemothorax in the trauma patient.

ABP Content Specification

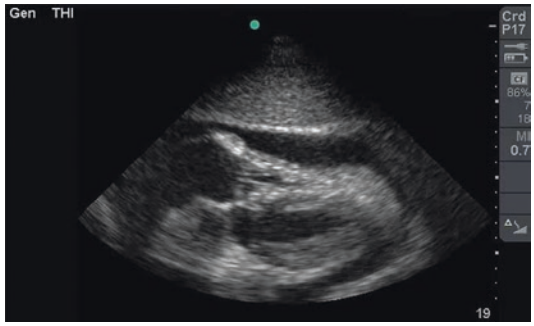
- Understand the role of ultrasound in the management of a major trauma victim.
- Know the indications and contraindications for focused access with sonography for trauma (FAST).
- Know the anatomy and pathophysiology relevant to focused access with sonography for trauma (FAST).
- Plan the key steps and know the potential pitfalls in performing focused access with sonography for trauma (FAST).

Question 3

A 13-year-old girl is brought to the ED via EMS with a single stab wound to the left anterior chest. She is complaining of shortness of breath. Her initial vital signs are as follows: temperature 98.3 °F, heart rate 114 beats/minute, respiratory rate 26 breaths/minute, blood pressure 88/60 mm Hg, and oxygen saturation 93%. She has bilateral breath sounds and her trachea is midline. Jugular venous distension is present and heart sounds are muffled. She has no significant past medical history and takes no medications.

While awaiting the result of a portable chest radiograph, a bedside ultrasound of the chest is performed. The images are provided below.

Subxiphoid cardiac

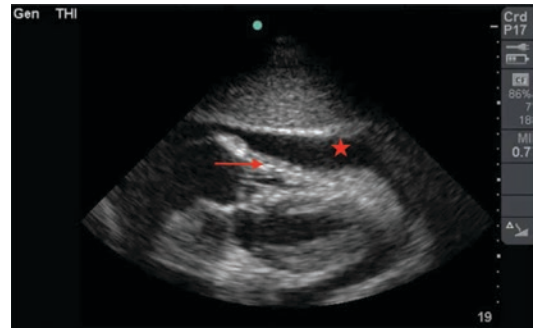


Which of the following statements is most correct?

A. The ultrasound image shows no abnormality, so you should order a CT scan of the abdomen to search for a cause of her hemodynamic instability.
B. A pericardial effusion is present and there is evidence of cardiac tamponade.
C. The patient has a left hemothorax and a chest tube should be placed.
D. Although a pericardial effusion is present, the size of it is not significant enough to cause tamponade.
E. The most likely cause of this patient's clinical status is a pneumothorax.

Correct Answer: B

Pericardial effusion can be rapidly diagnosed with bedside ultrasound and should be incorporated as part of the FAST examination.



Subxiphoid image of the heart, demonstrating a pericardial effusion (star) surrounding the heart. The free wall of the right ventricle can be seen to collapse (arrow), indicating increasing pressure on this chamber from the effusion and tamponade.

In this image, a moderate effusion is seen as an anechoic (black) collection surrounding the heart. Considering her mechanism of trauma, this would indicate likely cardiac injury and should be surgically explored and repaired.

Cardiac tamponade is a clinical diagnosis, indicating that the presence of an effusion is causing restriction of venous return and a decrease in cardiac output. On ultrasound, this can be recognized by the presence of mass effect on the right side of the heart. The pressure from the effusion will cause collapse of the right ventricle in early diastole and collapse of the right atrium in systole. This can be difficult to detect but can be seen as a "waving" or "bowing" of the right ventricular free wall. Clinically, signs of decreased venous return (distended neck veins) and decreased cardiac output (hypotension) are consistent with tamponade.

The most important factor in evaluating pericardial effusion and in diagnosing tamponade is to consider the rate of accumulation and the clinical picture. A patient with a more chronic effusion will have a gradual adaptation of the cardiac physiology to the pressure created by the effusion, while a patient with an acute injury can have a rapid increase in intrapericardial pressure from

a small amount of fluid. This is a critical concept, as most patients with traumatic effusions will have relatively small amounts of fluid present, which may confuse the examiner. Patients with even small effusions are at risk of hemodynamic collapse due to the rapid rise in pressure.

Although the liver is seen at the superior aspect of the image, the fluid associated with this image is surrounding the heart, not the liver. Therefore, Choice A is incorrect. Choice B is correct, as a pericardial effusion is present and the patient's clinical status is consistent with cardiac tamponade. Choice C is incorrect, as this fluid collection is pericardial, not in the plural space. Choice D is incorrect, as the size of the effusion does not indicate whether or not tamponade is present. As described earlier, small effusions can cause tamponade when the fluid collects rapidly. Choice E is incorrect, as no pneumothorax is demonstrated on ultrasound and breath sounds are present bilaterally.

Take-Home Message

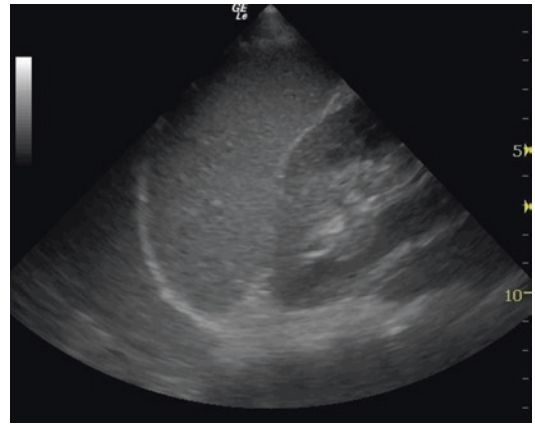
Small pericardial effusions can cause tamponade quickly due to their rapid accumulation. Tamponade can be rapidly identified using bedside ultrasound and the clinical picture of the patient.

ABP Content Specification

- Understand the role of ultrasound in the management of a major trauma victim.
- Know the indications and contraindications for focused access with sonography for trauma (FAST).
- Know the anatomy and pathophysiology relevant to focused access with sonography for trauma (FAST).
- Plan the key steps and know the potential pitfalls in performing focused access with sonography for trauma (FAST).

Question 4

A 6-year-old boy riding a bicycle was hit by a car and fell over the handlebars. He presented to the emergency department with ecchymosis in the epigastrium and with extreme pain. His vital signs are stable. He has right flank and epigastric tenderness. A FAST examination is performed and an image of the right upper quadrant is shown below. The remainder of the FAST is negative. There is microscopic hematuria. Definitive management consists of:

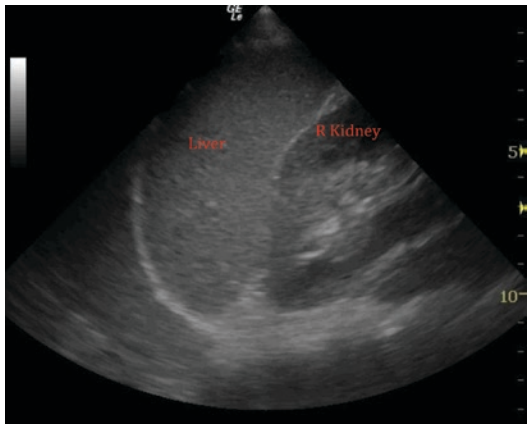


A. Call for a trauma consult in preparation of emergency laparotomy.
B. Obtain a contrast enhanced CT scan of abdomen and pelvis to evaluate for solid organ injury.
C. No further imaging is indicated as the FAST is negative.
D. Order a serum amylase to rule out an injury.
E. Administer antibiotics for likely bowel injury.

Correct Answer: B

This patient has sustained significant trauma to his abdomen, as evidenced by ecchymosis to his abdomen and tenderness on examination. The FAST image shown above does not demonstrate any free fluid in the right upper quadrant and the remainder of the examination is noted to be negative. However, this does not exclude the possibility of significant abdominal injury. The FAST examination is designed to identify free fluid within the peritoneum, to evaluate the pericardium for effusion, and to evaluate the chest for pneumothorax or pleural fluid. The sensitivity for detecting injury has consistently been shown to be low when compared to the sensitivity in detecting free fluid. Pediatric patients have several anatomic differences that can cause

confusion when interpreting a negative FAST examination. Children are more likely than adults to have solid organ (liver, spleen, etc.) injury without associated significant free fluid. In addition, children are more likely to have hollow viscus injury than adults and these injuries often do not cause intraperitoneal fluid.



There has been a concerted effort to diminish the number of CT scans performed in pediatric patients and adding additional information to a FAST examination has been evaluated. The addition of laboratory analysis, such as liver transaminases or amylase, has been studied as a method of increasing the sensitivity of the FAST examination. The BATiC score, which combines factors of the physical examination, laboratory findings, and FAST examination, demonstrated a sensitivity of 100% in ruling out intra-abdominal injury. However, the FAST examination by itself has not shown significant sensitivity to exclude intra-abdominal injury.

As such, the finding of a negative FAST examination in a stable pediatric patient who has experienced blunt abdominal trauma does not carry enough sensitivity to exclude possible intra-abdominal injury. When there is suspicion for abdominal injury, further assessment should take place. CT scan of the abdomen is one method to evaluate the abdomen. Another possible option would be to observe the patient with serial examinations performed by an experienced provider.

In this patient, Choice A is incorrect as the patient is hemodynamically stable and the FAST examination offers no evidence of intra-abdominal hemorrhage. As described earlier, although the FAST examination is negative, there is concern for intra-abdominal injury based on the clinical presentation (abdominal wall ecchymosis, abdominal tenderness) so further investigation would be warranted and Choice C is incorrect. A serum amylase may offer additional information, but by itself or in conjunction with a negative FAST is not sufficient to rule out an injury. Choice E is incorrect as this diagnosis has not yet been determined. The FAST examination is negative and at this stage in the management of this patient, a diagnosis of hollow viscus injury has not yet been established. Choice B is correct. The patient has a negative FAST examination and findings concerning for intra-abdominal injury. A CT scan with contrast is an acceptable method for evaluating this patient.

Take-Home Message

The FAST examination is designed to identify abdominal free fluid, pericardial effusion, pneumothorax, or pleural fluid, not intra-abdominal injury. The finding of a negative FAST examination does not exclude the presence of injury.

ABP Content Specifications

- Understand the role of ultrasound in the management of a major trauma victim.
- Know the indications and contraindications for focused access with sonography for trauma (FAST).
- Plan the key steps and know the potential pitfalls in performing focused access with sonography for trauma (FAST).

Suggested Reading

Question 1

Fischer JW, Sivitz AB, Abo AM. Chapter 20: Pediatric applications. In: Ma O, Mateer JR, Reardon RF, Joing SA, editors. Ma and Mateer's emergency ultrasound. 3e ed. New York: McGraw-Hill; 2014.

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Question 4

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Holmes JF, Gladman A, Chang CH. Performance of abdominal ultrasonography in pediatric blunt trauma patients: a meta-analysis. J Pediatr Surg. 2007;42(9):1588–94.

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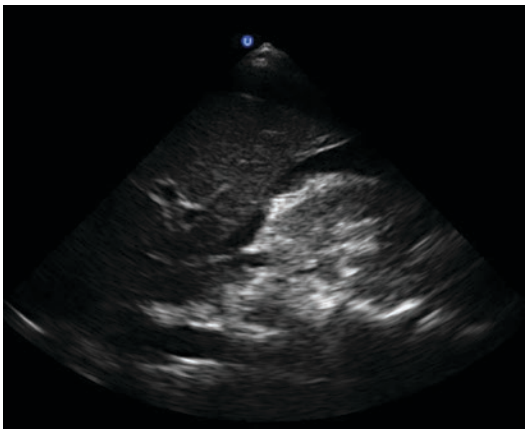
25 Emergency Point of Care Ultrasound

Allysia Guy

Question 1

A 17-year-old female presents to the emergency department (ED) with right lower quadrant pain and vomiting. She has a history of nausea and vomiting for the last 4 weeks. She denies trauma. Upon further questioning, she describes a history of pelvic inflammatory disease treated last year. Her last menstrual period was 6 weeks ago. Her initial vital signs are as follows: temperature 99.1 °F, heart rate 110 beats/minute, respiratory rate 18 breaths/minute, blood pressure 90/40 mm Hg, and oxygen saturation 98% on room air. You requested a urinalysis and urine pregnancy test and decide to perform a FAST (focused assessment with sonography in trauma) examination (see below). What is the best next step in management?



A. Request uncrossed matched blood and perform immediate transfusion
B. Obtain an emergent OBGYN consultation
C. Pain management and administer IV antibiotics while awaiting laboratory results
D. Order a CT scan of abdomen and pelvis
E. Perform a bedside scan of the appendix

Correct Answer: B

The area shown in this bedside ultrasound image is Morison's pouch. It is the most sensitive region to detect free fluid in the abdomen. FAST

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_25

examination in this region can detect as little as 250 ml. A low frequency probe is used for depth. Probe marker should be faced towards the patient's head.

In this case, the patient most likely has a ruptured ectopic pregnancy. She has risk factors such as a history of Pelivic Inflammatory disease (PID) and presents with a low blood pressure. The patient should receive a fluid bolus before blood transfusion is initiated and cross-match should be requested. Pain management should also be considered. This patient is unstable and should be taken to the OR, not for CT scan in this situation.

Take-Home Message

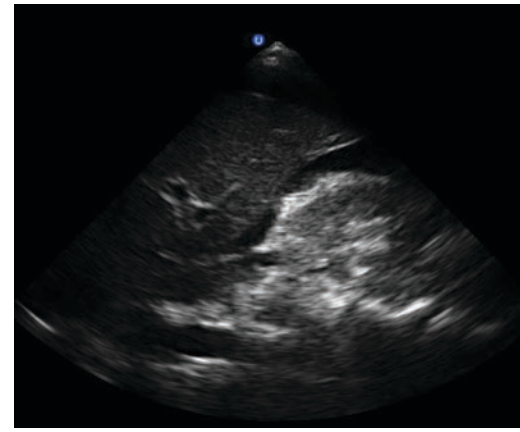
The presence of free fluid in the abdomen may necessitate emergent surgical intervention. A surgical evaluation and immediate OR preparation.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to ultrasound evaluation of potential ectopic pregnancy.
- Know the indications and contraindications for ultrasound evaluation of potential ectopic pregnancy.

Question 2

An 8-year-old boy arrives at a level 1 trauma center after being struck by a car while walking to school. He is on a back board and cervical collar. He is alert and complaining of abdominal pain. On examination, his vital signs are as follows: temperature 99.2 °F, heart rate 120 beats/minute, respiratory rate 28 breaths/minute, and blood pressure 70/40 mm Hg. His pelvis is stable. On secondary survey, you notice left upper quadrant tenderness. You visualize the image shown below on FAST exam. What is your next step?



A. Type, screen, and cross-match at least 6 units of blood, monitor blood pressure closely, and administer a fluids bolus while waiting for cross-matched blood.
B. Call a level 1 trauma code.
C. Order a CT scan of abdomen and pelvis.
D. Wait for trauma surgery consult recommendations.
E. Repeat the FAST examination.

Correct Answer: B

This image is the right upper quadrant portion of the FAST (focused assessment with sonography in trauma) showing Morison's pouch. It is the most sensitive region to detect free fluid in the abdomen. The image shows free fluid in the abdomen in the setting of unstable vital signs. Trauma surgery involvement, transfusion protocol, and OR activation should all occur immediately. Waiting for a consult or a type and screen will not benefit an unstable patient. An unstable patient should not be sent for a CT scan. Open laparotomy or interventional radiology is required as soon as possible for stabilization.

Take-Home Message

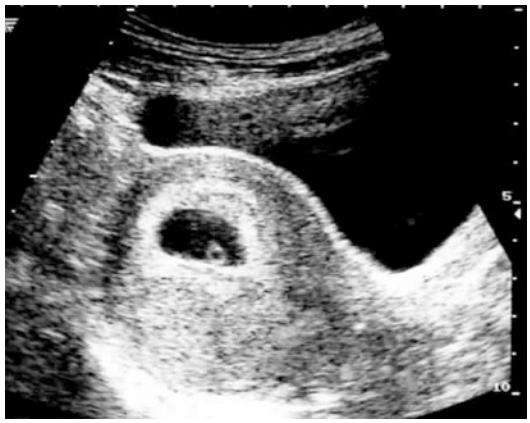
Traumatic free fluid in the abdomen detected by bedside US requires emergent surgical intervention. Mobilizing the OR and contacting surgeons as soon

as possible is standard of care. Calling a trauma code in a level 1 trauma center would accomplish this most efficiently.

ABP Content Specification
- Know the indications and contraindications for focused access with sonography for trauma (FAST).
- Understand the role of ultrasound in the management of a major trauma patient.

Question 3

A 14-year-old girl presents to the ED after having back pain, suprapubic pain, urgency, frequency, and vomiting. She denies vaginal discharge but admits to being sexually active with her boyfriend without contraception. On examination, flank tenderness is elicited. Her urine pregnancy test is positive. The urinalysis shows WBCs, nitrites, ketones, and blood. Evaluation with pelvic ultrasound is shown below. Definitive treatment at this time is to:



A. Perform urgent amniocentesis.
B. Evaluate for an ectopic pregnancy.
C. Consult surgical service.
D. Admit the patient to OB/GYN service for pyelonephritis.
E. Send patient home a follow-up and oral antibiotics as long as she is able to tolerate oral fluid.

Correct Answer: D

This is a pelvic ultrasound image obtained transabdominally. This patient has a definitive intrauterine pregnancy as there is a distinct yolk sac within the gestational sac. Yolk sacs can be seen transabdominally at 6–6.5 weeks of gestation and transvaginally as early as 5–5.5 weeks. Other signs of definitive pregnancy on ultrasound include gestational sac plus a fetal pole or fetal pole with fetal heart tone. Fetal pole may be seen around 7 weeks transabdominally and at 6 weeks transvaginally. Cardiac activity may be seen around 7.5 weeks transabdominally and 6.5 weeks transvaginally. Vaginal examination should be completed to evaluate for discharge, blood in the vault, or an open cervical os. Pelvic examination is standard for any patient who presents in early pregnancy with the chief complaint of pelvic pain. There is no indication for amniocentesis or surgery consultation.

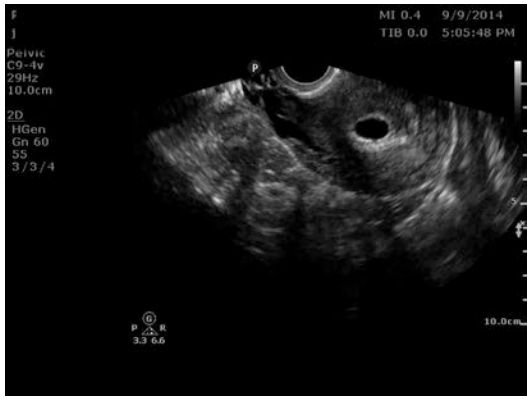
This patient presents with pyelonephritis in the setting of pregnancy. She continues to vomit and has ketones in her urine. All pregnant patients with pyelonephritis should be admitted to obstetric service as they require IV antibiotics and further observation.

Take-Home Message
Pregnant patients who present with pyelonephritis should be admitted to the hospital for IV fluids and antibiotics.

ABP Content Specification
- Recognize and interpret relevant laboratory and imaging studies for urinary infections.

Question 4

A 17-year-old female presents to the ED with severe abdominal pain and bleeding. Her betahCG is 1000. Her vital signs are stable. There is a history of pelvic inflammatory disease. On examination, she is very tender in the suprapubic region and in the right adnexa. Bedside ultrasound is pictured below. The next course of action is to:



A. Place two large-bore IV lines, type and screen, blood, test for Rh factor (RH), status and request for an emergent OB/GYN consult.
B. Immediate transfer to the operating room for salpingectomy.
C. Call for an official ultrasound.
D. Send the patient home. She has early signs of pregnancy and you do not expect to find a definitive intrauterine pregnancy (IUP) at this time.
E. Arrange for outpatient follow-up as the patient has a definitive intrauterine pregnancy (IUP) on bedside ultrasound.

Correct Answer: A

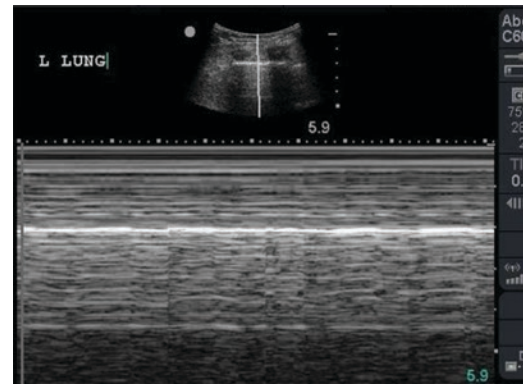
This image shows a gestational sac. It is not a definitive IUP. Severe pain and bleeding in the absence of a definitive IUP yield great concerns for a ruptured ectopic pregnancy. Ectopic pregnancy can present with a pseudogestational sac as shown in this image. This patient is stable during initial evaluation and therefore further workup and consult can be completed while the patient is monitored. The patient should still be prepped for operative procedures as she experiences pain and active bleeding. It is possible that this patient may become unstable. Large bore IVs must be placed. Most OB consulting services usually perform a bedside ultrasound for further evaluation.

Take-Home Message
Confirmation of a definitive IUP is most important when evaluating early pregnancies in the ED. A definitive IUP is a gestational sac with a yolk sac, but not a gestational sac alone.

ABP Content Specification
- Know the anatomy and pathophysiology relevant to ultrasound evaluation of potential ectopic pregnancy.
- Know the indications and contraindications for ultrasound evaluation of potential ectopic pregnancy.
- Recognize the complications associated with ultrasound evaluation of potential ectopic pregnancy.

Question 5

A 12-year-old boy fell off a 10-foot ladder and is brought by emergency medical services (EMS) on a backboard with cervical stabilization. He complains of right-sided rib pain and has difficulty breathing. His vital signs are as follows: temperature 99.0 °F, heart rate 142 beats/minute, respiratory rate 32 breaths/minute, blood pressure 80/40 mm Hg, and oxygen saturation 92% on 2 L of oxygen. His trachea is midline. He is very anxious and in pain. You perform an extended FAST (EFAST) in the ED as shown below. The patient remains hypoxic and dyspneic. What is the definitive management of this finding?



A. Administer broad spectrum antibiotics.
B. Immediate blood transfusion.
C. Tube thoracostomy.
D. Take the child to the OR.
E. Perform needle decompression.

Correct Answer: C

The patient should receive trauma evaluation (trauma code) and may need to go to the OR for the management of other injuries; however, these injuries have yet to be determined. The patient presents with respiratory distress with confirmed pneumothorax on ultrasound. During the extended FAST evaluation, a high-frequency probe is placed on the patient's chest in the supine position along the mid-clavicular line. The probe marker is pointed towards the patient's head. The M-mode (motion time setting of the ultrasound) is used to evaluate for lung sliding. In absence of lung sliding, the pattern above and below the pleural line as depicted will be the same, the "barcode" sign. When lung sliding is preserved, as in a normal lung examination, there is a "seashore" or "sandy beach" sign where the pattern above and below the pleural line is distinctly different. Ultrasound is more sensitive than X-ray for detection of pneumothorax; however, X-ray may give a better picture with regard to percentage of lung collapse. All traumatic pneumothoraces have the potential to expand and chest tube is indicated. The patient is unstable and symptomatic due to the traumatic pathology and emergent chest tube is clinically indicated.

Take-Home Message

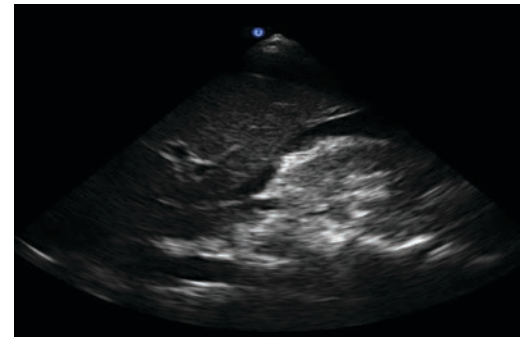
The absence of lung sliding on bedside US is highly sensitive for the diagnosis of pneumothorax.

ABP Content Specification

- Plan the management of simple and tension pneumothorax following blunt chest trauma.
- Know the indications for and interpret the findings of ultrasonography following blunt chest trauma.

Question 6

A 13-year-old girl is brought to the ED after a high-impact motor vehicle collision (MVC). She is on the backboard and has a cervical collar. She is complaining of abdominal and back pain. She is very anxious. Her vital signs are as follows: temperature 98.1 °F, heart rate 112 beats/minute, respiratory rate 22 breaths/minute, and blood pressure 110/60 mm Hg. See the FAST image below. Definitive course of action should include:



A. Call trauma surgery for emergency laparotomy.
B. Order a urine pregnancy test.
C. Place two large bore IVs and call for O+ blood.
D. Place two large bore IVs and call for CT scan
E. Place a chest tube.

Correct Answer: A

This image is the right upper quadrant (RUQ) portion of the FAST (focused assessment with sonography in trauma) examination showing fluid in Morison's pouch. Beware that heart rate and blood pressure may be normal even though the patient is bleeding. In class I blood loss, heart rate and blood pressure may remain normal. Class II blood loss patients may lose 15 to 30% of blood volume without significant change in blood pressure. Respiratory rate and heart rate will increase in class II blood loss. In class III hemorrhage, there is up to 40% blood loss. Heart rate and respiratory rate are significantly increased, while urine output is significantly decreased. Class IV hemorrhage is considered a loss of 40% or more of blood volume or end organ failure. Anxiety may also indicate early hypovolemia.

Take-Home Message

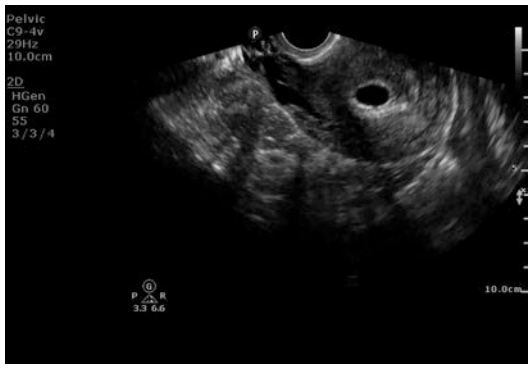
Free fluid on FAST examination after a patient experienced trauma and requires OR mobilization immediately.

ABP Content Specification

- Know indications for and interpret findings of ultrasonography following blunt abdominal trauma.
- Know the indications and contraindications for focused access with sonography for trauma (FAST).
- Understand the role of ultrasound in the management of a major trauma patient.

Question 7

A 15-year-old girl presents with suprapubic and back pain. She reports a history of STDs and unprotected sex. Her LMP was 2 months ago. She is hemodynamically stable but with suprapubic tenderness on examination. There is no vaginal bleeding and the cervical os is closed. Her bedside US is shown below. Further evaluation includes all of the following *except*:



A. Request obstetric/GYN consultation and obtain official ultrasound.
B. Wait for her beta-hCG to determine best treatment.
C. Place two large bore IVs and place on a monitor.
D. Send type and screen to find out Rh status.
E. Patient education at bedside.

Correct Answer: B

Discriminatory beta-hCGs have no place in ED evaluations; however, it may aid in OB follow-up. If an ectopic pregnancy is suspected on the basis of clinical examination and history, the patient should be evaluated emergently by OB and an official ultrasound should be obtained. An IV access should be established and the patient should be carefully monitored because of the risk for rupture. Rh status should be determined during early pregnancy in case bleeding ensues. A definitive intrauterine pregnancy includes a gestation sac with a yolk sac present, a fetal pole, or fetal heart tones. Depicted in this image is a simple gestational sac; therefore, further evaluation is needed. Evaluation of the uterus may be completed using a transabdominal or transvaginal approach, although transvaginal ultrasounds are more sensitive during early pregnancy.

Take-Home Message

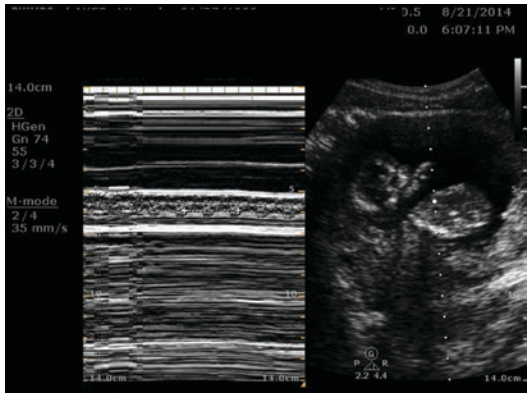
The absence of an IUP yields more concern for an ectopic in early pregnancy rather than a specific quantitative beta-hCG value.

ABP Content Specification

- Know the indications for and interpret results of ancillary studies in patients with ectopic pregnancies.
- Provide management for a patient with an ectopic pregnancy and the potential complications of this condition.

Question 8

An 18-year-old female was evaluated and treated for nausea, vomiting, and epigastric pain intermittently. She also has had 4 months of amenorrhea. She has not had any pelvic pain or vaginal bleeding. She has no history of pelvic infections or surgeries. She has not been to a doctor for at least 1 year. You obtain a bedside ultrasound. Which of the following is true?



A. The patient requires emergent OB evaluation.
B. The patient should be discharged with a follow-up with their primary care provider.
C. Quantitative beta-hCG must be ordered to determine pregnancy status.
D. Her urine should be checked for urinary tract infection and the patient should be treated for hyperemesis.
E. Evaluation of fetal heart tone (FHT) is most important with regard to the clinical evaluation.

Correct Answer: D

The patient is pregnant with most likely hyperemesis and/or a urinary tract infection. A well-formed fetus is seen on bedside transabdominal ultrasound. The fetus also has a strong heartbeat as evaluated by M mode as depicted in the image. According to ALARA (as low as reasonably achievable), radiological safety principle fetal heart tone should be evaluated by M mode with the lowest energy output rather than pulse wave or color Doppler. Evaluation of FHT using Doppler or pulse wave in the rat model has been shown to be correlative with endocardial cushion defects. In the absence of abdominal tenderness or bleeding, there is no need for emergent OB evaluation in the setting of an IUP on bedside sonogram. Beta-hCG will not contribute to evaluation of any emergent conditions in this setting. OB follow-up should be arranged if emesis can be controlled and patient is tolerating p.o. in the department.

Take-Home Message

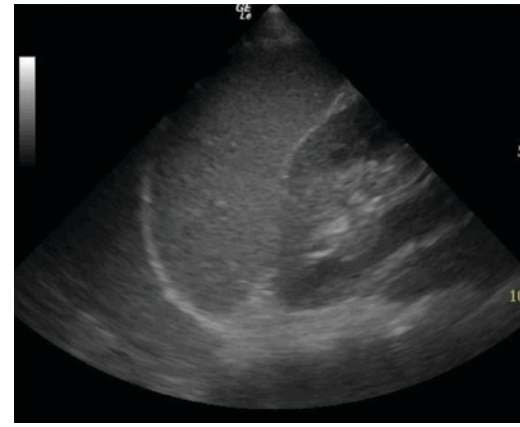
UTI and hyperemesis are very common during pregnancy. The patient must be ruled out for pyelonephritis and tolerating oral intake before discharge from the department; otherwise, the patient should be admitted.

ABP Content Specification

- Recognize and interpret relevant laboratory and imaging studies for urinary infections.

Question 9

A 6-year-old boy riding a bicycle was hit by a car and fell over the handlebars. He is complaining pain in epigastrium. His vital signs are stable. On exam he has ecchymosis and tenderness in the epigastrium as well as tenderness in the right flank. Bedside ultrasound is shown below. There are 10 RBCs in the urine. Definitive management consists of.



A. Calling for a trauma consult in preparation of emergency laparotomy.
B. Ordering a CT scan with IV contrast to evaluate for solid organ injury.
C. Obtaining serum lipase level.
D. Administering a fluid bolus and pain medications with expectant management.
E. Discharging home with good patient education.

Correct Answer: B

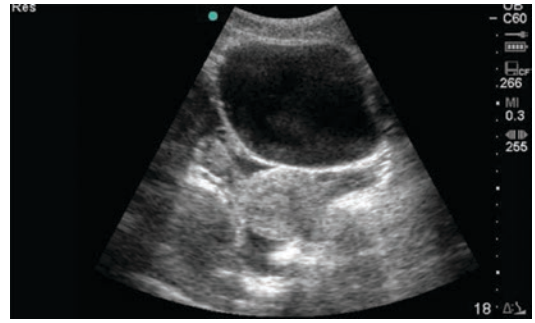
The patient has epigastric and flank pain/tenderness after falling off a bicycle and being hit by a car. Depicted are the RUQ portions of the FAST examination. It seems unremarkable, but there are some limitations with regard to this evaluation as inferior pole of right kidney is not shown. There is no blood in Morison's pouch, which is the most sensitive region to detect blood in the peritoneum. As per mechanism, examination, and laboratory results, you should be concerned about retroperitoneal injury, which will not be detected by US. This patient will require a CT scan. This patient is hemodynamically stable and there is no indication for emergent laparotomy. Lipase is an adjunct to your evaluation. Fluid bolus and pain management is indicated but is not definitive.

Take-Home Message
Even though an initial FAST examination is negative in the setting of trauma, further evaluation is required when clinical examination and mechanism indicate.

ABP Content Specification
- Know indications for and interpret findings of ultrasonography following blunt abdominal trauma.
- Know common patterns and mechanisms of abdominal injury in children with blunt trauma.

Question 10

A 15-year-old girl presents with pelvic cramping. Her last menstrual period was 2 months ago. She has no history of sexually transmitted disease or previous pelvic pain. She is sexually active with her boyfriend. On examination, she is hemodynamically stable but is tender in the suprapubic region. Her bedside abdominal ultrasound is below. Her urine pregnancy test is positive. What is the next course of action?



A. Place two large-bore IVs, order official ultrasound, and call for an OB consult.
B. Call obstetrics/GYN service for emergent evaluation in the ED.
C. Conduct a pelvic examination.
D. The patient can be discharged in stable condition.
E. Test for hepatitis.

Correct Answer: B

The patient is hemodynamically stable at this time; however, the suprapubic portion of her FAST examination is positive for free fluid. The uterus is also depicted on this bedside US examination. There is no IUP visualized. In absence of a definitive intrauterine pregnancy, OB must be contacted for an emergency evaluation in the ED due to a high suspicion of ectopic pregnancy. Establishing two large-bore IVs is also appropriate in this setting; however, the patient should not leave the ED for further imaging at this time. A Pelvic examination is unlikely to yield more information. The patient has free fluid on her ultrasound and should not be discharged. She requires evaluation from OB in the ED.

Take-Home Message
Pregnant patients who present with acute pain and free fluid in the abdomen require immediate OB evaluation and OR mobilization.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to ultrasound evaluation of potential ectopic pregnancy.
- Know the indications and contraindications for ultrasound evaluation of potential ectopic pregnancy.

Suggested Reading

Question 1

Moore C, Todd WM, O'Brien E, Lin H. Free fluid in Morison's pouch on bedside ultrasound predicts need for operative intervention in suspected ectopic pregnancy. Acad Emerg Med. 2007;14(8):755–8.

Question 2

Hsu JM, Joseph AP, Tarlinton LJ, Macken L, Blome S. The accuracy of focused assessment with sonography in trauma (FAST) in blunt trauma patients: experience of an Australian major trauma service. Injury. 2007;38(1):71–5.

Question 3

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Dart RG, Dart L, Mitchell P, Berty C. The predictive value of endometrial stripe thickness in patients with suspected ectopic pregnancy who have an empty uterus at ultrasonography. Acad Emerg Med. 1999;6(6):602–60.

Question 4

Dart R, Dart L, Mitchell P. Normal intrauterine pregnancy is unlikely in patients who have echogenic material identified within the endometrial cavity at transvaginal ultrasonography. Acad Emerg Med. 1999;6(2):116–20.

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Question 5

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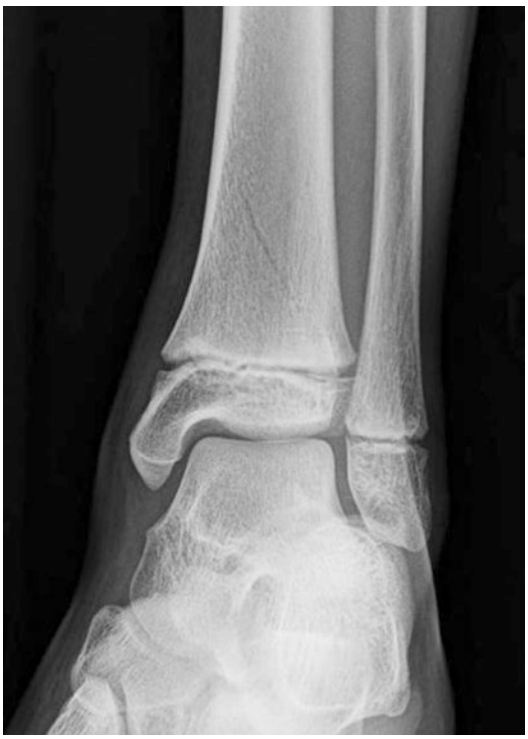
Orthopedics

26

Neal Patrick Johnson, Mike Gardiner,
Michael Gorn, and Sheryl Yanger

Question 1

A 10-year-old boy presents to the emergency department with ankle swelling and tenderness after falling from a tree from a height of approximately 5 feet. His radiograph is shown below. What classification of fracture is shown?



A. Salter–Harris I
B. Salter–Harris II
C. Salter–Harris III
D. Salter–Harris IV
E. Salter–Harris V

Correct Answer: A

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_26

This child has a presumed Salter–Harris type I fracture involving the physis. Pediatric fractures involving the physis (growth plate) can have long-term effects on future growth if not promptly identified and treated. Salter–Harris classification categorizes these fractures on the basis of the involvement of the metaphysis, physis, and epiphysis. Classification guides therapy and prognosis. Generally, prognosis worsens from Salter–Harris type I to type V injuries. The rate of growth disturbance is approximately 30% for all types, but only 2% result in significant functional disturbance.

- Type I: Fracture running horizontally through the physis
- Type II: Fracture involving a portion of the physis and extending through the metaphysis
- Type III: Fracture involving the articular surface through the epiphysis and then exiting through a portion of the physis
- Type IV: Fracture across metaphysis, physis, and epiphysis
- Type V: Crushing injury to the physis

In the image above, there are no obvious fractures of the metaphysis or epiphysis, ruling out a Salter–Harris types II, III, and IV.

Negative X-ray findings do not rule out a Salter–Harris type I or type V fracture. In the presence of swelling and tenderness overlying a bony physis with a negative radiograph, type I injury should be presumed. In the presence of physeal swelling, tenderness and a mechanism involving significant axial loading, a type V fracture should be suspected.

Salter–Harris fracture classification

Salter type	Fracture location	"SALTER"	Prognosis
I	Epiphyseal slip	*S*lipped or straight across	Excellent, non-operative
II	Portion of the physis extending through the metaphysis	*A*bove	
III	Portion of the physis and epiphysis	*L*ower	Often unstable, often surgical
IV	Across metaphysis, physis, and epiphysis	*T*hrough or two	Prone to limb length discrepancies (surgery indicated)
V	Compression injury of physis	*ER*asure of growth plate	

Take-Home Message
Suspect Salter–Harris I fracture if there is tenderness over a physis, even with normal radiographs.

Image(s)
Courtesy of Robert Vezzetti

ABP Content Specification
- Know the five types of physeal fractures defined by the Salter–Harris classification system.
- Plan the management of epiphyseal injuries.

Question 2

A 13-year-old boy presents to the emergency department with right knee pain for the last 3 weeks. His mother informs you that he has played in multiple soccer tournaments over the past few weeks and after his game today, he had worsening pain and his knee is now swollen. The patient denies any injury and tells you his pain has improved since he arrived at the ED 2 hours ago. On examination, the patient has tenderness to the right anterior proximal tibia. There is no appreciable warmth or joint effusion noted, and pain is elicited with extension of both knees against resistance. Bilateral hip examination is unremarkable. What is the appropriate next step in the management for this patient?

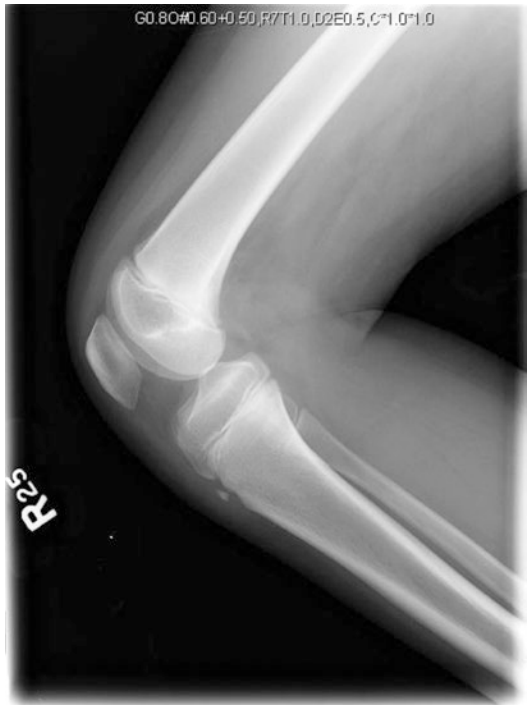
A. Arthrocentesis of right knee with synovial fluid analysis
B. Knee immobilizer and follow-up with an orthopedic surgeon
C. Immediate orthopedic surgery consultation

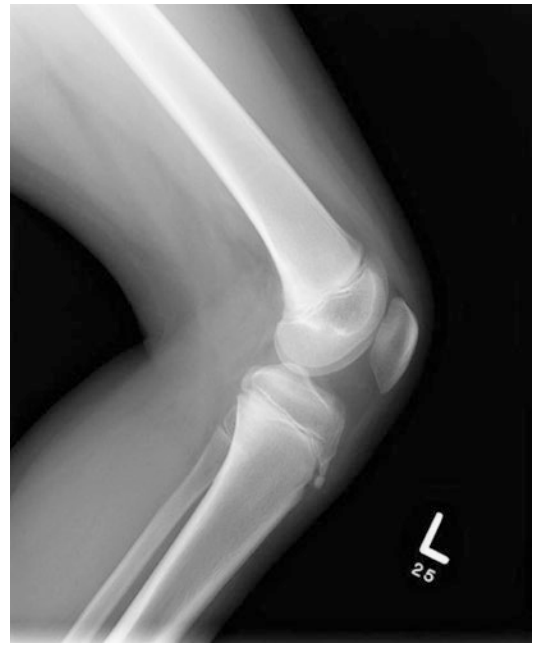
D. Nonsteroidal anti-inflammatory medication and follow-up with pediatrician
E. Obtain radiographs of both knees with sunrise view

Correct Answer: D

This child has Osgood–Schlatter disease, which is a developmental disturbance characterized by osteochondritis of the tibial tuberosity due to repeated strain at the quadriceps muscle tendinous insertion site into the tuberosity (apophysitis). These patients present with tenderness, pain, and swelling at the site of insertion of the patellar tendon on the tibial tubercle.

The disease is typically seen in boys aged 10–15 years and girls aged 8–13 years at the time of growth spurt. Although usually unilateral, Osgood–Schlatter disease can present bilaterally in 30% of patients. Contraction of the quadriceps against resistance usually reproduces pain.





The diagnosis is clinical and imaging is not routinely required. If imaging is obtained, plain radiographs are often normal. More severe cases may demonstrate findings shown in the image above including edema of the patellar tendon or abnormalities in the area of the tibial tuberosity.

Treatment of Osgood–Schlatter disease, like other overuse injuries, generally involves NSAIDs, ice after exercise, and modification or reduction of activities. Following prolonged avoidance of activity, quadriceps stretching and hamstring strengthening reduce the rate of reinjury. Ninety percent of patients respond to conservative therapy. Complete recovery without residual pain or weakness generally occurs. In rare cases, a 2- to 3-week trial of nonweight bearing may be appropriate. Steroid injections are not recommended because of the risk of patellar tendon rupture.

Take-Home Message

Diagnosis of Osgood–Schlatter disease is clinical. Imaging is not generally necessary for diagnosis.

Image
Courtesy of Dr. John Amodio, Cohen Children's Medical Center, New Hyde Park, New York

ABP Content Specification
- Plan the management of repetitive stress injuries.

Question 3

A 6-week-old girl is brought to the ED by her mother due to a diaper rash that has not improved with an over-the-counter diaper rash ointment. During your physical examination, you notice when you flex the hips and knees to 90°, while applying pressure anteriorly to the greater trochanter and abducting the leg, you feel a clunk. You notice asymmetry to the skin folds of the infant's thighs. The infant is moving both lower extremities well. After completing the rest of the physical examination and appropriately addressing the mother's concerns of the rash, you explain your clinical examination findings and discuss the need for additional workup. What is the best next step in confirming the diagnosis?

A. Bilateral knee radiograph
B. Bone scan
C. Pelvic CT scan
D. Pelvic radiograph
E. Pelvic ultrasound

Correct Answer: E

This child's presentation is consistent with developmental dysplasia of the hip (DDH). DDH is the displacement of the femoral head from the acetabulum, usually due to a poorly formed acetabular fossa during development; this leads to subluxation of the femoral head. DDH is often found prior to 2 months of age but can be easily missed. Missed cases of DDH often are uncovered when the child has delayed ambulation or has a limp with the onset of walking. Children with DDH often have asymmetric skin folds and limb shortening on presentation in the first few months of life. The strongest risk factors for DDH are female gender, breech position, and family history of DDH.

All infants in the ED should be evaluated for DDH by using the Ortolani and Barlow maneuver. The Ortolani maneuver is performed by flexing the hips and knees to 90°, applying pressure directed anteriorly to the greater trochanter while abducting the legs. If a "click" or "clunk" is felt or heard, it is considered positive for dislocation and relocation of the hip. The Barlow maneuver is performed by flexing the hip to 90° and adducting the hip while applying pressure posteriorly on the knees. If a "click" is heard or felt, the test is positive.

Confirmatory testing for DDH depends on the age of the child. Infants less than 6 months of age require ultrasound to confirm the diagnosis (*see indications below*), given that the acetabulum and femoral head will not be sufficiently ossified at this age to assess for appropriate joint alignment. If the child is older than 6 months, a pelvic radiograph will confirm diagnosis. DDH on pelvic radiograph will appear with the dislocated hip located lateral and superior to the appropriately located hip. The technique for determining appropriate hip placement from plain film involves drawing horizontal lines along the inferior pelvis (triradiate epiphysis) and vertical lines along the lateral acetabulum. In a properly located hip, the femoral epiphysis (femoral head) will be located in the inferomedial quadrant formed by these lines, whereas a dislocated hip will fall elsewhere. Referral to an orthopedic surgeon is appropriate for suspected and confirmed cases of DDH. A missed diagnosis of DDH can result in delayed onset of walking and gait abnormalities. Usual treatment involves placement of a Pavlik harness to forcibly maintain proper positioning of the femoral head in the acetabulum for 6–12 weeks.

Indications for ultrasound screening of the infant hip at 4–6 weeks include:

1. Abnormal findings on physical or imaging examination of the hip
2. Monitoring of patients with DDH treated with a Pavlik harness or another splint device
3. Family history of DDH
4. Breech presentation regardless of sex
5. Oligohydramnios and other intrauterine causes of postural molding
6. Neuromuscular conditions

Take-Home Message
Asymmetric skin folds and limb shortening in an infant less than 2 months of age should raise suspicion for developmental dysplasia of the hip. Barlow and Ortolani maneuvers should be performed on all infants in the ED as a part of routine examination. In children younger than 6 months of age, pelvic ultrasound is the imaging method of choice to confirm diagnosis, while in older children plain film radiographs will confirm the diagnosis.

ABP Content Specification
- Know how to evaluate and manage congenital dislocation of the hip.

Question 4

An 11-year-old obese boy is brought by his mother for left knee pain for 1 month. The patient denies any trauma. The pain is described as dull and achy, nonradiating, and made worse when he walks up stairs. On examination, the patient is noted to have an antalgic gait favoring his left side. His left knee is unremarkable with no swelling, tenderness, and full range of movement. On examination of his left hip, passive flexion causes his leg to abduct and externally rotate. On passive range of motion, the patient is unable to completely flex or internally rotate his left hip, limited by stiffness and pain. What imaging will reveal the most likely diagnosis:

A. Three-view plain radiographs of left knee joint
B. MRI of left knee
C. AP and lateral views of left hip joint
D. AP and frog leg views of the pelvis
E. CT left hip joint

Correct Answer: D

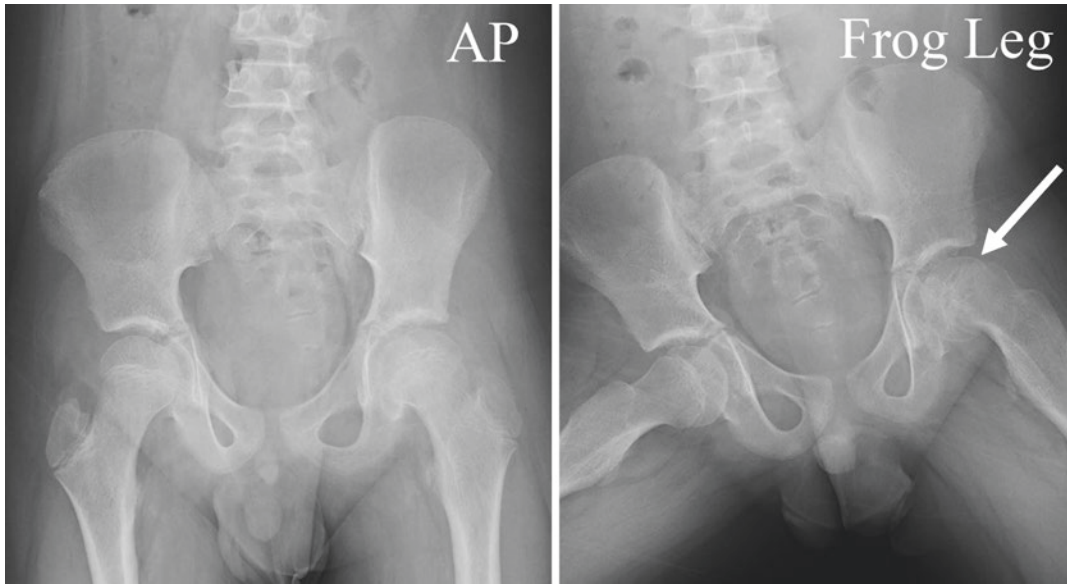
Slipped capital femoral epiphysis (SCFE) is characterized by slipping of the femoral epiphysis of the hip. Most often, there is no associated trauma.

This may be related to the rapid growth during this age. SCFE is a Salter–Harris type I fracture caused by the displacement of the femoral neck relative to the femoral head (epiphysis) at the femoral physis. This fracture most commonly occurs with the femoral neck becoming displaced anterolaterally and superiorly relative to the femoral head.

Most commonly, it occurs at the onset of puberty in obese children. This should be suspected in children under the age of 10 years with certain endocrinopathies such as hypothyroidism, excess growth hormone, hypopituitarism, and hypogonadism. Therefore, one should evaluate for these endocrine abnormalities in younger children. Down syndrome is also associated with SCFE. The contralateral side may be involved in up to 25% of cases.

Clinical presentation includes child hip (groin) pain, thigh pain or, knee pain. Knee pain may be the only symptom in 10–15% of cases.

The hip is often held in passive external rotation. When passive flexion of the hip on the affected leg produces leg abduction and external rotation, this finding is very suggestive of SCFE. If SCFE is suspected, they should be placed on non-weight-bearing status.



Obtain AP and frog-leg views of the pelvis (choice D), which is diagnostic in most of cases. A positive finding on X-ray shows the femoral head "falling off" of the femoral neck (often referred to as ice cream falling off the cone). This is not actually the case as the femoral head remains in the acetabulum and SCFE is really caused by anterolateral and superior displacement of the femoral neck.

Diagnosis is supported by drawing "Klein's line" along the superior aspect of the femoral neck. In a hip, this line will intersect the femoral epiphysis in the lateral–superior aspect of the epiphysis, whereas this line will not intersect the epiphysis in cases of SCFE. Often, AP films do not show the findings of SCFE, which is why frog-leg views are necessary, as demonstrated in the image earlier. Early in the course of the disease, plain radiograph may be normal, and MRI (choice E) may be necessary for diagnosis. MRI is the most sensitive test for identifying early disease. However, MRI is generally reserved when plain films are nondiagnostic, or for monitoring the contralateral hip in patients with unilateral SCFE. CT may be helpful in severe SCFE to help plan appropriate surgical approach but is not indicated for initial diagnosis.

Take-Home Message

The physician should have a high index of suspicion for slipped capital femoral epiphysis in obese adolescents presenting with hip or knee pain. AP and frog-leg views of the pelvis are usually diagnostic for SCFE, showing the femoral head "falling off" of the femoral neck and a "Klein's Line" drawn along the superior femoral neck that does not intersect the femoral head.

Images

Courtesy of Robert Vezzetti

ABP Content Specification

- Know the etiology and understand the pathophysiology of slipped capital femoral epiphysis.
- Recognize the signs and symptoms of slipped capital femoral epiphysis.

Question 5

A 14-year-old boy presents to the emergency department with left wrist pain and swelling that began suddenly after a fall while snowboarding the day prior. He fell backward onto an outstretched hand and immediately became

nauseated after hitting the snow. On examination, his left wrist is swollen with normal range of motion. Pain is elicited when the patient pinches his thumb and index finger together ("OK" sign) as well as tender to palpation between the extensor pollicis longus and extensor pollicis brevis. The remainder of his neurovascular examination of the hand is normal. The radiographs of the wrist, including lateral, oblique, and PA views, show no fracture. What is the appropriate management for this patient?

A. Radial gutter splint with repeat radiograph in 7–10 days
B. Rest, ice, elevation, nonsteroidal anti-inflammatories
C. Thumb spica splint with repeat radiograph in 7–10 days
D. Ulnar gutter splint with orthopedic follow-up in 1–2 weeks
E. Volar wrist splint with orthopedic follow-up in 1–2 weeks

Correct Answer: C

This patient has an occult scaphoid fracture. The scaphoid is the most commonly fractured carpal bone and injuries may occur following falls on the outstretched hand, causing hyperextension of the wrist. Tenderness over the anatomic snuffbox (between the extensor pollicis longus and brevis tendons) is 90% sensitive for detecting a scaphoid fracture. If scaphoid fracture is suspected, along with routine plan radiographs, an ulnar-deviated scaphoid view should be obtained (not obtained in the patient above). Even with appropriate imaging, up to 30% of scaphoid fractures may not be seen initially. Fractures may take up to 1–2 weeks to become evident on imaging. Appropriate treatment for suspected occult scaphoid fracture is immobilization with a thumb spica splint. Follow-up for reexamination and repeat radiographs should occur after 7–10 days.

If no fracture is present on an initial X-rays, but there is a high index of suspicion for a scaphoid fracture, then place the patient on a short-arm thumb spica splint and advice follow up in 2 weeks. If repeat X-rays are negative but the patient continues to have scaphoid pain, an MRI or a CT scan should be obtained. Radiographically nondisplaced scaphoid fracture treatment depends on the location of the fracture.

Distal scaphoid fractures can be managed with a short-arm thumb spica splint and appropriate follow-up with orthopedics. For a mid-body or proximal scaphoid fracture, a long-arm thumb spica splint should be applied and followed up with a hand surgeon in 5–7 days. Proximal-third fractures should be immobilized from 12 to 20 weeks.

Displaced scaphoid fractures require more aggressive treatment due to a significant rate nonunion. Displacement of 1 mm or more, or greater than 15° of angulation, is an absolute indication for internal fixation.

Since the blood supply to the scaphoid is distal to proximal, scaphoid fractures are harder to heal than other carpal fractures. Avascular necrosis (AVN) is a common complication, occurring in up to 30% of proximal scaphoid fractures.

Take-Home Message

Patients presenting with a "sprained wrist" and tenderness over the anatomical snuffbox should be presumed to have an occult scaphoid fracture. If radiographs are negative for fracture, splinting and follow-up radiograph are warranted in 7–10 days.

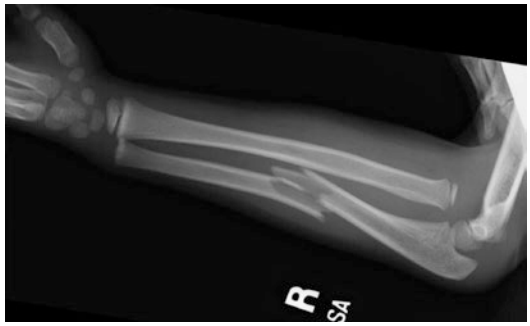
ABP Content Specification

- Know and understand the mechanism of injury of navicular fractures.
- Plan the management of a child with a navicular fracture.

Question 6

An 8-year-old girl fell from a swing onto an outstretched right arm. She presents to the emergency department with pain in the right elbow and forearm. The mother denies head injury or history of nausea or vomiting. On examination,

the right proximal forearm is markedly swollen and tender. A bony structure is palpable on the anterior–proximal forearm. The right hand, snuffbox, humerus, and clavicle are nontender. She is unable to pronate, supinate, flex, and extend at the elbow. Distally, she is neurovascularly intact and can move all fingers without pain. Radiographs are obtained and shown below.



What is the most likely diagnosis?

A. Colles fracture
B. Essex-Lopresti fracture
C. Galeazzi fracture
D. Maisonneuve fracture
E. Monteggia fracture

Correct Answer: E

This child has a Monteggia fracture defined as an ulnar fracture associated with radial head dislocation at the proximal radioulnar joint. There are four types of Monteggia fractures (*see* Table 26.1). Monteggia fractures account for less than 5% of forearm injuries. This fracture is usually associated with a fall on an outstretched hand with forced pronation and an extended elbow. When the ulna fractures, it causes energy to dissipate along the interosseous membrane proximally, leading to displacement of the proximal radioulnar joint. In a small number of cases, injury to the radial nerve has been reported; this usually self-resolves in 4–6 months.

Patients usually present with elbow pain and swelling, limited range of motion, and paresthesia or numbness. Immediate evaluation by an orthopedist is imperative. Treatment depends on the type of fracture (*see* Table 26.2). Closed fracture should generally be reduced within 6–8 hours to decrease the risk of permanent articular damage or further nerve injury. Open fractures will require emergent orthopedic consultation and likely operation.

Colles fracture (choice A) is a fracture of the distal radius. The Essex-Lopresti fracture (choice B) is a comminuted fracture of the radial head accompanied by a dislocation of the distal radioulnar joint. Galeazzi fracture (choice C) is a fracture of the radius with dislocation of the distal radioulnar joint. In the ED, this requires a long-arm splint with the wrist in full supination.

Maisonneuve fracture (choice D) is a spiral fracture of the proximal fibula and ankle injury usually causing distal tibiofibular syndesmosis or malleolar fracture.

Table 26.1 Monteggia classifications

Type	Dislocation	Fracture
I	Anterior	Metaphysis–diaphysis
II	Posterior	Metaphysis–diaphysis
III	Lateral	Metaphysis
IV	Anterior	Radial diaphysis, ulnar diaphysis
Hybrid lesion	Anterior, posterior, or lateral	Metaphysis or olecranon

Table 26.2 Treatment of Monteggia fracture

Type of ulnar injury	Treatment
Plastic deformation	Closed reduction of the ulnar bow and cast immobilization
Incomplete (greenstick or buckle) fracture	Closed reduction and cast immobilization
Complete transverse or short oblique fracture	Closed reduction and intramedullary K-wire fixation
Long oblique or comminuted fracture	Open reduction and internal fixation with plate and screws

Take-Home Message

An ulnar fracture with a radial head dislocation is known as a Monteggia fracture. Monteggia fractures require prompt identification and immediate orthopedic consultation.

Image(s)

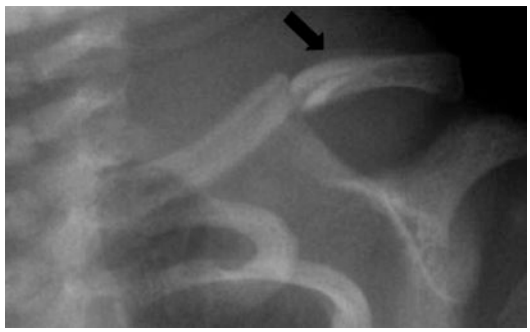
Courtesy of Robert Vezzetti

ABP Content Specification: Monteggia Fracture

- Know and understand the mechanisms of injury.
- Recognize a child with fracture.
- Plan the management of a child with fracture.

Question 7

A mother presents to the emergency department with her 7-day-old daughter after she noticed she was not moving her left arm and had a lump over the anterior left shoulder. The mother states that her pregnancy was complicated by gestational diabetes. She boasts that she was able to deliver her daughter vaginally even though the newborn weighed 10 pounds and 3 ounces. On examination, a palpable mass is noted over the left clavicle. The infant has minimal movement of the left upper extremity compared to the right. Both extremities appear well perfused with no other deformities or abnormal arm positioning. A radiograph was obtained. What is the appropriate next step in management?



A. Closed reduction followed by immobilization for 4–6 weeks
B. Immobilization for 2 weeks, follow-up with pediatrician
C. Notification of child protective services
D. Neurologist consultation
E. Orthopedic consultation

Correct Answer: B

The child above has a left middle third clavicular fracture. Fracture of the clavicle is the most common obstetrical fracture type, occurring in 1–13% of all births. Incidence is higher for larger-birth weight infants and deliveries requiring instrumentation or forced maneuvers. Identification of the fracture may be difficult. Sometimes deformities are not evident or are subtle. A mass or swelling may become evident in the first few weeks of life due to callus formation.

Infants can present with upper extremity palsy secondary to brachial plexus injury or "pseudoparalysis." Pseudoparalysis happens when an infant is hesitant to move his or her extremity due to pain. Clavicular radiographs will usually confirm the diagnosis, though are not uniformly necessary if the examination is otherwise diagnostic. Birth-related clavicular fractures are generally nonoperative. Typically, immobilization for up to 2 weeks and follow-up with a pediatrician for reevaluation of upper extremity movement is warranted. Immobilization can be obtained in infants by using a safety pin to attach a long shirt-sleeve to the shirt. Parents should not unnecessarily manipulate the extremity. Evolution of a mass over the clavicle is common and may take up to 6 months to resolve. Most brachial plexus injuries will resolve spontaneously, but follow-up is important to monitor signs of improvement.

Diagnosis of clavicular fracture in older children is usually straightforward. Mechanism of injury is commonly from a fall onto the shoulder or direct blow injury. Brachial plexus injuries are not common. Treatment involves immobilization with a sling for 3–4 weeks or less commonly a figure-of-eight splint.

Summary of fracture locations and management:

- Proximal third: Uncommon, risk for great vessel injury, orthopedic consultation warranted
- Middle third: Most common location, sling/shoulder immobilizer for 3–4 weeks, routine follow-up
- Distal third: Uncommon, nondisplaced need immobilization, displaced fractures may need orthopedic consultation

Closed reduction (choice A) is only indicated for sternoclavicular dislocation after orthopedic consultation. Child protective services (choice B)

should be notified in cases when nonmobile older children present with clavicular fractures or the mechanism of injury is unclear. Neurology consultation (choice D) is rarely indicated because of the high probability that the palsy will resolve on its own. Orthopedic consultation (choice E) is not routinely indicated in clavicle fractures, particularly middle third fractures. Orthopedic consultation is indicated in medial and displaced distal clavicular fractures, sternoclavicular dislocations, open fractures, or significantly tented skin.

Take-Home Message

Clavicular fractures are common and routinely do not require intervention. Upper extremity palsy is usually self-resolving but should be reevaluated by a pediatrician.

Image

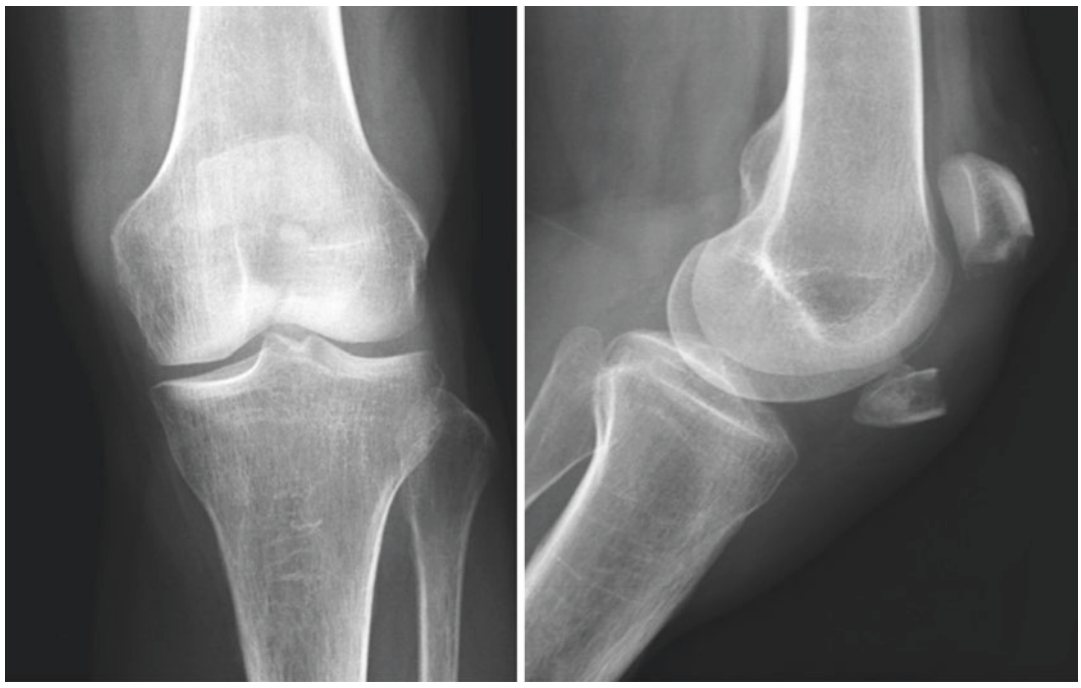
Fadell M, Miller A, Trefan L, Weinman J, Stewart J, Hayes K, Maguire S. Radiological features of healing in newborn clavicular fractures. Eur Radiol. 2016. https://doi.org/10.1007/s00330-016-4569-y.

ABP Content Specification: Clavicular Fracture

- Know and understand the mechanisms of injury.
- Recognize a child with fracture.
- Plan the management of a child with fracture.

Question 8

A 14-year-old boy involved in a motor vehicle accident presents to the emergency department via ambulance with complaints of right knee pain. EMS notifies you that the patient's vehicle struck a parked car at 20 mph. He was ambulatory on scene with an obvious limp and had no head injury or loss of consciousness. The patient remembers the accident and states "my leg hit the dashboard really hard." He otherwise has no complaints. Physical examination is remarkable for normal vital signs and a swollen and tender anterior right knee without any obvious lacerations. Straight leg raise against gravity is attempted but stopped because of pain and he is unable to ambulate secondary to pain with weight bearing. There is no hip tenderness or other deformity of the distal right extremity. Radiographs are obtained and shown below. What is the appropriate management for this patient?



A. Compression bandage, rest, ice, and analgesia
B. Knee immobilizer, rest, ice, and analgesia for 4–6 weeks
C. Knee immobilizer, rest, ice, and analgesia with referral to orthopedist for an early open reduction with internal fixation
D. Long leg cast
E. Emergent washout and open reduction with internal fixation

Correct Answer: C

The patient above has a transverse patella fracture. Patella fractures in children are less common than those in adults. There are multiple types of patellar fractures with transverse fractures being the most common. The most common mechanisms of injury are direct blows or sudden contraction of the extensor mechanism or both. Patients usually present with a swollen and tender anterior knee. Knee extension and weight bearing may not be possible. The integrity of the extensor muscle can be checked by having the patient perform a straight leg raise against gravity. Complete distal patella avulsion may cause visual elevation of the patella during contraction of the quadriceps as well as an inability to extend the knee or perform straight leg raise. For suspected patellar injuries, three-view plain film radiographs, including a sunrise view, should be obtained.

Most patellar fractures are managed nonoperatively. However, in cases with displacement of >3 mm, step-off of >2 mm, or disruption of the extensor mechanism, open reduction with internal fixation (ORIF) is indicated. ORIF can generally be performed as an outpatient after the knee is immobilized and the patient is given instructions for rest, ice, and analgesia. The above radiographs reveal a fracture with significant displacement that will require ORIF. Open patellar fractures with significant displacement will require antibiotic coverage, urgent washout, and ORIF (choice E). The patient in this vignette does not have evidence of an open fracture and can potentially be managed as an outpatient.

Compression bandages (choice A) may be appropriate for knee sprains but would not be indicated for fracture management. Knee immobilization alone (choice B) may result in nonunion of the patella. While long leg casting (choice D) and MRI may be performed as a part of this patient's future management, neither of these is indicated as a part of the emergency department management.

Take-Home Message

Patellar fractures resulting in a displacement of >3 mm, step-off >2 mm, or a disruption of the extensor mechanism require orthopedic consultation for open reduction.

Image(s)

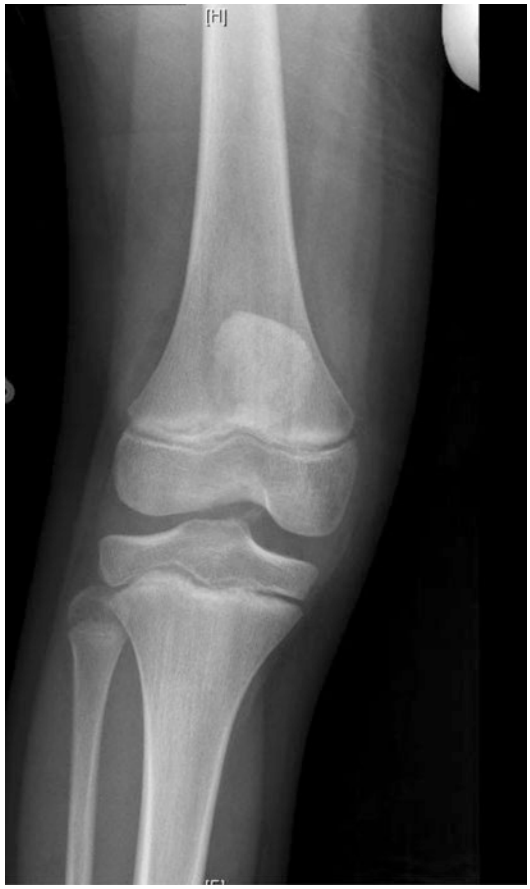
Gwinner C, Märdian S, Schwabe P, Schaser K-D, Krapohl BD, Jung TM. Current concepts review: fractures of the patella. GMS Interdisciplinary Plastic and Reconstructive Surgery DGPW. 2016;5:Doc01. https://doi.org/10.3205/iprs000080.

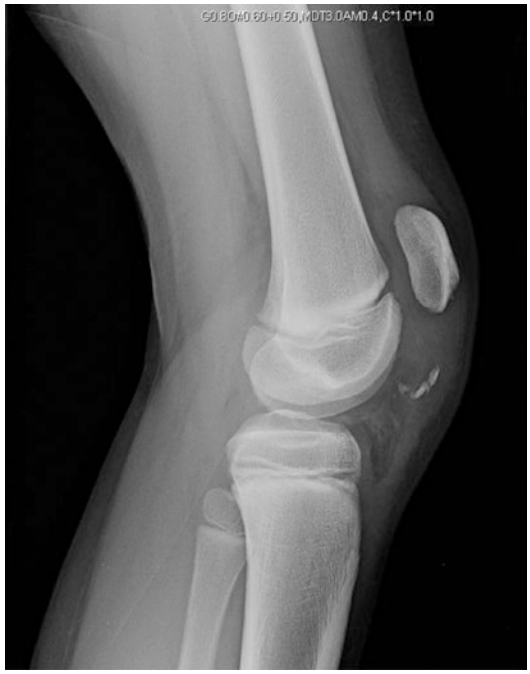
ABP Content Specification: Patellar Fracture

- Know and understand mechanism of injury.
- Recognize a child with a patellar fracture.
- Plan the management of a child with a patellar fracture.

Question 9

A 12-year-old boy presents with right knee pain. What is the most likely mechanism of injury indicated by the radiographic finding below?





A. Congenital abnormality
B. Direct blow to the lateral knee from a football helmet
C. Direct blow to the anterior knee from a motor vehicle accident
D. Onset of pain when turning on a fixed knee
E. Onset of pain during a hurdle jump

Correct Answer: E

The radiograph shown demonstrates "patella alta" (superiorly displacement patella) associated with an ossific fragment that is the typical appearance of a patellar sleeve fracture. Patellar sleeve fractures are unique to the pediatric population usually occurring between the age of 8 and 12 years. The name comes from an avulsion of the distal patellar cartilaginous "sleeve" from the body of the patella. Avulsion occurs when the quadriceps forcefully contracts with the knee in a flexed position. This injury is most common in sporting activities associated with forced jumping motions, such as hurdles. Symptoms may be similar to other patellar fractures, including swelling, tenderness, decreased mobility, and inability to ambulate. In severe cases or cases with complete separation, a palpable gap may be appreciated, and the patella may be high-riding. It is proposed that severity of injury cannot be appreciated by plain films, and that MRI is often indicated if a patellar sleeve fracture is suspected. Treatment is similar to other patellar fractures and should involve consultation with an orthopedic specialist. Patients with intact extensor mechanism and displacement <3 mm can generally be managed nonoperatively, whereas others will require ORIF.

Take-Home Message

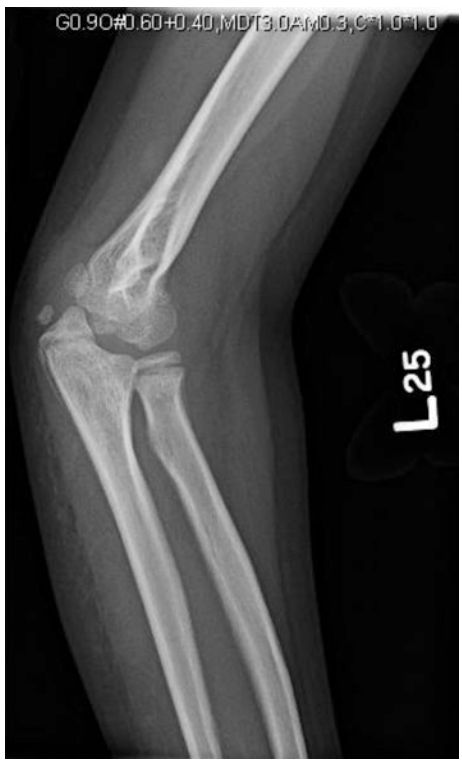
Diagnosis of patellar sleeve fracture may be delayed and should be suspected in a pediatric patient with no history of direct blow injury who is unable to extend the knee or perform straight leg raise. Plain films may be nondiagnostic, and MRI may be necessary. Most patellar sleeve fractures are managed nonoperatively, although cases with displacement of >3 mm or interruption of the extensor mechanism may require surgical repair.

Image(s)
Courtesy of Dr. John Amodio, Cohen Children's Medical Center, New Hyde Park, New York

ABP Content Specification: Patellar Fracture
- Know and understand mechanism of injury.
- Recognize a child with a patellar sleeve fracture.
- Plan the management of a child with a patellar sleeve fracture.

Question 10

A 10-year-old boy presents to the emergency department with his mother for left elbow pain. The mother notifies you that her son has osteogenesis imperfecta but does not receive any treatment. The patient states that he injured his elbow at home when he accidently tripped and fell on the ground onto an outstretched hand. On examination, he appears uncomfortable, with pain and swelling noted to the posterior aspect of the elbow. There is limited extension at the elbow due to pain. He has no forearm or wrist tenderness and is neurovascularly intact. Plain films of his elbow are shown below. What are the most likely diagnosis and appropriate treatment?



A. Capitellum fracture, immobilization with elbow flexed at 45° for 4–6 weeks
B. Capitellum fracture, orthopedic consult with open reduction with internal fixation
C. Radial head fracture, orthopedic consult with open reduction with internal fixation
D. Olecranon fracture, immobilization with elbow flexed at 45° for 4–6 weeks
E. Olecranon fracture, orthopedic consult with open reduction with internal fixation

Correct Answer: D

The patient above has a nondisplaced proximal ulnar (olecranon) fracture. Olecranon fractures usually result from a fall on outstretched hands and less commonly from a direct blow. Although olecranon fractures are not common in the pediatric population, children with osteogenesis imperfecta (OI) are predisposed to this injury. Encountering young patients with olecranon fractures and no past medical history should raise concern for OI or child abuse.

Symptoms of olecranon fracture often involve swelling, tenderness, and decreased mobility of the elbow, particularly overlying the point of the elbow. Depending on severity, it may be possible to palpate crepitus or a defect between the avulsed boney fragments. It is important to obtain radiographs of both the elbow and forearm to evaluate the position of the radial head and neck as an olecranon fracture may be part of a Monteggia fracture dislocation.

Treatment depends on severity of injury. Orthopedic consultation is always warranted with olecranon fractures. If fracture is nondisplaced or displaced <5 mm, immobilization at a 45° flexion should be instituted with follow-up in 4–6 weeks. Displacement >5 mm, unstable fractures, or Monteggia fractures should undergo open reduction with internal fixation.

The capitellum (choices A and B) is the lateral distal articular surface of the humerus. The radial head (choice C) is intact on the lateral view with good position of the epiphyseal plate.

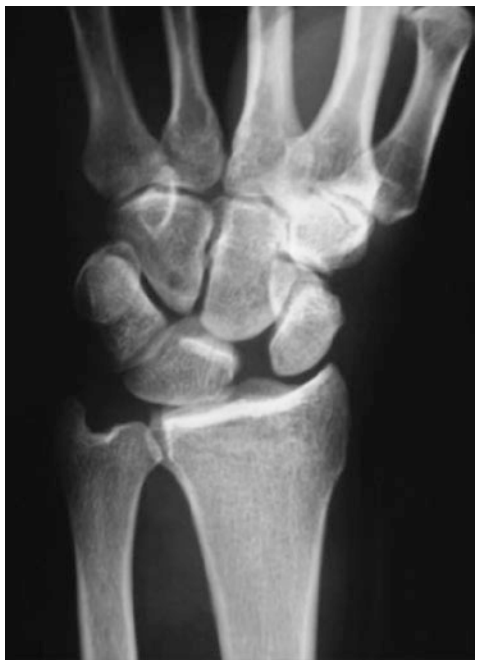
Take-Home Message
Olecranon fractures should involve orthopedic consultation, and if the mechanism of injury is unclear, concern for osteogenesis imperfecta or child abuse is warranted.

Image(s)
Courtesy of Dr. John Amodio, Cohen Children's Medical Center, New Hyde Park, New York

ABP Content Specification: Olecranon Fracture
- Know and understand the mechanisms of injury.
- Recognize a child with fracture.
- Plan the management of a child with fracture.

Question 11

A 16-year-old boy presents to the ED with right wrist pain that began after his football game earlier in the day. He denies any known trauma to the wrist. He states he is a lineman and his job is to push people around throughout the game. He placed ice on his wrist after the game and took an anti-inflammatory drug with minimal relief of his pain. He denies any numbness or tingling in his hand. On examination, he has a notably swollen and tender right wrist, with pain that is accentuated with range of motion. He has no tenderness to the anatomic snuff-box. Radial, median, and ulnar nerves appear intact distally. Capillary refill is 2 seconds. A wrist radiograph is ordered and shown below. What is the most likely diagnosis?

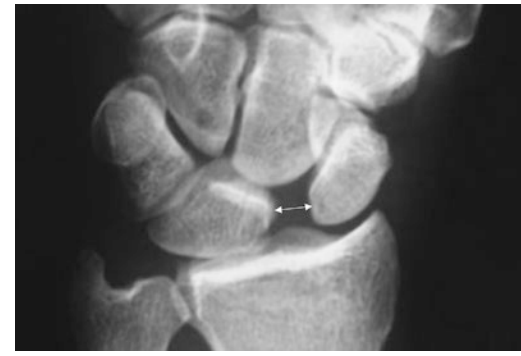


A. Carpal tunnel syndrome
B. Distal radial fracture
C. Lunate fracture
D. Scapholunate dislocation
E. Scaphoid (navicular) fracture

Correct Answer: D

The above is an example of a scapholunate dislocation or dissociation. Injury occurs when the scapholunate ligament ruptures allowing the scaphoid to displace proximally to a more vertical position. This creates a gap between the scaphoid and lunate as seen in the radiograph. Scapholunate dislocations usually occur from trauma to an extended wrist. Scapholunate dislocations are becoming more prevalent in the pediatric population with contact sports and falls. A fall on outstretched hands or repetitive pushing with active forceful extension of the wrist can lead to injury.

Examination will reveal tenderness, swelling, and decreased range of motion. Some patients may mention a "snapping" or "clicking" sound with wrist motion. A scaphoid shift maneuver, also known as "Watson's sign," may provide information about the stability of the scaphoid. The maneuver is done by applying pressure to the scaphoid prominence and with appropriate manipulation determining whether the scaphoid shifts dorsally. Sometimes a "click" can be felt. The maneuver must always be compared to the opposite extremity and may be inconsistent.



Wrist radiographs will show a widening of the scapholunate joint space. A gap of >3 mm is considered abnormal and indicative of dislocation.

Some refer to the widened gap at the "Terry Thomas sign" after the British comedian who had a characteristic large gap between his front teeth.

Treatment involves a thumb spica splint or cast for all patients and early referral to an orthopedic surgeon. Often these patients will eventually need arthroscopic or open repair of the ruptured ligament. Documented complications of this injury include degenerative arthritis with limited range of motion and chronic pain.

Upon close inspection of the radiograph above, there are no obvious fractures noted (choices B, C, and E). Occult fractures should always be in the differential, but considering the mechanism of injury above, a fracture is less likely. Carpal tunnel syndrome (choice A) is not commonly seen in the pediatric population and not typical of the presentation above.

Take-Home Message

The classic "Terry Thomas sign" is indicative of a scapholunate dislocation. This injury often occurs with repetitive trauma to an extended wrist. Most cases of scapholunate dislocation require orthopedic consultation and hand immobilization with a thumb spica splint or cast.

Image(s)

Ross M, Loveridge J, Cutbush K, Couzens G. Scapholunate ligament reconstruction. J Wrist Surg. 2013;2(2):110–5.

ABP Content Specification: Wrist Dislocation

- Recognize a child with this presentation.
- Plan the management of a child with injury.

Question 12

A 2-year-old boy is brought to the emergency department by his mother because of decreased movement of his left arm. The mother states that the child was trying to jump off a table, when she grabbed his left wrist and lowered him down to the ground. She states he immediately cried and quickly calmed, but has not moved his left arm since that time. The mother is in tears and admits she is scared she broke her son's arm. The child is anxious and fearful of the examiner; he is holding his left elbow flexed at 45° with his left forearm held in pronation, refusing to move his left arm. With good distraction, there is no apparent deformity, point tenderness, or swelling to the left forearm or elbow. What is the appropriate next step in management?

A. Plain film radiographs of the left elbow
B. Forced hyperpronation of left forearm
C. Place in a posterior long-arm splint and arrange orthopedic follow-up
D. Compression bandage, ice, rest, and analgesia
E. Reassurance and follow-up with pediatrician

Correct Answer: B

The patient above has radial head subluxation, also known as "Nursemaid elbow." Nursemaid elbow is common in the pediatric population and is caused by a sudden pull of a distal upper extremity with an extended pronated forearm. This mechanism causes the annular ligament to move and become entrapped between the radial head and capitellum. Children usually present without pain, but refuse to use the affected arm.

On examination, there is usually no swelling. The elbow may be flexed or fully extended with the forearm held in slight pronation. Mild tenderness may be noted over the radioulnar joint. Younger children are usually noncompliant and an adequate examination may be difficult. There can be resistance with passive range of motion and pain with rotation of the forearm.

Radiographs are not usually indicated if the clinical picture and history are clear. If the child has a known mechanism of injury that is consistent with radial head subluxation with no focal findings to the arm, imaging is not warranted.

There are two commonly utilized methods for reducing a Nursemaid elbow (see the Table 26.3 below). A randomized trial found that hyperpronation had a greater rate of successful reduction on first attempt than supination flexion. If one reduction technique does not work, then the other should be attempted. Some providers prefer to perform both maneuvers simultaneously with hyperpronation followed by complete supination and flexion. If reduction is attempted, and

Table 26.3 Two common methods for reducing a radial head subluxation

Supination-flexion method	Hyperpronation method
1. Control affected elbow with thumb firmly placed on radial head 2. Grasp patient's wrist with opposite hand 3. Fully supinate the forearm followed by complete flexion of the elbow 4. An audible or palpable pop may indicate reduction	1. Control affected elbow with thumb firmly placed on radial head 2. Grasp patient's wrist with opposite hand 3. Fully extend arm at the elbow 4. Forcibly (though gently) pronate the forearm past neutral 5. An audible or palpable pop may indicate reduction

the child continues not to move his arm 5–10 minutes after the procedure, radiographs should be obtained to evaluate for fracture. Following reduction, some children immediately resume normal use of their arm, while others may cry and may not immediately use their arm but, with observation and encouragement, will resume normal use. Parents should be educated to avoid lifting the child by the wrists as there is an approximately 30% rate of recurrence.

As discussed earlier, in typical cases of radial head subluxation, plain film radiographs (choice A) are generally not indicated. Elbow splinting (choice C) may be warranted if the elbow is fractured, though that is not the case in this vignette. Fractures are less common in the setting of radial head subluxation. R.I.C.E. (choice D) is indicated in an elbow sprain, which usually manifests with swelling. Reassurance (choice E) is not indicated in a child who is still unable to move their arm. Children may spontaneously reduce the elbow and have a normal examination; reassurance can be given at this time.

Take-Home Message

No imaging is indicated with a high clinical index of suspicion of a radial head subluxation with a typical mechanism, no concerning physical examination findings, or history of a fall. Hyperpronation and supination-flexion techniques are both widely used reduction techniques and may be used in combination.

ABP Content Specification: Recognize a child with dislocation (subluxation) of the radial head.

Question 13

A 16-year-old boy involved in a motor vehicle accident presents to the emergency department via ambulance with a complaint of left knee pain. Emergency Medical Services (EMS) notifies you that the patient was the unrestrained driver of a vehicle that struck a tree at 25 mph. He was non-ambulatory on scene. On arrival to the ED, the patient is in a c-collar and appears unconfortable keeping his left knee flexed at a 90° angle. He has significant swelling and deformity to his left knee with a bony structure lateral to the knee, determined to be the patella. After bedside radiographs confirm your suspected diagnosis, you have the patient extend the knee and apply pressure to the lateral aspect of the patella with immediate reduction with rapid improvement in pain. Repeat radiographs show the patella in anatomic position without obvious fracture, and evidence of a joint effusion. Distal neurovasculature is intact. The patient's trauma workup is otherwise unremarkable. What is the appropriate management for his knee injury?

A. Compression, ice, rest, and analgesia and follow-up with pediatrician
B. Knee immobilizer for 2 weeks with orthopedic follow-up
C. Magnetic resonance imaging of knee
D. Orthopedic consultation for early open reduction with internal fixation
E. Therapeutic arthrocentesis of joint effusion

Correct Answer: B

The patient above had an uncomplicated patella dislocation with successful reduction. Patella dislocations are common in adolescents and are frequently associated with sporting events

or, less commonly, trauma. Ninety percent of dislocations are lateral and most spontaneously reduce prior to arrival at the ED. Patellar dislocations can be painful and patients tend to flex the knee, but this makes it difficult for the patellar tendons to relocate the patella medially. If identified, patellar dislocations should be reduced promptly. Analgesia and sedation may be necessary, but in most cases, it delays reduction and prolongs duration of pain.

Reduction is performed by gradually extending the knee and applying pressure on the lateral aspect of the patella pushing medially. The patella often reduces easily. Sometimes the simple movement of extending the knee will cause the patella to spontaneously reduce. A radiograph should be obtained in all patellar reductions to look for osteochondral fractures. Radiographs following reduction will often show evidence of joint effusion, although these are generally self-limiting.

Recommendations for postreduction management of primary patella dislocation are varied. Acute surgical fixation has been advocated in the past, but there is no strong literature to support this route over nonoperative treatments. Some orthopedic surgeons advise early nonoperative mobilization, while others opt for complete immobilization in extension for up to 6 weeks. A randomized study showed increased redislocation rates in early mobilization patients, and worsened motion restriction in complete immobilization patients. Orthopedic follow-up is important to evaluate for unrecognized associated ligamentous injuries or osteochondral fractures. Future intervention may be indicated if joint laxity or other abnormalities are identified

R.I.C.E. (choice A) may help improve the patient's symptoms, but should not be the sole treatment. Patellar dislocation acutely can cause a high likelihood of instability at the joint and require an immobilizer. MRI (choice C) and ORIF (choice D) are not indicated for an uncomplicated patellar dislocation. An orthopedist may want an MRI in an outpatient setting if ligamentous damage is suspected. Arthrocentesis (choice E) is never indicated in an acute knee effusion secondary to patellar dislocation.

Take-Home Message

Patella dislocations are usually easily reduced with gradual knee extension and should always have postreduction imaging. Knee immobilization and follow-up with an orthopedic surgeon are indicated to evaluate for ligamentous damage.

ABP Content Specification: Patellar Dislocation

- Know and understand the mechanism of injury.
- Recognize a child with this presentation.
- Plan the management of a child with injury.

Question 14

A 10-year-old girl is brought to the ED via EMS for left hip and knee pain after falling off a structure at the playground. EMS reports that the patient fell from a height of 10 feet and had no head injury or loss of consciousness. EMS tells you she was initially nonambulatory and had a left lower extremity deformity with internal rotation and shortening of the extremity. Upon arrival at the ED, the deformity had resolved. The patient says her hip pain has improved and her knee pain is gone. On examination, left hip flexion and extension is limited due to pain. Femoral, popliteal, and dorsalis pedis pulses are 2+. The left knee is nontender with good range of motion. Lower extremity neurological examination is normal. The patient has no other complaints besides mild left hip pain. Examination is otherwise unremarkable. Radiographs of the pelvis, hip, and knee show no signs of dislocation, fracture, or asymmetric joint spacing. What is the appropriate next step in management?

A. Analgesia, ice, rest, and follow-up with the orthopedic surgeon
B. ED observation for 2–4 hours with repeat imaging
C. Closed reduction of left hip
D. CT scan of left hip
E. Orthopedic consultation with early plan for open reduction with internal fixation

Correct Answer: D

The child's presentation is concerning for a spontaneously reduced hip dislocation. Hip dislocations are rare in pediatrics. Less force is required to dislocate a child's hip when compared to adults due to the nonossified acetabulum and increased joint laxity. Hip dislocations may spontaneously reduce, although this reduction may occasionally be incomplete. The mechanism of injury for hip dislocations in the pediatric population varies. More than 90% are posterior dislocations. Patients usually present with pain and a shortened and internally rotated leg. Neurovascular structures should always be assessed and radiographic imaging obtained.

Closed reduction should be attempted in the ED once dislocation is confirmed. Reduction should preferably be done using procedural sedation. The most common technique (for posterior displacement) is to flex the hip and knee to 90° and apply axial traction to the thigh. A postreduction CT scan of the hip is recommended to look for intra-articular fractures and to judge the adequacy of the reduction.

Most hip dislocations reduce easily and have good long-term outcomes as long as the reduction occurs within 6 hours of dislocation. If the hip cannot be reduced or there is an associated fracture, then an open reduction is preferred. Delay in reduction has a high incidence of avascular necrosis (AVN) of the femoral head, and osteoarthritis of the hip joint.

Analgesia, ice, rest, and follow-up (choice A) are important for pain relief and to decrease swelling, but only after complete reduction is confirmed and a fracture is not seen. Observation and repeat imaging (choice B) are not indicated as the imaging will likely not change with time. The child's hip appears to have spontaneously reduced; therefore, an attempt at closed reduction (choice D) is not warranted at this time. ORIF (choice E) may eventually be indicated, but only if CT scan identifies pathology.

Take-Home Message

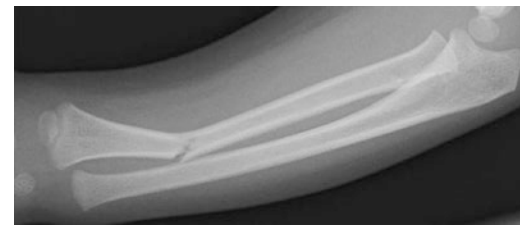
Dislocated hip(s) should be reduced urgently to decrease the risk of avascular necrosis. A postreduction CT scan of the hip is recommended to look for intra-articular fractures and to assess the adequacy of the reduction.

ABP Content Specification: Dislocation of the Hip

- Know and understand the mechanism of injury.
- Recognize a child with this presentation.
- Plan the management of a child with injury.

Question 15

What type of fracture is demonstrated in this image?



A. Bowing deformity
B. Buckle fracture
C. Comminuted fracture
D. Complete fracture
E. Greenstick fracture

Correct Answer: E

The radiograph above shows a classic greenstick fracture of the ulna and radius. Greenstick fractures occur when trauma results in disruption in one of the cortices of the bone, and a bowing deformity of the other. Green stick fractures are unique to pediatric bones, and most occur in children less than 10 years of age. These fractures occur in children due to decreased calcification of the pediatric skeleton leading to increased pliability of bones. The need for closed versus open reduction depends on the degree of angulation. Usually <10% angulation can be managed with a cast if no obvious deformity is evident on physical examination.

Bowing deformities (choice A) are plastic deformities of bone that are unique to children.

These deformities have no discernible fracture or cortical disruption evident on plain films. Buckle fractures (choice B) are common metaphyseal fractures occurring in children in which axial loading of the bone results in buckling of one or both cortices of the bone. Comminuted fractures (choice C) consist of multiple fragmented segments of bone. Complete fractures (choice D) have complete separation of both cortices.

Take-Home Message

Greenstick fractures are one of several fracture patterns unique to the pediatric skeleton. These fractures occur because of the plasticity and decreased calcification of pediatric bones. Greenstick fractures result when trauma leads to fracture of one cortex with plastic deformity of the opposing cortex.

Image(s)

Courtesy of Robert Vezzetti

ABP Content Specification

- Recognize greenstick (incomplete) and buckle fractures.

Suggested Reading

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Stapczynski JS, Tintinalli JE. Musculoskeletal disorders in children. In: Tintinalli's emergency medicine: a comprehensive study guide. 8th ed. New York: McGraw-Hill Education. p. 923–5.

Question 7

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Question 8

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Question 9

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Procedures

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Barbara Blackie and Ehab Said Aki

Question 1

Which of the following is a life-threatening complication associated with endotracheal intubation?

A. Right mainstem intubation
B. Barotrauma to the tympanic membranes
C. Malignant hyperthermia
D. Dental trauma
E. Tension pneumothorax

Correct Answer: E

Pneumothorax, particularly tension pneumothorax, is a life-threatening complication of endotracheal intubation. It may occur due to aggressive positive pressure ventilation. Signs of the development of a tension pneumothorax include increased resistance to ventilation, rapidly decreasing blood pressure, decreased breath sounds, or tracheal deviation to the opposite side of the pneumothorax. Immediate decompression with a large-bore needle should be performed. Right mainstem intubation and dental trauma are relatively benign potential complications of intubation. Barotrauma to the typmanic membranes is not a complication of endotracheal intubation. Malignant hyperthermia may be a complication with the use of inhalational anesthetics or succinylcholine, but is not a complication of endotracheal intubation itself.

Take-Home Message
Tension pneumothorax is a clinical diagnosis and requires prompt needle decompression. Tension pneumothorax is a possible complication of endotracheal intubation.

ABP Content Specification
Recognize the complications associated with emergent endotracheal intubation.

Question 2

Which of the following is a contraindication for rapid sequence intubation (RSI)?

A. Hyperkalemia
B. Myasthenia gravis
C. Le Fort 1 facial fracture
D. Mediastinal mass
E. Allergy to ketamine

Correct Answer: D

Rapid sequence intubation is defined as the nearly simultaneous administration of a potent

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_27

sedative or induction agent and neuromuscular blocking agent. It is contraindicated in patients where securing of the airway is potentially difficult. This should be considered in the context of the environment, skill of the operator, and available equipment. Relative contraindications include traumatic anatomic distortion such as massive facial trauma, facial burns, and so on.

Hyperkalemia is a contraindication for the use of succinylcholine but not for RSI. Nondepolarizing muscle relaxants should generally be avoided when the patient has a neuromuscular disease such as myasthenia gravis because paralysis can persist for an excessively long period of time. Allergy to a particular medication is not a contraindication for RSI.

Sedating and paralyzing a patient with a mediastinal mass may cause subglottic obstruction that cannot be overcome by endotracheal intubation. This has the potential to become a "can't ventilate-can't oxygenate situation."

Awake techniques of intubation can be considered with difficult airways in older children but are not feasible in young uncooperative children. If intubation is required, access to surgical airway equipment and back up assistance from anesthesia or ENT service is desirable.

Take-Home Message
It is important to recognize and anticipate contraindications to intubation prior to performance of RSI and it is desirable to have back up assistance if available.

ABP Content Specification
Know the indications and contraindications for rapid sequence induction for intubation.

Question 3

Which of following does not cause difficulties when performing bag-mask ventilation in an infant?

A. Quality of the seal of the mask around the face
B. Upper airway obstruction
C. Facial anomalies
D. Absence of teeth
E. Small airways obstruction

Correct Answer: D

The quality of the seal of the mask is very important and is achieved by gently opening the airway in a "sniffing position" and using an "EC" clamp method.

Bag mask ventillation (BMV) requires a patent airway and a good mask seal. An appropriately sized mask is extremely important. BMV may be difficult if facial anomalies or injuries compromise the seal. The absence of teeth in an adult has been identified as a risk factor for ventilation, but this has not been described in children. Edentulous adults are relatively more difficult to ventilate due to the inability to make an appropriate seal between the mask and the oral cavity. Small airway obstruction and lung disease can contribute to difficulty with bag-mask ventilation by requiring adjustment of both the force required to inflate the lungs and the rate of breaths delivered.

Take-Home Message
Appropriately sized mask and proper seal using the EC Clamp method are essential for effective bag-mask ventilation.

ABP Content Specification
- Know the indications and contraindications for bag-mask ventilation.
- Plan the key steps and know the potential pitfalls in performing bag-mask ventilation.

Question 4

Regarding the pediatric airway, which statement is correct?

A. Oropharyngeal airways may result in laryngospasm and vomiting if placed in a conscious patient.

B. Oral airways cause more trauma but are more easily placed than nasal airways.
C. When sizing the nasopharyngeal airway, it should run the length from the tip of the patient's nose to just above the angle of the mandible.
D. The narrowest portion of the infant or young child's airway is the level of the vocal cords.
E. Nasal airways are soft rubber or plastic tubes that are inserted through the nostril and into the oropharynx so the distal end sits just above the larynx.

Correct Answer: A

The oropharyngeal airway (OPA) is used to relieve airway obstruction. It displaces the tongue anteriorly and prevents the tongue falling back on the posterior pharyngeal wall, thereby reducing airway obstruction by the relatively large tongue. OPAs can elicit a significant gag reflex when inserted and are not usually tolerated in children who are awake. This may cause vomiting and aspiration. OPAs are sized properly when the flange is at the central incisors and the tip is at the angle of the mandible. An OPA should be placed whenever bag-mask ventilation is required.

Nasopharyngeal airways (NPAs) are soft rubber or plastic tubes that are inserted through a nostril and into the oropharynx. Once inserted, they sit just above the epiglottis not at the larynx. Measure the appropriate size by holding the device next to the child's face: the proper length is equal to the distance from the nares to the tragus of the ear. NPAs are contraindicated in patients with basilar skull fracture. NPAs are better tolerated than OPAs particularly when the patient's jaw is clenched or the patient is semiconscious.

Take-Home Message
The oropharyngeal and nasopharyngeal airways are useful adjuncts in airway management when used appropriately. Oropharyngeal airways are not well tolerated by awake children and may cause vomiting.

ABP Content Specification
Know the anatomy and/or pathophysiology relevant to airway adjuncts, oxygen delivery, and suctioning.

Question 5

A 7 year old presents with altered mental status after being hit by a car. Once the airway and breathing have been stabilized, you ask the nurses about the status of his vascular access. The nurses tell you they have been trying, but cannot cannulate his veins since he is hypotensive. Your next approach to secure access is

A. Insert an intraosseous in the medial aspect of the proximal tibia
B. Insert an intraosseous in the sternum
C. Insert a femoral central line
D. Insert an internal jugular IV line
E. Place an IV in a saphenous vein

Correct Answer: A

Vascular access can be challenging in the child who is critically ill or injured. The intraosseous route has been used successfully for patients of all ages and provides rapid, safe, and reliable access to the circulation. This child needs rapid vascular access for boluses of fluid as well as blood products. IO vascular access can be utilized in neonates, infants, children, and adults when rapid vascular access is required for emergent administration of essential medications, fluids, or blood products and attempting other methods of obtaining vascular access (peripheral or central) will cause delays in patient care.

Intraosseous infusions and medications reach the central circulation about as effectively as central venous infusions. Circulating medication levels are equivalent between IV and IO routes. Blood samples obtained can be used for analysis for chemistry, cross matching, and culture.

Contraindications to using an IO include osteogenesis imperfecta, proximal ipsilateral

fracture, loss of skin integrity (such as burns, infection), compartment syndrome, previous IO attempt at the same location within the last 24 hours, and ipsilateral limb with significant vascular injury. All of these are relative, and in most cases, require an alternative site, or alternative form of vascular access. Complications of intraosseous infusion are rare but include infection such as cellulitis, bacteremia/sepsis, and osteomyelitis, compartment syndrome, fat embolus, fracture, and damage to the growth plate.

The proximal tibia, just below the growth plate approximately 1–3 cm below the tibial tuberosity, is the preferred site for intraosseous access in children. The proximal tibia has a broad flat surface with a thin layer of skin covering the bone. The distal tibia can be used if the proximal tibia is not available. The site of insertion is the medial surface at the tibia proximal to the medial malleolus. It can be difficult in those with a large muscle or subcutaneous bulk and may require a longer needle.

The sternum is not the preferred site in children because of the potential complications such as sternal puncture and mediastinitis. The other possible sites, but seldom used, include the superior iliac spine, the distal radius, and the distal ulna.

Take-Home Message

The preferred site for intraosseous insertion is the anteromedial surface of the tibia, approximately 1–3 cm below the tibial tuberosity.

ABP Content Specification

- Know the indications and contraindications for intraosseous infusion.
- Plan the key steps and know the potential pitfalls in performing intraosseous infusion.
- Recognize the complications associated with intraosseous infusion.
- Know the anatomy and pathophysiology relevant to intraosseous infusion.

Question 6

A 5 year old child has been stabilized in your ED and is awaiting transfer to the PICU. He has received two 20 ml/kg boluses of normal saline and 10 ml/kg of packed red blood cells, and in addition to head injury and pneumothorax, he has bilateral pulmonary contusions and a grade 3 liver injury. His blood pressure and vital signs had normalized, but now his cardiac monitor suddenly shows ventricular tachycardia. He has no pulse. Your next immediate step should be

A. Call for a cardiac ECHO
B. Initiate CPR with a compression to ventilation rate of 30:2 at a rate of at least 100/minute
C. Initiate CPR with a compression to ventilation rate of 15:2 at a rate of at least 100/minute
D. Immediately administer 5 mg/kg of amiodarone IV
E. Immediately administer 0.01 mg/kg epinephrine IV

Correct Answer: C

VT is defined as a rapid, wide complex QRS tachycardia. If the patient has no pulse, CPR should be initiated promptly and continued until a defibrillator is available. Defibrillation should be administered immediately at 2 J/kg followed by chest compressions. The initial treatment is a single shock followed by 2 minutes of chest compressions without pulse check. For two-rescuer CPR for infants and children, the compression-ventilation ratio is 15:2. For a single rescuer, the compression-ventilation ratio is 30:2. Chest compressions should be performed at a rate of 100 compressions per minute. In such situation, pharmacologic therapy includes epinephrine and, in cases refractory to shock and epinephrine, amiodarone or lidocaine. Patients with VT with a pulse but poor perfusion should receive synchronized cardioversion started at 0.5–1 J/kg.

This is not a common rhythm in children. The majority of children with ventricular tachycardia have an underlying condition such as myocarditis, prolonged QT syndrome, medication exposures (e.g., cyclic antidepressants), or electrolyte imbalance.

Take-Home Message
Despite the cause of pulseless arrest, the first action should be CPR.

ABP Content Specification

- Recognize the unstable arrhythmias leading to cardiac arrest.
- Know the treatment of unstable dysrhythmias.
- Know the techniques of pediatric advanced life support in cardiopulmonary arrest.

Question 7

A 13-year-old boy arrives with EMS after being stabbed while at a local mall. On arrival, he has three oozing stab wounds to his left anterior chest, left lateral chest, and left flank. His vitals show a heart rate of 130 beats/minute, a respiratory rate of 36 breaths/minute, a blood pressure of 80/60 mm Hg, and oxygen saturation of 94% while on oxygen by face mask. His capillary refill is 5 seconds. He is sleepy but responsive and is complaining of chest pain and tightness. He has two IVs, one in each antecubital fossa and has received 400 ml of normal saline. He has muffled heart sounds and slightly distended neck veins. On US, the pericardial sac is fluid filled and there is scalloping of the ventricular walls.

When performing pericardiocentesis, you should

A. Position the patient in reverse Trendelenburg position, insert a 20-gauge needle at a 45-degree angle 1 cm to left of the xiphoid process with ultrasound guidance.
B. Position the patient in a Trendelenburg position, insert a 20-gauge needle at a 45-degree angle 1 cm to left of the xiphoid process with ultrasound guidance.
C. Position the patient in reverse Trendelenburg position, insert a 25-gauge needle at a 45-degree angle 1 cm to right of the xiphoid process with ultrasound guidance.
D. Position the patient in reverse Trendelenburg position, insert a 25-gauge needle at a 45-degree angle 1 cm to left of the xiphoid process with ultrasound guidance.
E. Position the patient in Trendelenburg, insert a 20-gauge needle at a 90-degree angle 1 cm to left of the xiphoid process with ultrasound guidance.

Correct Answer: A

Pericardiocentesis is a lifesaving measure and ideally performed in a controlled setting such as the cardiac catheterization laboratory with electrocardiographic and hemodynamic monitoring. Pericardial tamponade often occurs in postoperative cardiac patients or can be a result of chest trauma. Rapid filling of the pericardial space may result in hemodynamic compromise.

Place patient in semirecumbent position at about 30–45-degree angle on the stretcher. The needle should be inserted through the subxiphoid skin, advancing it toward the left shoulder or the suprasternal notch while monitoring progress on the ultrasound images. Once the needle tip enters the pericardial sac, start withdrawing the fluid. This should result in immediate improvement in the hemodynamic status. Avoid the internal mammary artery which is located 3–5 cm lateral to the sternum.

Complications of pericardiocentesis include perforation of the ventricles, perforation of the stomach or intestines, ventricular and atrial arrhythmias, coronary artery or left internal mammary puncture, hemothorax, pneumothorax, pneumopericardium, hepatic injury, bleeding, and infection. Contraindication for pericardiocentesis includes bleeding disorders such as coagulopathy and thrombocytopenia.

Take-Home Message
Cardiac tamponade should be emergently treated with ultrasound-guided pericardiocentesis. This is a treatable cause of Pulseless Electrical Activity.

ABP Content Specification

- Recognize the signs and symptoms and complications of pericardial effusion and tamponade.
- Know the indications and contraindications for pericardiocentesis.
- Plan the key steps and know the potential pitfalls of pericardiocentesis.

Question 8

A 3-year-old boy is brought to the ED by paramedics after choking on a bead. The paramedic states that when they arrived at the home he was in respiratory distress with audible stridor, and during transport, he has become lethargic. He is getting oxygen by nonrebreather, and his oxygen saturation is 90%, heart rate is 140 beats/minute, respiratory rate 50 breaths/minute, and blood pressure 100/64 mm Hg. He is in severe respiratory distress with intercostal and substernal retractions and nasal flaring. You have alerted the anesthesiologist and ENT surgeon who are on the way to the ED.

What are the best next steps in management?

A. Start an IV, give epinephrine, and bag the patient while getting ready to intubate.
B. Bag the patient, prepare to intubate, and have a surgical airway kit at the bedside.
C. Bag the patient, assemble intubation equipment, insert laryngoscope, and if the foreign body is visible, remove with McGill forceps.
D. Start back blows to dislodge the foreign body, check oropharynx and, if visible, remove with McGill forceps and prepare to intubate.
E. Continue providing oxygen via the nonrebreather mask and await further back up.

Correct Answer: E

In the setting described, a multidisciplinary team can be mobilized very quickly and the child taken immediately to the operating room for controlled removal. Given that the patient has adequate vital signs, the priority would be to maintain these vital signs.

For a child, perform subdiaphragmatic abdominal thrusts (Heimlich maneuver) until the object is expelled or the patient becomes unresponsive. For an infant, deliver repeated cycles of 5 back blows (slaps) followed by 5 chest compressions until the object is expelled or the infant becomes unresponsive. Abdominal thrusts are not recommended for infants because they may damage the infant's relatively large and unprotected liver. If the child becomes unresponsive, start CPR with chest compressions (do not perform a pulse check). After 30 chest compressions, open the airway. If you see a foreign body, remove it but do not perform blind finger sweeps because they may push obstructing objects farther into the pharynx and may damage the oropharynx. And, any finger inserted in the mouth is at risk for being bitten. At this point, there are options depending on personnel and other available resources. Attempt to give 2 breaths and continue with cycles of chest compressions and ventilations until the object is expelled; or, an alternative advanced care plan involves taking an early look with a laryngoscope or rigid bronchoscope to see if the foreign body is high enough to be retrieved.

An IV would be needed in this patient, but should not take priority before the reestablishment of a patent airway. Bagging the patient may be required if there is a precipitous drop in the saturations to prevent progression to respiratory failure and arrest, although this may cause the foreign body to completely occlude the airway.

Take-Home Message

In a patient with a semi- obstructed airway, the first priority is to prevent full obstruction.

ABP Content Specification

- Know the indications and contraindications for acute upper airway foreign body removal.
- Plan the key steps and know the potential pitfalls in performing acute upper airway foreign body removal.

- Recognize the complications associated with acute upper airway foreign body removal.

Question 9

Continued from question 8: As you proceed, the child becomes unresponsive, and you are not able to dislodge the foreign body with abdominal thrusts or CPR. When you look with direct laryngoscopy, you visualize a foreign body just below the vocal cords, partially obstructing the trachea. It is beyond the reach of the forceps. The child's saturations are falling, now in the 80s, heart rate is 180 beats/minute and his blood pressure is 98/50 mm Hg.

How will you next proceed?

A. Attempt to intubate the patient
B. Prepare for a needle cricothyrotomy
C. Ask anesthesia and ENT to come faster
D. Attempt to bag-mask ventilate
E. Request that an IV be placed in order to give RSI medications

Correct Answer: D

In this setting when respiratory failure is imminent, maintaining adequate oxygenation is critical. Bag-mask ventilation with appropriate positioning must be initiated. Infants usually require placement of padding under the shoulders or upper torso to prevent excessive flexion of the neck due to their large occiput and others place in a sniffing position.

Appropriate technique involves selecting the correct mask size, opening the airway, making a tight seal (EC clamp) between the mask and face, delivering effective ventilation, and assessing the effectiveness of that ventilation. The EC clamp technique of bag-mask ventilations involves the three fingers of one hand lifting the jaw (they form the "E") while the thumb and index finger hold the mask to the face (making a "C").

The provider should avoid excessive ventilation, using only the force and tidal volume necessary to just make the chest rise. Overly aggressive bagging can result in increased intrathoracic pressure decreased cardiac output, decreased cerebral blood flow, and coronary perfusion; air trapping and barotrauma; and increased risk of regurgitation and aspiration. Bag-mask ventilation initially may improve oxygenation enough to buy some time until a definitive airway can be obtained. Intubation- which may push the bead into one side or the other, or completely obstruct the airway and preparing for a needle cricothyrotomy are other options, but not before attempts are made to improve his oxygenation. An IV is needed, but not before airway management.

Take-Home Message

When patients with a foreign body in the airway continue to deteriorate, bag-mask ventilation should be attempted to improve oxygenation and potentially disloge the object.

ABP Content Specification

- Plan the key steps and know the potential pitfalls in performing acute upper airway foreign body removal.
- Recognize the complications associated with acute upper airway foreign body removal.

Question 10

Continued from question 9: You have proceeded with this child's care, however, have been unable to retrieve, dislodge, or work around the obstruction and attempts to intubate are unsuccessful. You therefore decide to ventilate via the percutaneous transtracheal route.

Select the correct technique.

A. Puncture the skin in the midline directly over the cricothyroid membrane with a 14–18 gauge over the needle catheter attached to a 5 ml syringe, direct the needle at a 45-degree angle caudally while applying negative pressure on the syringe. Once air is aspirated, remove the syringe and withdraw the needle while gently advancing the catheter downward position.
B. Puncture the skin in the midline directly over the cricothyroid membrane with a 14–18 gauge over the needle catheter attached to a 5 ml

syringe, direct the needle posteriorly while applying negative pressure on the syringe. Once air is aspirated, remove the syringe and withdraw the needle while gently advancing the catheter downward into position.

C. Puncture the skin in the midline directly over the cricothyroid membrane with a 12 gauge over the needle catheter attached to a 10 ml syringe, direct the needle at a 90-degree angle caudally while applying negative pressure on the syringe. Once air is aspirated, remove the syringe and withdraw the needle while gently advancing the catheter downward into position.

D. Make a transverse incision over the cricothyroid membrane and incise through the membrane transversely. Then spread the tissues with a hemostat and insert an ETT.

E. Make a vertical incision in the midline directly over the cricothyroid membrane and insert a 12 gauge over the needle catheter (with the needle removed). Direct the catheter at a 45-degree angle caudally and attach to jet ventilation.

Correct Answer: A

Cricothyrotomy should be considered when a difficult airway becomes a "failed airway." There are anatomic differences between children and adults, such as a smaller cricothyroid membrane and a rostral, funnel-shaped, and more compliant pediatric larynx. These anatomic limitations make this procedure very difficult in young children. Also, the cricoid cartilage is the narrowest portion of the airway and the isthmus of the thyroid gland approaches the level of the cricothyroid membrane. However, a needle cricothyrotomy may be performed. Needle cricothyrotomy can be performed in patients of any age. Contraindications to cricothyrotomy include laryngeal fractures, subglottic stenosis, and distorted or unidentifiable neck anatomy. The establishment of the airway should take precedence over all these considerations. The larynx consists of the thyroid cartilage, the cricothyroid membrane, and the cricoid cartilage. The cricothyroid membrane can be palpated as an indentation between the thyroid and cricoid cartilages. It is performed by inserting a 12–14-gauge catheter (14–18 gauge for younger children) at a 45-degree angle through the cricothyroid membrane until air is aspirated. Due to the small caliber of the catheter, if there is a complete obstruction to exhalation, achieving airway access via a needle cricothyrotomy may not allow adequate airway control.

To perform a cricothyrotomy in a child approching puberty or older, a vertical midline incision is made over the cricoid membrane through the sternohyoid muscle until the cricothyroid membrane is visualized. A smaller horizontal incision is made near the inferior border of the cricothyroid membrane and the incision is widened using a pair of curved scissors or a small curved hemostat. Through the opening made, an appropriate size endotracheal tube or tracheostomy tube is inserted and secured. Cricothyrotomy is associated with significant complications, and should therefore not be used until less invasive measures have failed.

Take-Home Message

Cricothyrotomy can be lifesaving in situations of obstructed airway when conventional methods fail.

ABP Content Specification

- Know the indications and contraindications for surgical cricothyrotomy.
- Plan the key steps and know the potential pitfalls in performing surgical cricothyrotomy.
- Recognize the complications associated with surgical cricothyrotomy.
- Know the anatomy and pathophysiology relevant to surgical cricothyrotomy.

Question 11

A 12-year-old boy presents with a significant nosebleed. On examination, he is alert and coherent and his shirt front is soaked in blood. His heart rate is 115 beats/minute, his blood pressure is 110/70 mm Hg. His left nare reveals active bleeding without any visible vessles to cauterize. A vasoconstrictor spray has not controlled the bleeding. You prepare to pack his nose to try and stop the bleeding.

The correct statement regarding nasal packing is

A. Use a nasal tampon or tight roll of gauze, coat the material with water-soluble lubricant or antibiotic ointment. Using gloved fingers or forceps, insert the packing gently and quickly along the floor of the nasal cavity until the string of the tampon reaches the nare or the end of the gauze is just inside the canal.
B. Use only gel foam, and insert this into the nares with forceps until past the second turbinate.
C. Use the pharyngeal approach, insert a nasal tampon string first, or a tight roll of gauze into the mouth using small forceps, and pull the string or gauze out through the nose to bring any remaining clots with it. Secure the string, or ensure the gauze sits just inside the nare.
D. Call for ENT to pack the nose bleed as it is a severe bleed and will require the OR.
E. Perform a bleeding disorder panel of bloodwork before packing the nose.

Correct Answer: A

Nasal mucosa is vascular, so even seemingly minor injuries can cause significant blood loss. Almost 90% of nosebleeds are anterior, and can usually be controlled by direct pressure. Most nasal bleeding originates at a plexus of arterioles and venules in the anteroinferior septum (Little's area). This plexus is supplied by the superior labial artery and the septal and nasal branches of the anterior ethmoid artery. Less than 10% of nosebleeds occur in the posterior nose and involve the posterolateral branches of the sphenopalatine artery.

If direct pressure alone does not stop the bleeding, the next step would be to use vasoconstrictive agents such as oxymetazoline or cautery when the vessel can be visualized. Blind cautery is not recommended, and is contraindicated for those with a known bleeding disorder. If these efforts fail, the next step is nasal packing.

Impregnation of the gauze or intranasal application of oxymetazoline or phenylephrine is common practice, but caution is required due to the potential for systemic effects such as CNS depression and hemodynamic changes.

Take-Home Message

Most children that present with epistaxis bleed from the anterior vessels and bleeding can be easily controlled with pressure. Those that have persistent bleeding can be treated with nasal packing using a nasal tampon or tight roll of gauze.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to the management of epistaxis.
- Plan the diagnostic evaluation and initial intervention for patients with epistaxis.

Question 12

A 15-year-old girl is brought to the ED complaining of pain and the inability to remove her contact lenses. She fell asleep wearing them and is now unable to get them out. When you examine her, she is anxious, crying and has slightly injected conjunctiva. Her lenses are visible on her eyes.

How will you proceed?

A. Irrigate with saline to remove the lenses.
B. Provide procedural sedation in the ED and remove the lenses.
C. Tell her not to worry, they will come out easily after a few hours and she can remove them at home.
D. Instill local anesthetic drops, pinch the lens between the thumb and forefinger and remove it.
E. Apply fluorescein to make the lenses more visible then remove by pinching.

Correct Answer: D

It may be difficult and painful to remove contact lenses if there is corneal edema from prolonged wearing. After instilling local anesthetic drops, separate the eyelids. Then entrap the lens edges with the eyelids, after this, attempt to expel

the lens by forcing the lower lid under the inferior edge of the lens. Irrigation is unlikely to disloge the lenses due to the corneal edema and they will only become more difficult to remove with time. There is no need to apply fluorescein as they are already visible, and local anesthetic drops should make the procedure tolerable in an adolescent such that sedation is not required.

Take-Home Message
Prolonged wearing of contact lenses can cause eye pain, discomfort and even corneal ulceration. Treat underlying corneal abrasion or ulceration after removal of the lenses.

ABP Content Specification
- Know the indications and contraindications for contact lens removal.
- Plan the key steps and know the potential pitfalls in performing contact lens removal.

Question 13

A 15-year-old male fell down a hill at a construction site while walking home from school. He landed on an exposed metal rod, or rebar. The construction crew was able to cut the rebar quickly, and EMS arrived with him collared and lying on his right side on a backboard. The rod enters his left lateral chest and exits directly through his left mid back. His HR on arrival is 143, his RR is 30, his oxygen saturation is 94% on a nonrebreather, and his blood pressure is 80/44. He is sleepy but responsive when asked questions. He has two large IVs in both antecubital fossae each running 1 liter of saline. He is transferred to the stretcher in your resuscitation bay, and as you begin your primary survey, his BP alarms at 70/50. The cardiac monitor shows a HR of 180 with short runs of ventricular tachycardia. As you plan your next move in the management of this patient you ask for the cardiovascular surgeon and an emergency thoracotomy tray STAT. You can't remember the last time you said those words and quickly review the indications for when an emergency thoracotomy might be indicated in the ED.

The indications for an ED thoracotomy are:

A. To manage any cardiac arrest secondary to blood loss from any source
B. To obtain control of active hemorrhage from the lung hilum or heart, and to gain access to provide open cardiac massage
C. To provide improved access for definitive care for major thoracic injuries
D. To identify injuries and assist in the removal of penetrating objects that may be present
E. To cross clamp the aorta in patients with blunt trauma who have arrived with no vital signs

Correct Answer: B

Emergency thoracostomy is performed in trauma patients with severe refractory hemodynamic instability or witnessed cardiac arrest to control hemorrhage from the lung hilum or heart. In general, it is more successful for cardiac injuries, which can be repaired. Patients with penetrating trauma do better compared to blunt trauma. Stab wounds have a higher survival rate than firearm injuries. The incision starts at the lateral border of the left sternocostal junction inferior to the nipple over the fifth rib into the fourth intercostal space extending to the posterior axillary line and be deep enough to partially transect the latissimus dorsi muscle. Thoracostomy should not considered if there are nonsurvivable injuries, prolonged cardiac arrest or for patients with blunt chest trauma without vital signs.

Take-Home Message
Emergency Thoracotomy is a procedure of last resort for patients that present with cardiac arrest due to pericardial tamponade or penetrating cardiac injury.

ABP Content Specification
- Know the indications for emergent open thoracotomy in the emergency department.
- Plan the management of cardiac tamponade following penetrating injury.

Question 14

A 5-year-old boy was playing in the yard while his father was mowing the lawn on a ride on mower. The child fell, and the father reversed over him, not realizing he was there. He arrives in the ED with paramedics and the boy is distressed, screaming and agitated. His pelvis is unstable. You bind his pelvis, but you note bruising at the perineum and blood at the urethral meatus.

You are awaiting a surgical team, and want to investigate the possible urethral injury. What should be the next step in management?

A. Insert a Foley or feeding tube into the distal penile urethra, then inject a small amount of contrast into the penile urethra and obtain a spot film with an AP radiograph and watch for extravasation.
B. CT the pelvis, as the CT will also confirm urethral and bladder injuries.
C. Assume the urethra is injured and call for urology service to assess when the child goes to the OR.
D. Insert a Foley or feeding tube into the distal penile urethra with the tip at the base of glans, obtain an initial film of the penis and/or lower pelvis, inject a small amount of contrast into the penile urethra and obtain a spot image with an oblique angle to the penis, looking for extravasation of contrast.
E. MRI the pelvis as the visualization of all relevant structures will be maximized.

Correct Answer: D

Traumatic injury to the urethra may occur in up 10% of patients with pelvic fractures. The male urethra consists of an anterior part (bulbous urethra), and a posterior part (prostatic and membranous urethra). The anterior part of the urethra that is commonly injured is the bulbar urethra, which can occur with straddle injuries. Posterior urethral injuries are usually associated with pelvic fractures. The typical triad for urethral injury includes blood at the urethral meatus, inability to void, and a distended bladder. Perineal ecchymosis may be present.

Bladder injuries can include bladder contusions and ruptures (intraperitoneal or extraperitoneal). Extraperitoneal rupture is more common and is seen with pelvic fractures. Intraperitoneal ruptures generally occur when there is a full bladder at the time of blunt lower abdominal trauma.

Retrograde urethrogram is used to identify urethral injuries and should be performed before inserting a Foley catheter. A blind insertion may potentially make a partial tear/injury worse. Any extravasation of contrast outside the urethra is diagnostic; inability to see the proximal urethra in the context of gross extravasation of contrast indicates a complete rupture. A partial injury may show extravasation but there may also be flow of contrast through the proximal urethra into the bladder. An initial "scout" film prior to the injection of contrast is an important component of the retrograde urethrogram.

CT can identify bladder injuries but is not as good at identifying urethral injuries. MRI may identify these more clearly but is rarely indicated in a trauma situation and never with an unstable patient. The accessibility to MRI is a major obstacle in many places and the evidence for use still is needed.

Contraindications to performing a urethrogram would include doing this in an unstable patient, known allergy to contrast agents and a relative contraindication would be in someone who has an active UTI. Complications include bleeding and urethral or bladder trauma.

Take-Home Message

Among patients with pelvic fractures, there is a high risk of concomitant urethral injury which can be detected by performance of retrograde urethrography. Gross hematuria indicates bladder injury. Blood at meatus is suggestive of urethral injury and blind catheter passage should be avoided. A retrograde urethrography should be performed before any attempt to insert a Foley catheter.

ABP Content Specification

- Recognize the signs and symptoms of urethral trauma.

- Plan the diagnostic evaluation and the management of a patient with genitourinary trauma.
- Recognize the importance of and limitations of urinalysis, intravenous pyelography, ultrasonography, and computed tomography in assessing genitourinary injuries.

Question 15

A full-term neonate who was delivered at home arrives at 24 hours of age with the chief complaint of poor feeding. On arrival, the baby is in shock and is brought to the resuscitation room. While the gray, flaccid baby is being bagged, the nurses place the baby on the monitor and try for IV access which is unsuccessful.

Which of the following is correct regarding umbilical catheterization?

A. The umbilicus contains one large thick-walled artery between two smaller thin-walled veins.
B. The artery can usually be accessed within the first 24 hours of life. It is occasionally possible to use the umbilical artery up to 14 days after birth.
C. The umbilical vein can be accessed for up to 1 month of age.
D. Umbilical vein catheterization is the preferred procedure for the newborn in shock and in need of rapid resuscitation.
E. Umbilical artery catheters can be used for delivering medications only.

Correct Answer: D

An umbilical vein catheterization (UVC) is an option if peripheral intravenous access cannot be achieved in a neonate under 7 days of age.

The umbilical vein is a single vessel with thin walls and has a large lumen. It is usually flattened or compressed within the cord stump. There are two thick-walled umbilical arteries that are smaller in diameter than the umbilical vein.

Umbillical vein access can be used for delivering blood, fluids, total parenteral nutrition, taking blood for analysis, delivering medications, and for exchange transfusions. This may be used in emergent situations in which delivery of medications, fluid, or blood products are required. In any emergent situation, such as this, the intraosseous route may be preferred and may take less time than obtaining umbilical vein access. In an emergent situation, insert the catheter only 1–2 cm beyond the point at which blood return is seen. This is usually only 4–5 cm in a term infant. After this point, the umbilical vein branches.

The contraindications for UVC placement include omphalitis, omphalocele, gastroschisis, and peritonitis. Also, avoid if there is vascular insufficiency to a lower extremity.

Take-Home Message

For newborns needing emergent resuscitation, umbilical vein catheterization can provide rapid central access to the baby's circulation.

ABP Content Specification

- Know the indications and contraindications for umbilical vessel catheterization.
- Plan the key steps and know the potential pitfalls in performing umbilical vessel catheterization.
- Recognize the complications associated with umbilical vessel catheterization.
- Know the anatomy and pathophysiology relevant to umbilical vessel catheterization.

Question 16

When performing a median nerve block, which of the following is true?

A. The needle should be inserted perpendicular to the skin just radial to the palmaris longus tendon 2 cm proximal to the flexor wrist crease.
B. The needle should be inserted perpendicular to the skin just ulnar to the palmaris longus tendon at the proximal level of the wrist crease.
C. The needle should be inserted at a 45-degree angle to the skin just radial to the palmaris

longus tendon at the proximal level of the proximal flexor wrist crease.
D. The needle should be inserted at a 45-degree angle to the skin just ulnar to the palmaris longus tendon at the level of the proximal flexor wrist crease.
E. Do not perform a median nerve block in a patient with carpal tunnel syndrome.

Correct Answer: A

For median nerve block, the needle should be inserted about 2 cm proximal to the wrist crease between the tendons of the flexor carpi radialis and palmaris longus. A median nerve block at the wrist provides analgesia to the palmar surface of the lateral two-thirds of the hand, including the thumb, second and third fingers, and half of the fourth finger. There are no absolute contraindications to median block except for allergy to the anesthetic agents.

Take-Home Message
The median nerve block is a frequently used regional block for repair procedures involving the palmar surface of the lateral two-thirds of the hand.

ABP Content Specification
- Know the anatomy and pathophysiology relevant to local and regional anesthesia.
- Plan the key steps and know the potential pitfalls in performing local and regional anesthesia.

Question 17

When performing an infraorbital nerve block, which of the following is true?

A. Insert the needle at the mucolabial fold just proximal to the first premolar with the axis of the needle pointing toward the maxillary bone.
B. Insert the needle through the external skin mid cheek and insert into the infraorbital foramen.
C. The failure rate for infraorbital nerve blocks is greater than 15%.
D. Insert the needle at the mucolabial fold just posterior to the first premolar with the axis of the needle following the axis of the tooth and pointing at the infraorbital foramen.
E. Insert the needle at the mucolabial fold just anterior to the first premolar with the axis of the needle following the axis of the tooth and pointing at the infraorbital foramen.

Correct Answer: E

This anesthetizes the branches of the anterior and middle superior alveolar nerves. The innervation of these nerves includes the area below the eye, the lower part of the side of the nose and part of the upper lip. The landmark is the junction of the medial one-third and the lateral two-thirds of the inferior orbital rim where the infraorbital nerve exits from the infraorbital foramen.

Avoid entering into the infraorbital foramen, as the nerve can be injured. Entering the orbit can cause globe injury. Other complications involve reactions to the anesthetic and infection.

Take-Home Message
Infraorbital block is performed by inserting a needle intraorally anterior to the first premolar and directed toward the infraorbital foramen.

ABP Content Specification
Know the role and risks of regional and local anesthetic blocks in the management of injured children.

Question 18

Which of the statements below is correct when preparing to perform an internal jugular cannulation?

A. The internal jugular vein can be found lateral to the clavicular superior vena cava, at the head of the sternocleidomastoid muscle.
B. The internal jugular vein can be found in the angle formed by the two heads of the sternocleidomastoid muscle.

C. The internal jugular vein can be found posterior to the angle formed by the two heads of the sternocleidomastoid muscle.
D. A left-sided approach to this vein is recommended during a resuscitation.
E. Compared to the subclavian vein, the internal jugular approach has a higher risk of causing a pneumothorax.

Correct Answer: B

The landmarks for the internal jugular vein are at the two heads of the sternocleidomastoids, just below the apex of the triangle between them. It is superficial and just lateral to the carotid artery. The right-sided approach is better during a resuscitation as there is a direct route to the SVC, the line placement is generally out of the resuscitation field and the anatomy is exposed and available for direct compression. The internal jugular approach has relatively low iatrogenic complication rate such as pneumothorax.

Take-Home Message
Internal jugular vein can be accessed through insertion of the needle between the two heads of the sternocleidomastoid muscle below the apex of the triangle.

ABP Content Specification
- Know the indications and contraindications for central venous access.
- Plan the key steps and know the potential pitfalls in performing central venous access.
- Recognize the complications associated with central venous access.
- Know the anatomy and/or pathophysiology relevant to central venous access.

Question 19

Which of the statements below accurately describes how to insert a chest tube in a trauma situation?

A. Insert the chest tube adjacent to any penetrating wound.
B. Insert the chest tube in the 2nd or 3rd intercostal space at the anterior clavicular line.
C. Insert the chest tube in the 4th or 5th intercostal space between the anterior and mid-axillary lines.
D. Chest tubes should all be inserted using ultrasound guidance by an experienced operator.
E. When inserting a chest tube, use a size 28g for ages 1–2 years.

Correct Answer: C

The standard tube placement is as described in response C. Anterior approach should be considered if there are injuries to the area outlined in C. A chest tube can also be inserted between the 2nd and 3rd intercostal spaces if required. Inserting near or at a penetrating injury can cause more harm, may not generate a tight seal, can promote infection, and may reduce the ability to examine or repair injuries. Most chest tubes in a trauma situation do not require ultrasound guidance; however, in elective situations or where there is an empyema, ultrasound guidence can be very helpful. For a child between 1–2 years of age, the largest tube that should be used is a 24 g.

Take-Home Message
Chest tube placement is performed by inserting the chest tube in the 4th or 5th intercostal space between the anterior and mid-axillary lines and alternately on occasions between the 2nd and 3rd left interspace.

ABP Content Specification
- Know the indications and contraindications for tube thoracostomy and needle decompression of the chest.
- Plan the key steps and know the potential pitfalls in performing tube thoracostomy and needle decompression of the chest.
- Recognize the complications associated with tube thoracostomy of the chest.
- Know the anatomy and pathophysiology relevant to tube thoracostomy of the chest.

Question 20

Which of the following is the most likely complication of anterior nasal packing?

A. Sepsis
B. Necrotizing fasciitis
C. Pressure necrosis
D. Seizure
E. Dysphagia

Correct Answer: C

Tight anterior nasal packing can cause ischemia leading to pressure necrosis. Infection can occur with nasal packing as secretions are obstructed in a warm wet environment. Necrotizing fasciitis has been reported after nasal packing but is uncommon and staphlococcus toxic shock can occur, but is rare. Seizures would not be a complication of packing, and dysphagia is a potential complication of posterior nasal packing.

Take-Home Message
Anterior nasal packing is effective in controlling epistaxis and care should be taken to not pack too tightly to avoid pressure necrosis to the nasal septum.

ABP Content Specification
Recognize the complications associated with the management of epistaxis.

Question 21

An 18-month-old boy arrives in the ED after putting a bead in his nose. Mom was unable to remove the bead at home as he was uncooperative. When you examine the child, a red bead is completely obstructing the right nare, and the center of the bead is not visible.

What foreign body removal technique would you start with in this case?

A. Bag Valve Mask technique
B. McGill forceps
C. Ask the child to blow his nose in a tissue
D. Consult ENT as he is at high risk for aspirating the bead
E. Use a wall suction device on low intermittent suction

Correct Answer: A

The BVM technique of using a small mask over the mouth, obscuring/blocking the clear nare and then briskly bagging can be very effective in removing complete obstructions. The child should hold his breath, but if he is too young to understand, a couple of initial "breaths" with the BVM will often get him to hold his breath anyway. While manually pinching the unobstructed nostril closed, the ventilation bag is compressed. This forces the air into the mouth resulting in dislodgement and ejection of the foreign body.

Another technique using the same principle is the parent doing mouth to mouth while blocking the clear nostril, using the same mechanism as the BVM. The child holds his breath, the air blown is forced behind the obstruction, usually clearing it from the nostril. The family and child's comfort level can determine which technique is preferred.

McGill forceps would be too large for the nose, but are very useful for removing foreign bodies in the upper airway or posterior pharynx. In an uncooperative child, any of these techniques can be challenging, and there is a small risk of aspiration. Most of these kinds of foreign bodies do not need ENT consultation unless it proves difficult to remove, there is a button battery that is not easily extracted, or there has been significant injury from the foreign body itself. A wall suction device can also be useful for foreign body removal and could be used in this case; however, the suction device needs to be on high and not low intermittent. Other techniques include the use of skin glue or the use of small forceps. Prior to any of the manual procedures, a vasoconstrictor and/or an anesthetic can be beneficial.

Take-Home Message
There are several techniques for removing foreign bodies of the nose: determine the consistency, or origins, of the object, as well as the tolerance of the child and family to select the best technique for the situation.

ABP Content Specification
- Know the indications and contraindications for nasal foreign body removal.
- Know the anatomy and pathophysiology relevant to nasal foreign body removal.
- Recognize the complications associated with nasal foreign body removal.
- Plan the key steps and know the potential pitfalls in performing nasal foreign body removal.

Question 22

A 12-month-old boy presents with rectal prolapse after longstanding constipation. What steps will be followed in the reduction of the prolapse?

A. This procedure should be done in the operating suite as there is a risk of perforation.
B. This procedure can be done under procedural sedation with the patient supine. Using gloved hands and a speculum, gradually compress tissue until the prolapse has reduced.
C. This procedure does not require any sedation as it is not painful. Using gloved hands and a speculum, gradually compress tissue until the prolapse has reduced.
D. Position the child prone in the knee-chest position; lubricate the prolapsed mucosa with water-soluble lubricant and, apply circumferential pressure on the prolapsed mucosa while guiding the rectum internally with a finger placed in the central orifice.
E. Position the child supine; ensure the patient is monitored appropriately if sedation is required for a large or difficult reduction in an anxious child. Generously lubricate the prolapsed mucosa with water-soluble lubricant. With gloved hands, apply circumferential pressure on the prolapsed mucosa while guiding the rectum externally.

Correct Answer: D

Before reduction is attempted, confirm the diagnosis by carefully examining the mass to ensure that the patient does not have hemorrhoids, a prolapsed polyp, or a prolapsed intussusception. Consider the diagnosis of cystic fibrosis in a child with noninfectious diarrhea and rectal prolapse. A history of constipation should also be sought.

Depending on the size of the rectal prolapse, the level of anxiety in the patient and the level of discomfort, considerations should be made for pain management and/or sedation. Small prolapses may be reduced with local measures only. For those who have had an unsuccessful attempt without sedation, they should likely have sedation for further attempts.

In terms of the process of reducing, the child is best managed in the knee-chest position, although careful monitoring will be required for those undergoing the procedure with sedation.

Take-Home Message
Chronic constipation is the leading cause of rectal prolapse and cystic fibrosis should always be in the differential. Reduction is accomplished by gradual reinsertion of the prolapsed rectum into the anus with a relaxed abdomen and on occasions, with the use of sedative agents.

ABP Content Specification
- Plan the management for a child with rectal prolapse.
- Recognize the signs and symptoms of rectal prolapse.
- Recognize how to differentiate rectal prolapse from more serious conditions (e.g., intussusception).

Question 23

Which of the following statements is correct when managing paraphimosis?

A. Retraction of the foreskin for longer than 6 hours can lead to autoamputation.
B. The current standard of care is to apply ice or sugar to the end of the penis to reduce swelling prior to any attempt at reduction.
C. Pricking the edematous foreskin with a 25-gauge needle has been shown to be a superior method of reducing edema prior to attempting to reduce a paraphimosis.
D. Reduction of a paraphimosis should be completed by gloving, placing the thumbs of both hands on the glans with the fingers behind the prepuce. Apply steady pressure to the glans with the thumbs and apply countertraction to the foreskin with the fingers as the prepuce is pulled down. Ensure the constricting band of tissue comes distal to the glans with the prepuce.
E. Reduction of a paraphimosis should be completed by gloving, placing the thumbs of both hands on the glans with the fingers behind the prepuce. Apply steady pressure to the glans with the thumbs, and apply countertraction to the foreskin with the fingers as the prepuce is pulled down. Ensure the constricting band of tissue remains proximal to the glans.

Correct Answer: D

Paraphimosis is a medical emergency and requires urgent reduction. This refers to a retracted foreskin in uncircumcised boys which cannot be returned to the normal position. In paraphimosis, when the foreskin is retracted and becomes a constricting band of tissue, blood flow is compromised and edema results. As the glans swells, the foreskin will not be able to return to its normal position and the edema can worsen from there. Prolonged paraphimosis has the potential risk of ischemia and necrosis of the glans penis. The diagnosis is clinical.

Reduction in the ED should not be attempted if there is suspicion of necrosis. Edema reduction is often needed (ice, application of an elastic bandage over the entire length of the penis for 5–10 minutes) prior to making an attempt at reducing the paraphimosis. Manual circumferential compression of the glans by hand for several minutes can also reduce edema. In some cases, pricking the foreskin with a small needle or needle aspiration of the glans penis may allow for reduction.

Appropriate pain control is crucial to facilitate successful reduction and, in some instances, may need dorsal penile block. The key for proper reduction is to ensure that the constricting band of tissue around the glans penis located proximal to the swollen edematous area, is pushed distally. In some cases, this constricting band is incised to facilitate reduction (Dorsal slit procedure). A pediatric urology consultation should be obtained emergently if there is necrosis, urinary obstruction, or inability to complete the reduction. Although not absolute, circumcision may be required to prevent recurrence.

Take-Home Message

Paraphimosis is an emergent problem and needs prompt reduction. After reducing the edema to the distal penis, the prepuce is pulled up and over the glans while simultaneously pushing down the glans with both thumbs to bring the constricting band toward the distal glans.

ABP Content Specification

- Know the indications and contraindications for paraphimosis reduction.
- Know the anatomy and pathophysiology relevant to paraphimosis reduction.
- Recognize the complications associated with paraphimosis reduction.
- Plan the key steps and know the potential pitfalls of paraphimosis reduction.

Question 24

Which of the following statements is correct when performing a suprapubic bladder tap?

A. The area for the tap is 1–2 cm below the umbilicus.
B. The area for the tap is 1–2 cm above the symphysis pubis.
C. Insert the needle slightly cephalad, 10–20° off perpendicular, and advance forward in adolescent and adult patients.
D. Insert the needle slightly cephalad, 10–20° off perpendicular, and advance forward in infants and small children.
E. There is no role for the use of ultrasound in a suprapubic tap.

Correct Answer: B

Suprapubic aspiration is indicated for children less than 2 years of age when a sterile sample is required and urethral catheterization is difficult and contamination has to be avoided (gastroenteritis with diarrhea or diaper dermatitis/rash). Difficulty to access the urethra can happen when there is a tight foreskin or labial adhesions preclude good visualization of the urethra. The procedure itself is not difficult; however, success hinges on the volume of urine in the bladder at the time of the tap. Experience with the technique improves the success rate, but a primary factor for failure to obtain urine is the lack of urine in the bladder at the time of the attempt. Ultrasound visualization of the bladder (appears on ultrasound as an anechoic (black) structure just below the abdominal musculature) increases the success rate of this procedure. If the bladder is distended, inserting a needle 1–2 cm above the symphysis pubis in the midline perpendicular to the skin allows for aspiration of the urine.

Take-Home Message
Suprapubic aspiration for urine can be performed by placing the needle 1–2 cm above the symphysis pubis preferably using ultrasound guidance.

ABP Content Specification
- Know the indications and contraindications for suprapubic bladder aspiration.
- Know the anatomy and pathophysiology relevant to suprapubic bladder aspiration.
- Recognize the complications associated with suprapubic bladder aspiration.
- Plan the key steps and know the potential pitfalls in performing suprapubic bladder aspiration.

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Dental

28

Carolyn K. Holland

Question 1

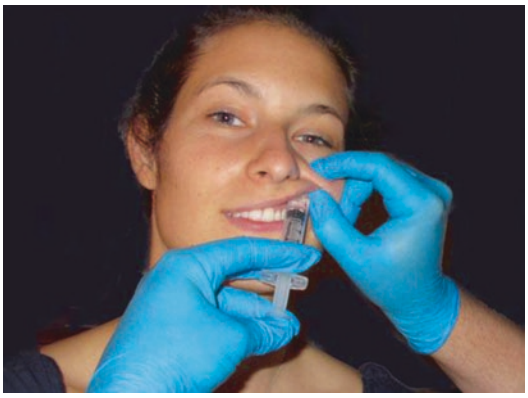
Which of the following descriptions of orofacial anesthesia techniques is *INCORRECT*?

A. Infraorbital block: inject around the infraorbital foramen, blocks anterior maxillary teeth on same side as block
B. Inferior alveolar nerve block: inject into the mandibular sulcus, blocks mandibular teeth on same side as block
C. Mental block: inject into the mental foramen, blocks anterior mandibular teeth on same side as block
D. Anterior superior alveolar block: inject at the apex of the canine tooth, blocks the canine tooth
E. Posterior superior alveolar block: inject distal to distal buccal root of upper second molar, blocks maxillary molar

Correct Answer: C

Injection directly into the mental foramen can cause neurovascular damage. A mental nerve block only anesthetizes the skin and soft tissue of the lower lip—not the teeth.

Infraorbital block	Anesthetic injected around the infraorbital foramen	Blocks anterior and middle superior alveolar nerves	Blocks anterior maxillary teeth



Intraoral approach to infraorbital block. (From Springer Publication – *Atlas of Emergency Procedures*, Ganti Latha. Your chapter on Regional Anesthesia. Figure 89.5)

Inferior alveolar nerve block	Anesthetic injected in the mandibular sulcus that funnels into the mandibular foramen	Blocks the inferior alveolar nerve and many times the lingual nerve	Blocks mandibular teeth and skin of chin and lower lip on same side as the block

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
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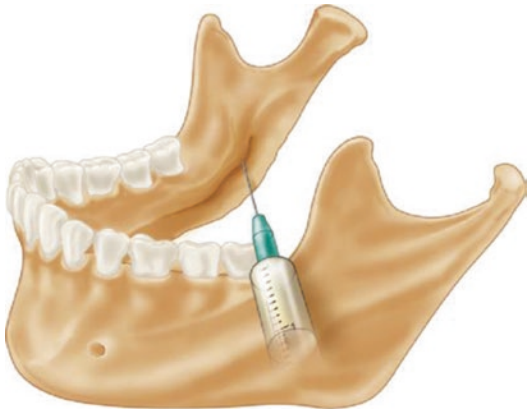
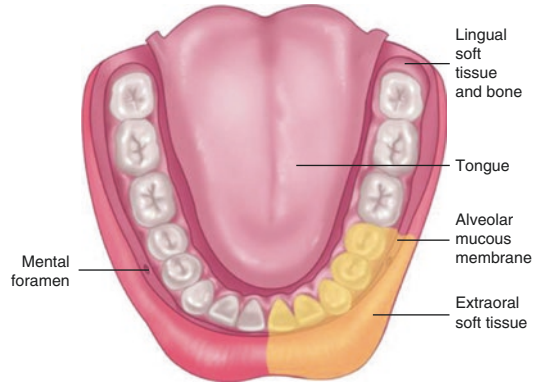
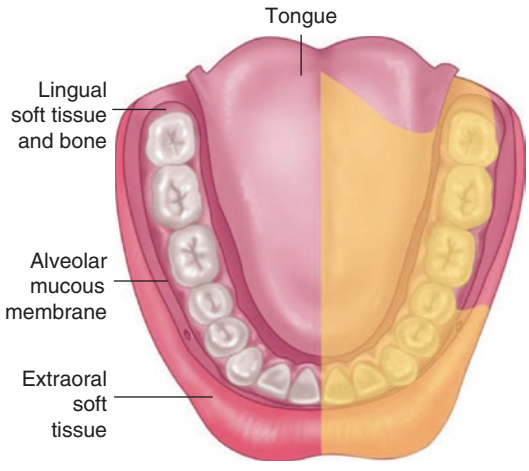


Approach to inferior alveolar nerve block. (Photo reprinted with permission from Springer: *Atlas of Emergency Procedures* by Latha Ganti, editor. 2016)

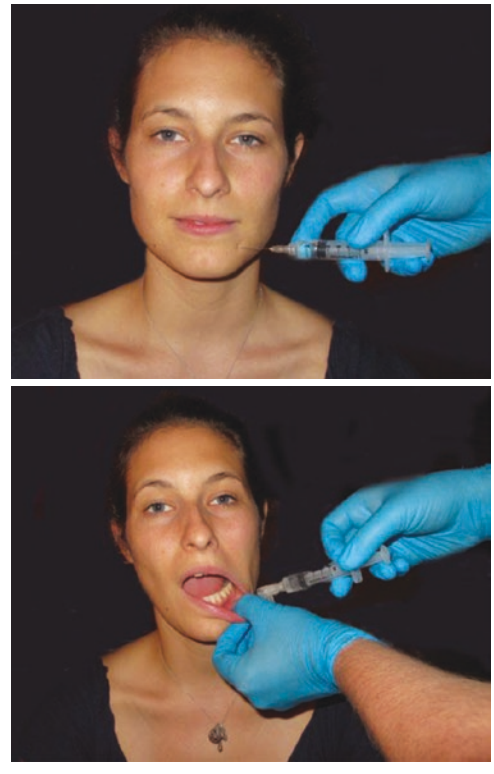


Area anesthetized by mental nerve block. (Drawing reprinted with permission from Springer: *Atlas of Emergency Medicine Procedures*, by Latha Ganti, editor. 2016)



Area anesthetized by inferior alveolar block. (Drawings reprinted with permission from Springer: *Atlas of Emergency Medicine Procedures*, Latha Ganti, editor. 2016)

Mental nerve block	Anesthetic injected around the mental foramen	Blocks the mental nerve which is a continuation of the inferior alveolar nerve	Blocks the skin/ soft tissue of the lower lip



Extraoral and intraoral approaches to mental nerve block. (Photos reprinted with permission from Springer: *Atlas of Emergency Medicine Procedures* by Latha Ganti, editor. 2016)

Supraperiosteal infiltration This includes • Posterior superior alveolar (PSA) nerve • Middle superior alveolar (MSA) nerve • Anterior superior alveolar (ASA) nerve	Anesthetic injected near periosteum of bone that supports tooth. PSA—distal to the distal buccal root of the upper second molar MSA—junction between second premolar and first molar ASA—apex of canine tooth	Blocks nerve of individual tooth by diffusing through the maxillary bone due to its porous nature even into adulthood. Supraperiosteal infiltration can also be used on individual mandibular teeth in children as the mandible remains less dense and the anesthetic can diffuse through the bone to the nerve supplying the tooth	Blocks individual tooth. Central and lateral incisors (permanent) can have cross-innervation so both need to be blocked PSA—maxillary molar teeth MSA—mesobuccal root of the maxillary first molar ASA—canine tooth

Take-Home Message

Facial nerve blocks can be used to provide pain control from dental issues and avoid the need for opioids. By using a long-acting anesthetic, such as bupivacaine, a nerve block can last hours, potentially getting a patient to definitive dental care during business hours with good pain relief. Additionally, they are ideal for local anesthesia to repair lacerations without distorting local anatomy. They are well within the scope of practice for emergency department providers.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to orofacial anesthesia techniques.

Question 2

Which of the following is NOT a relative or absolute contraindication for the use of local orofacial anesthesia?

A. Injecting through infected tissues (i.e., abscess on gingiva)
B. Allergy to the anesthetic agent
C. Anatomic landmarks that are grossly distorted
D. Localized bleeding
E. None of the above

Correct Answer: D

Injecting through infected tissues is a relative contraindication. Local anesthetic has lower efficacy in inflamed tissue. Putting a needle through infected tissue increases the risk of spreading infection to nearby nerves and structures. Allergy to anesthetic agent is an absolute contraindication for use of local anesthesia. Grossly distorted anatomic landmarks are also an absolute contraindication for nerve blocks.

Take-Home Message

A nerve block, as opposed to local infiltration, should be performed in situations where local anesthetic infiltration may have to be delivered through infected tissue for two reasons:

1. The infection makes the anesthetic less effective.
2. The infection may spread to local structures from the needle passing through the infected area.

ABP Content Specification

- Know the indications and contraindications for orofacial anesthesia techniques.

Question 3

Which of the following statements regarding the treatment of dental abscesses is *FALSE*?

A. Dental abscesses are usually from normal oral flora such as Gram-positive cocci and anaerobes.
B. Penicillin is the antibiotic of choice for dental infections/abscesses.

C. All dental abscesses will require drainage, either in the Emergency Department or with a dentist/oral surgeon.
D. Most dental abscesses are found on the buccal aspect of the gingiva.
E. Untreated dental abscesses may lead to infections of the orbit, maxillary sinuses, or submandibular and sublingual areas.

Correct Answer: C

Dental abscesses occur commonly in children. Many of these require endodontic therapy or extraction of the offending tooth. Failure to drain a significant abscess may result in complications and increases morbidity. Antibiotics are required in patients when infection has spread beyond alveolar process.

Penicillin is the first-line therapy. Amoxicillin has broader coverage but does not have a more significant impact on infection; however, it is easier to dose and tastes better. Erythromycin was previously a second-line agent for those with penicillin allergy; however, current recommendations are to use clindamycin for penicillin-allergic patients as well as those with resistant dental infection.

The periapical abscess is most common which develops around root tip of tooth. The periodontal abscess occurs in the gingival soft tissue but is less common. All dental abscesses do not require drainage. Small periapical abscess without significant swelling can be treated with pain control and a trial of oral antibiotics and may not require drainage.

Take-Home Message

Dental infections require antibiotic therapy and penicillin or amoxicillin are the initial drugs of choice. For patients with penicillin allergy, clindamycin is the best option. While very small abscesses may not require drainage, moderate-sized abscesses can be drained by emergency department providers. Large abscesses have the potential to impact the airway and may require emergent treatment in the operating room.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to incision and drainage of a dental abscess.

Question 4

You are working in the Emergency Department of a tertiary care pediatric hospital when a 4-year-old boy presents at 11 pm on a Monday with tooth pain, facial swelling, fever, and decreased oral intake. Tooth pain has been present for weeks, but his mother only noticed swelling over the past day. The child has never seen a dentist and does not regularly brush his teeth. On examination, you notice that the patient has facial asymmetry with swelling over the right jaw line extending into the submandibular space. The patient has some difficulty with full mouth opening due to pain. On intraoral examination, there is swelling and tenderness of the gingiva inferior to the first mandibular premolar on the right as well as firm edema and elevation of the floor of the mouth without posterior displacement of the tongue. He has a normal respiratory effort without wheezing, stridor, or retractions. He has mild tachycardia with normal blood pressure and oxygen saturation. The steps in your initial management should be:

A. Oral antibiotics and discharge home with referral to see a dentist the next morning.
B. Incision and drainage of periapical abscess by the emergency department physician, oral antibiotics, and discharge home with referral to see a dentist the next morning.
C. Incision and drainage of the periodontal abscess by the emergency department physician, IV antibiotics, and admission to the general pediatric service with a dental consult in the morning.
D. Emergent consultation with a dental/oral surgeon, anesthesiologist, and critical care while the patient is in the emergency department, CT imaging of face to evaluate for drainable

abscess, IV antibiotics, and admission to the pediatric intensive care unit.

E. Emergent intubation of the patient by the emergency department physician, emergent consultation with a dental/oral surgeon while the patient is in the emergency department, incision and drainage in the operating room by the dental/oral surgeon, IV antibiotics, and admission to the pediatric intensive care unit.

Correct Answer: D

This patient has Ludwig's angina, a rapidly progressive submandibular/sublingual cellulitis. Up to 30% of cases of Ludwig's angina occur in children. Untreated, the infection can displace the base of the tongue and cause a potentially life-threatening obstruction of the airway. The source is usually a decayed lower tooth, often resulting from the spread of periapical abscesses of mandibular molars**.** It is usually caused by anaerobic streptococci, although any of the anaerobic flora of the mouth may be the cause. It initially presents with signs of dental abscess, but progress to a tense swelling of the mandibular floor and then cervical edema and appears as a "bull neck." Other features include elevation of the tongue above the lower teeth, a tender woody induration in the sublingual space, trismus, and odynophagia.

This patient appears to have a stable airway (no stridor or respiratory distress noted) and thus could tolerate IV placement and a CT scan while also getting an emergent consultation with oral surgery (for incision and drainage), anesthesia (for airway assessment and planning for airway control in the operating room), and critical care medicine (for admission to their unit). Without evidence of acute respiratory distress, emergent intubation in the emergency department is an unnecessary risk. However, these patients should be carefully monitored for airway compromise. Airway control for these patients is ideally performed in the operating room with flexible fiberoptic equipment available as well as preparation for potential tracheostomy. While historically the mainstay of treatment was incision and drainage, if there are no definitive abscesses visible on imaging, a trial of IV antibiotics for 24–48 hours may be appropriate. Beware that it is not a simple abscess that can be readily drained in the ED.

Oral antibiotics alone are appropriate for small periapical or periodontal infections that have not yet become fluctuant and thus don't require ED incision and drainage. ED incision and drainage and oral antibiotics are appropriate for small periapical or periodontal abscesses that are amenable to drainage to provide pain control and prevent spontaneous drainage, without considerable evidence of facial cellulitis. IV antibiotics with dental consultation in the morning are appropriate for odontogenic abscesses with localized facial cellulitis without extension into the submandibular space.

Take-Home Message

Ludwig angina is a potentially life-threatening infection of the mandibular floor. Dental sources of infection are common. Since rapid onset of airway compromise is life threatening, the priority is to stabilize the airway.

ABP Content Specification

- Know the indications and contraindications for incision and drainage of a dental abscess.
- Recognize the complications associated with incision and drainage of a dental abscess.

Question 5

Which of the following statements is *TRUE* regarding the difference between a periapical and a periodontal abscess?

A. Periapical abscess occurs when there is dental caries or a fracture present.

B. In a periodontal abscess, the pulp of the tooth is nonvital.

C. Periapical abscesses may have a retained foreign body that needs to be removed to prevent recurrence.

D. Incision for drainage of a periodontal abscess should extend to the level of the alveolar bone.
E. With a periapical abscess, dental X-ray shows a lateral radiolucency.

Correct Answer: A

Periodontal abscess	Periapical abscess
Associated with gum disease/gingivitis	Associated with dental caries and/or fractures
Vital tooth that may or may not require extraction or root canal	Nonvital pulp in tooth that will likely require eventual extraction and/or root canal
On dental X-rays, there may be a lateral radiolucency	On dental X-rays, there will be an apical radiolucency
Plaque and debris are entrapped in the periodontal pocket that may retain a foreign body	Have no pocket in the gingiva surrounding the infected tooth
Incision over the area of maximal fluctuance is adequate for drainage	Incision over the area of maximal fluctuance and dissection using hemostats along the abscess tract until entering the abscess cavity in the alveolar bone is required for adequate drainage

Take-Home Message

While traditional dental radiographs are often not available in the emergency department, many locations have a panorex available that can provide imaging. When viewing these films, a radiolucent area along the lateral surface of the root indicates a periodontal abscess while a periapical abscess is suggested by an apical rarefaction.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to incision and drainage of a dental abscess.

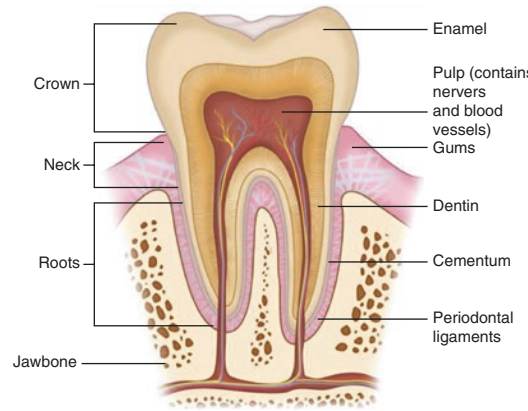
Question 6

Which of the following options for treatment of dental fractures is *CORRECT*?

A. A dental fracture involving only the enamel will require temporary covering and prophylactic antibiotics.
B. A Primary tooth sustaining a fracture with pulp exposure is common and requires an urgent root canal.
C. Dental fractures only involving the root of the tooth are easily distinguishable from luxation injuries.
D. Fractures involving the apical portion or the root make the tooth more mobile than those involving the cervical portion of the root.
E. Tooth fractures of secondary teeth with pulp exposure require immediate dental treatment with a temporary protective coating and referral to dentist.

Correct Answer: E

The management of fractures of teeth depends on which structures are involved—enamel, dentin, or pulp exposure. Ellis classification system describes dental fractures.



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Ellis Class I fractures involve only the dental enamel.

Ellis Class II fractures involve the enamel and the dentin.

Ellis III fractures involve the enamel, dentin, and pulp.

In Ellis class II fractures, dentin is visible as a softer, golden, or ivory-yellow middle layer. These are more serious in children and adolescents, as there is less dentin in children; it is dentin which is required to prevent bacteria from percolating into the pulp chamber.

Ellis III fractures should be suspected if there is pink or bloody discharge at the fracture surface which may indicate pulp exposure. Also evaluate for pulp exposure if the tooth is fractured. This is a dental emergency and requires immediate dental consultation.

Dental fractures involving only the enamel of either primary or secondary teeth do not require any emergent management in the ED and can be referred to a dentist for cosmetic repair.

Dental fractures with exposed dentin or pulp in primary teeth can be managed by observation to see if the tooth survives and/or eventual extraction to assist in the prevention of infection and decreased likelihood of damage to underlying permanent teeth.

Dental fractures that involve the root are mobile. More mobile fractures involve the cervical or middle root, while those involving the apical portion of the root may be non-mobile.

Secondary teeth with fractures that involve the pulp being exposed require emergent treatment. A temporary protective coating with calcium hydroxide or a glass ionomer product is used as soon as possible to prevent pulp infection and necrosis.

Take-Home Message

Ellis 1 fractures are purely cosmetic and require no emergent treatment. Ellis 2 fractures where the dentin is exposed and Ellis 3 fractures where the pulp is exposed require urgent dental evaluation to prevent development of pulpitis. Left untreated, pulpitis may become irreversible and require a root canal.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to management of dental fractures.
- Know the indications and contraindications for management of dental fractures.
- Plan the key steps and know the potential pitfalls in managing dental fractures.
- Recognize the complications associated with the management of dental fractures.

Question 7

You are at a soccer game when an 8-year-old player is struck in the mouth. You are asked to determine if he needs to go to the emergency department. On examination, you observe that the right upper incisor is absent and there is mild to moderate bleeding from the gingiva. The lips do not appear to have any lacerations. The patient is not coughing or having any difficulty breathing. After a quick examination of the surrounding ground, the avulsed tooth is found on the ground covered with dirt and grass clippings. Which of the following is NOT correct in the management of this patient?

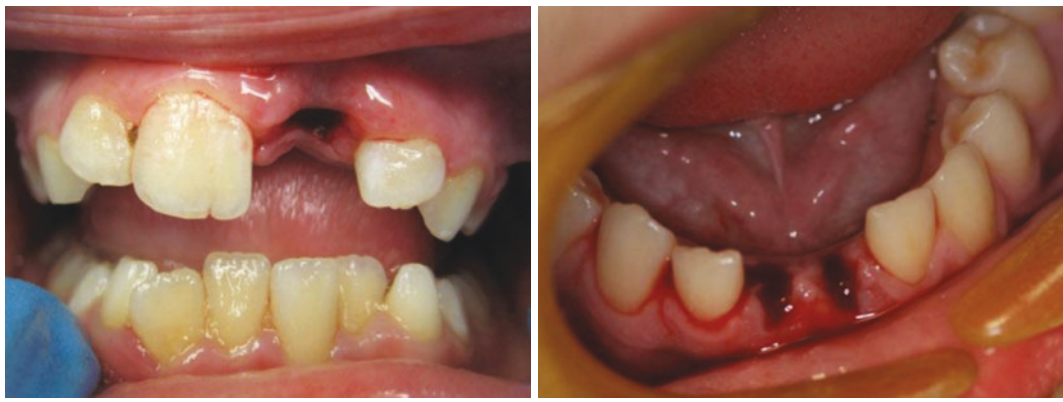
A. For avulsed secondary/permanent teeth, there is significant decreased viability of the periodontal ligament if the tooth is not reimplanted in 15–30 minutes.
B. For the best outcome, the tooth should have all of the dirt and debris immediately scrubbed off to decrease likelihood of infection after reimplantation.
C. While the ideal preservation medium is a cell culture medium, such as ViaSpan® or Hank's balanced salt solution, cool milk or the

patient's mouth is the next best choice for transportation of the tooth to definitive care.

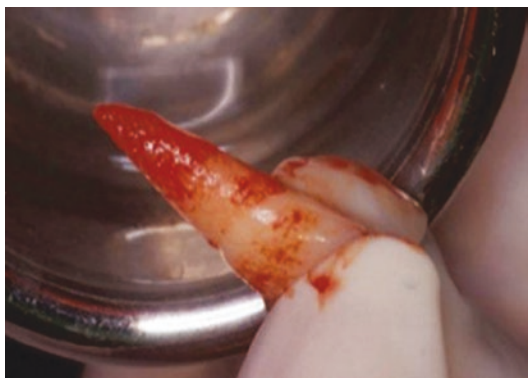
D. For avulsed primary teeth, replantation is not done due to the possible negative effects on the development of the secondary/permanent tooth behind it.

E. While adolescents who have an avulsed tooth replanted require a root canal, children who are 6–8 years of age may not need one as the root of an immature permanent tooth has an open apex and has the potential for revascularization.

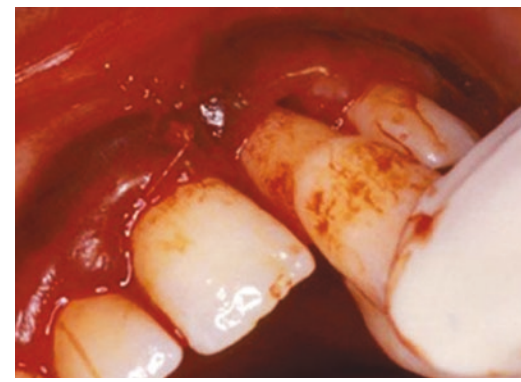
Correct Answer: B



Examples of avulsed teeth and remaining empty socket. (Photos reprinted with permission from Springer: *Atlas of Emergency Medicine Procedures* by Latha Ganti, editor. 2016)



Proper way to hold an avulsed tooth. (Photo reprinted with permission from Springer: *Atlas of Emergency Medicine Procedures* by Latha Ganti, editor. 2016)



Gentle replantation using digital pressure. (Photo reprinted with permission from Springer: *Atlas of Emergency Medicine Procedures* by Latha Ganti, editor. 2016)

Successful replantation of a permanent tooth that has been avulsed is dependent on survival of the periodontal ligament fibers. These fibers on the root of the tooth are delicate, and scrubbing of the root will destroy the fibers and place the tooth at risk for root resorption or ankylosis. It is important to only handle the tooth by the crown to avoid damaging these fibers. Storage in ViasSpan® or Hank's salt solution is ideal, but cold milk is the next best medium followed by intraoral saliva and physiologic saline as a last resort. Prior to replantation, the open socket

should be cleared of any clot which if present can also predispose the tooth to ankylosis. Once a tooth has been reimplanted, it needs to be stabilized with splinting to adjacent teeth, preferably with a flexible splint ideally applied by a dentist.

Take-Home Message
Primary teeth DO NOT get reimplanted. Best result for permanent teeth reimplantation is for it to be rapid with minimal time out of the mouth and minimal manipulation of the tooth root to preserve the periodontal ligament cells.

ABP Content Specification
- Know the indications and contraindications, the key steps, and the potential pitfalls.
- Recognize the complications associated with reimplanting an avulsed permanent tooth.

Question 8

Which of the following is NOT an accurate statement related to trauma to teeth and periodontal structures?

A. Intrusion injuries to primary teeth can be allowed to spontaneously re-erupt if there is no significant destruction of the surrounding tissue
B. Teeth with only concussive injuries that appear to have no displacement or increased mobility require no emergency treatment
C. Primary teeth that experience a lateral luxation injury need to be realigned and splinted as soon as possible
D. Intruded teeth can be completely invisible giving the false impression of a completely avulsed tooth
E. Grossly loose but not actually displaced teeth require immobilization with splinting as soon as possible

Correct Answer: C

Primary teeth that have an intrusion injury can be either allowed to spontaneously re-erupt OR extracted. This decision should be left to a dentist and will be based on multiple factors, including proximity of the intruded tooth to the tooth bud of the secondary tooth as well as damage to surrounding tissues and bone.

A concussive injury to teeth may result in mild edema. These teeth do not have increased mobility nor are they displaced; however, they may have increased sensitivity to percussion. While these injuries themselves do not require emergent treatment, it is important to fully evaluate the surrounding teeth and structures to rule out other injuries. It is possible that in the long term, a concussed tooth may eventually die from pulp necrosis and require extraction or a root canal and this information should be included in discharge instructions to the patient/family.

Primary teeth that have experienced an extrusion and/or lateral luxation injury should NOT be repositioned due to risk of damage to the underlying developing tooth. Instead, they should be extracted to allow the child to have normal occlusion and to protect the permanent tooth bud.

Teeth thought to be avulsed but not recovered require additional imaging to confirm that the tooth is neither completely intruded, nor avulsed and aspirated, ingested or imbedded in a lip laceration.

Teeth that are grossly mobile after injury likely have experienced a subluxation injury. This can significantly damage the important periodontal ligament. These teeth need to be splinted as soon as possible.

Take-Home Message
Primary teeth that are concussed and displaced should be left alone unless they are grossly mobile. There may already be damage to the developing tooth bud, and manipulation can also damage tooth bud.

ABP Content Specification
- Know the indications and contraindications for application of a dental splint.
- Reimplanting an avulsed permanent tooth—know the indications and contraindications.

Question 9

Which of the following dental injuries does NOT require splinting?

A. Reimplanted avulsed primary tooth
B. Crown-root fracture in secondary tooth
C. Alveolar ridge fractures
D. Mobile luxated secondary tooth
E. All of the above injuries require splinting

Correct Answer: A

Primary teeth that have been avulsed are not supposed to be reimplanted as this may cause damage to the secondary tooth bud and/or fusion to the alveolar bone.

Reimplanted avulsed secondary teeth, teeth that are grossly mobile and/or have been repositioned from their luxated position, or dental fractures that extend from the crown of the tooth to the root all require some immobilization to provide the best chance for survival of the tooth.

Take-Home Message
Don't reimplant primary teeth that have been avulsed. Secondary teeth that are mobile require emergent stabilization via splinting to increase likelihood of continued viability of the tooth, followed by urgent follow-up with a dentist.

ABP Content Specification
- Know the indications and contraindications for application of a dental splint.

Question 10

A 10-year-old boy has a dental injury that requires splinting. Which of the following options for splinting the tooth is *least* appropriate?

A. Application by an emergency physician of a periodontal paste, such as Coe-Pak, over the enamel and gingiva of the tooth requiring immobilization and extending over the adjacent healthy non-mobile teeth
B. Immobilization of the tooth by an emergency physician using 2.0 silk suture in a crisscross manner, including the palatal soft tissue and the vestibular soft tissue
C. Attachment of an acid-etch wire composite splint applied by a dentist that bonds a metal wire or splint directly to the injured tooth and the adjacent teeth
D. Use of commercially available arch-bars attached to the necks of teeth by wire ligatures applied by a dentist or oral surgeon
E. Use of a commercially available tissue adhesive, such as a cyanoacrylate, to apply steristrips to the injured tooth and adjacent teeth

Correct Answer: E

While there have been case reports published describing the use of cyanoacrylate-based tissue adhesives to secure splinting material to teeth, these adhesives are not currently approved for intraoral use and thus should be avoided.

All of the other descriptions of dental splints, such as Coe-Pak, silk sutures, acid-etch wire composite, and wire ligatures are appropriate for use in specific situations.

Periodontal dressing paste can be applied over the enamel and gingiva of the tooth requiring immobilization and extending over the adjacent healthy non-mobile teeth by an emergency physician. The most commonly used product is Coe-Pak—composed of zinc oxide/oil/a gum/and a fungicide in the pink paste that is combined with an activator in a different tube composed of liquid fatty acids thickened with rosin and bacteriostatic agents. The two substances are mixed together based on the box directions and form a thick gum like substance that can be applied to the teeth and gums to secure mobile teeth.

If as substance such as periodontal dressing paste is unavailable, 2.0 silk suture material can be utilized to secure a mobile tooth. The suture material should crisscross over the crown of the tooth and will likely need to go through the palatal soft tissue and the vestibular soft tissue to be secure. Utilization of a facial nerve block to provide adequate anesthesia is key for this procedure.

Dentists and oral surgeons are likely to use one of the following techniques to secure a grossly mobile tooth: acid-etch wire composite splint applied by a dentist that bonds a metal wire or splint directly to the injured tooth and the adjacent teeth; commercially available arch-bars attached to the necks of teeth by wire ligatures.

Take-Home Message
Splinting reimplanted and/or grossly mobile permanent teeth is a skill useful in the emergency department. Use of sutures or periodontal dressing paste is the most common technique employed by emergency physicians. This is a temporizing measure that can stabilize a tooth until the patient is able to follow up with a dentist.

ABP Content Specification
- Recognize the complications associated with application of a dental splint.
- Know the anatomy and pathophysiology relevant to application of a dental splint.

Question 11

Which of the following soft tissue injuries of the mouth does NOT require suturing?

A. Laceration of more than 2 cm on the dry mucosa of the lip
B. Laceration involving the vermillion border
C. Full-thickness laceration of the tongue
D. Through and through laceration of the lip
E. Linear laceration 1 cm long on central portion of tongue

Correct Answer: E

Lacerations of more than 2 cm that are on the dry mucosal surface of the lip will have better healing and cause less patient and parent distress if repaired.

Lacerations through the vermillion border of the lip that are left unrepaired can cause significant cosmetic deformity and thus always require repair.

While many tongue lacerations, especially those that are small, linear, and involve the central portion of the tongue, will heal quickly without the need for sutures, there are a few types of lacerations involving the tongue that require repair. Any tongue lacerations that involve large flaps on the side of the tongue, or the edge, or are through and through the tongue need suturing. Also, tongue lacerations that leave a gaping hole large enough for food particles to become entrapped should be considered for closure.

Full-thickness lip lacerations should have closure with the mucosal, skin, and muscle layers being closed separately. In small through and through lip lacerations, closure can be achieved by suturing the skin and mucosa alone, or even leaving a small open defect on the mucosal side if that defect is small enough to not collect food particles.

Take-Home Message
Tongue lacerations that involve the margins or those with large flaps need to be sutured, but most small and linear lacerations on the tongue surface heal well without the need to suture.

ABP Content Specification
- Know the indications and contraindications for management of soft tissue injuries of the mouth.

Question 12

A 3-year-old child sustains a laceration that extends through the orbicularis oris muscle, mucosa, and skin of the right lower lip. He is very anxious and you plan to do procedural sedation to facilitate the laceration repair. In preparing to repair this laceration, which of the following is an appropriate component of the care plan?

A. The use of lidocaine–epinephrine–tetracaine (LET) topical anesthesia in this laceration can negate the need for injectable anesthetic directly into the wound.
B. The best material to use on the repair of wet mucosal tissue is a non-absorbable suture such as nylon or proline.
C. Sutures in the mouth can require at least four-square knots to decrease the likelihood that

the constant motion of the tongue will untie the knots.

D. Direct infiltration of lidocaine with epinephrine into the laceration margins will give the best anesthesia without distortion of local structures.
E. Once the patient has awakened from his sedation, it is important to provide him food to eat prior to departing the emergency department.

Correct Answer: C

Intraoral sutures have a higher likelihood of becoming untied as compared to extra-oral sutures. This can be mitigated by using multiple "throws" for each suture placed, as well as doing inverted knots.

The use of lidocaine–epinephrine–tetracaine (LET) is contraindicated on the mucosal surface due to the potential for systemic absorption.

Nylon sutures can be annoying and painful due to the sharp ends that remain after cutting them and should thus be avoided in the mouth or on mucosal surfaces.

The best choice for anesthesia of this type of wound is with a mental block. This will provide good pain relief while avoiding the distortion (and blanching if epinephrine containing local anesthetic is used) of the vermillion border.

Parents should be advised to only give liquids to the patient until the LOCAL anesthesia has completely worn off.

Take-Home Message

Use a nerve block and absorbable sutures with multiple "throws" when repairing lip lacerations. Be wary of children eating immediately after repairs as they may still be numb and accidently injure the area just repaired by biting on when they are chewing.

ABP Content Specification

- Plan the key steps and know the potential pitfalls in performing management of soft tissue injuries of the mouth.
- Recognize the complications associated with management of soft tissue injuries of the mouth.

Question 13

Which of the following statements regarding dislocation of the temporomandibular joint (TMJ) is *TRUE*?

A. Conditions that are associated with the most commonly occurring type of TMJ dislocation include extreme mouth opening, prolonged mouth opening, and dystonic reactions or convulsions.
B. The most common position of an acute dislocation of the TMJ is in the posterior direction where the mandibular condyle becomes locked behind the mandibular fossa.
C. Closing of the jaw is controlled by the masseter, lateral/external pterygoid, and temporalis muscles.
D. Anterior, superior, and lateral dislocations are unusual and most frequently associated with significant trauma and concomitant fractures of the mandible.
E. Muscle spasms of the medial/internal pterygoid and temporalis muscles can make reduction difficult.

Correct Answer: A

Anterior dislocations of the TMJ are the most common and are associated with extreme mouth opening. These can occur with eating, yawning, laughing, or vomiting as well as prolonged mouth opening that can occur with oropharyngeal operative procedures or dental work.

Anterior dislocations result in the mandibular condyle being locked in the front of the articular eminence.

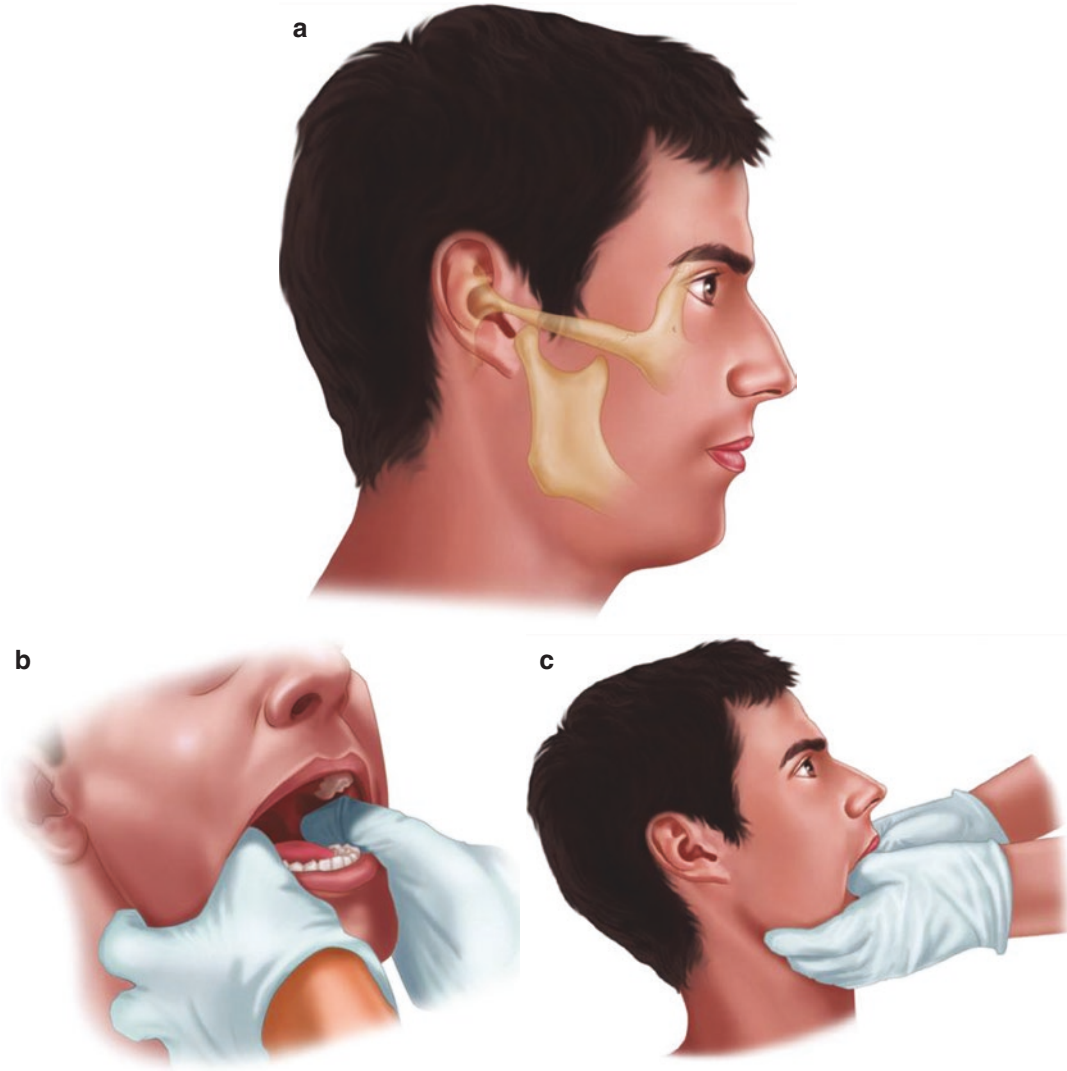
Opening of the jaw is controlled by the lateral/external pterygoid. Closure is controlled by the medial/internal pterygoid and the masseter and temporalis muscles.

Other types of mandibular dislocations are as follows:

- Posterior—usually due to trauma and associated with injury to the external auditory canal and/or temporal plate fracture

- Superior—usually due to severe trauma and associated with mandibular fossa fractures
- Lateral—usually due to trauma with associated fracture of the mandibular body

Spasms of the muscles associated with closure of the jaw (masseter, medial/internal pterygoid, and temporalis) can make reduction more difficult.



Reduction in progress: (**a**) In a mandibular dislocation, the condyle will be anterior and superior to the articular eminence. (**b**) Position the thumbs on mandibular molars and apply firm pressure in an inferior direction to distract the TM joint condyles so that they can reposition themselves into the glenoid fossa so that the TM joint can be reduced. (**c**) Lateral view of the distraction force with direction in an inferior direction to distract the condyle of the TM joint. (Drawings reprinted with permission from Spinger: *Atlas of Emergency Medicine Procedures*, by Latha Ganti, editor. 2016)

Take-Home Message

Anterior dislocations of the TMJ are most common. Firm pressure inferiorly on the mandibular molars intraorally often can reduce the TM joint dislocation. Patient may require procedural sedation to get adequate relaxation of the muscles associated with closure of the jaw (masseter, medial/internal pterygoid, and temporalis).

ABP Content Specification

- Know the anatomy and pathophysiology relevant to reduction of temporomandibular joint dislocation.

Question 14

A 15-year-old boy presents to the emergency department with the inability to close his mouth upon waking up this morning. Based on his complaint, you are concerned about a possible temporomandibular joint dislocation. During your evaluation of his complaint, all of the following are recommended EXCEPT?

A. A frank discussion with patient and parent of any medications that the patient is taking that could potentially cause a dystonic reaction
B. Radiographic evaluation of the mandible to exclude a fracture
C. Protection of your thumbs with gauze, finger splints, or tongue depressors to prevent injury from being bitten after successful reduction.
D. Testing the full range of motion of the TMJ after successful reduction
E. All the above is recommended

Correct Answer: D

It is important to investigate whether the patient is taking any medications that could have caused a dystonic reaction, which can mimic TMJ dislocation.

If the mechanism of dislocation is unknown or is associated with trauma, imaging studies such as radiographs or CT mandible are indicated to rule out fractures of the mandible prior to any attempts at reduction.

If the provider has his/her thumbs on the occlusal surface of the teeth during the reduction, it is possible to sustain significant injuries due to masseter muscle spasm after successful TMJ reduction. While placing thumbs on the buccal aspect of the ridge of the mandible may prevent this, it gives less leverage for the reduction. The muscles of the mandible are capable of generating over 300 lb/in^2 and thus capable of producing significant crush injuries.

After successful reduction, care should be taken to NOT open the mouth widely for up to 3 weeks to allow the involved ligaments and muscles to return to normal. During this time frame, a patient is at high risk for a recurrence of dislocation.

Take-Home Message

There is a high risk of recurrence of the TMJ dislocation and patients should eat a soft diet and avoid wide opening of the mouth for at least 2–3 weeks.

ABP Content Specification

- Plan the key steps and know the potential pitfalls in reducing temporomandibular joint dislocation.
- Recognize the complications associated with reduction of temporomandibular joint dislocation.

Suggested Reading

Question 1

Amsterdam JT, Kilgore KP. In: Roberts JR, Custalow CB, Thomsen TW, Hedges JR, editors. Roberts and Hedges' clinical procedures in emergency medicine. Philadelphia: Elsevier/Saunders; 2014). Regional anesthesia of the head and neck. p. 541–50.

Kassutto Z. Dental procedures. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 652–7.

Question 2

Amsterdam JT, Kilgore KP. In: Roberts JR, Custalow CB, Thomsen TW, Hedges JR, editors. Roberts and Hedges' clinical procedures in emergency medicine. Philadelphia: Elsevier/Saunders; 2014). Regional anesthesia of the head and neck. p. 541–50.

Kassutto Z. Dental procedures. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 652–7.

Question 3

Harris EM. Incision and drainage of a dental abscess. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 659–62.

Question 4

Harris EM. Incision and drainage of a dental abscess. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 659–62.
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Question 5

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Question 6

Loiselle JM, Pitone M. Management of dental fractures. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams and Wilkins; 2008. p. 663–8.
McTigue DJ. Diagnosis and management of dental injuries in children. Pediatr Clin North Am. 2000;47(5):1067–84.

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McTigue DJ. Diagnosis and management of dental injuries in children. Pediatr Clin North Am. 2000;47(5):1067–84.

Question 8

Benko K. In: Roberts JR, Custalow CB, Thomsen TW, Hedges JR, editors. Roberts and Hedges' clinical procedures in emergency medicine. Philadelphia: Elsevier/Saunders; 2014). Emergency dental procedures. p. 1342–61.
Nelson LP, Needleman HL, Padwa BL. Dental trauma. In: Fleisher GR, Ludwig S, editors. Textbook of pediatric emergency medicine. Philadelphia: Lippincott Williams & Wilkins; 2010. p. 1289–97.

Question 9

Benko K. In: Roberts JR, Custalow CB, Thomsen TW, Hedges JR, editors. Roberts and Hedges' clinical procedures in emergency medicine. Philadelphia: Elsevier/Saunders; 2014). Emergency dental procedures. p. 1342–61.
Diaz MC. Splinting teeth. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 674–9.

Question 10

Benko K. In: Roberts JR, Custalow CB, Thomsen TW, Hedges JR, editors. Roberts and Hedges' clinical procedures in emergency medicine. Philadelphia: Elsevier/Saunders; 2014). Emergency dental procedures. p. 1342–61.
Diaz MC. Splinting teeth. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 674–9.
Lin S, Emodi O, Abu El-Naaj I. Splinting of an injured tooth as a part of emergency treatment. Dent Traumatol. 2008;24(3):370–2.

Question 11

Attia MW, Loiselle J. Management of soft-tissue injuries of the mouth. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 680–7.
Lammers RL, Smith ZE. In: Roberts JR, Custalow CB, Thomsen TW, Hedges JR, editors. Roberts and Hedges' clinical procedures in emergency medicine. Philadelphia: Elsevier/Saunders; 2014). Methods of wound closure. p. 644–89.

Question 12

Attia MW, Loiselle J. Management of soft-tissue injuries of the mouth. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 680–7.

Lammers RL, Smith ZE. In: Roberts JR, Custalow CB, Thomsen TW, Hedges JR, editors. Roberts and Hedges' clinical procedures in emergency medicine. Philadelphia: Elsevier/Saunders; 2014). Methods of wound closure. p. 644–89.

Question 13

Pratt A, Loiselle JM. Reduction of temporomandibular joing dislocation. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 688–92.

Riviello RJ. In: Roberts JR, Custalow CB, Thomsen TW, Hedges JR, editors. Roberts and Hedges' clinical procedures in emergency medicine. Philadelphia: Elsevier/Saunders; 2014). Otolaryngologic procedures. p. 1298–341.

Question 14

Pratt A, Loiselle JM. Reduction of temporomandibular joing dislocation. In: King C, Henretig FM, editors. Textbook of pediatric emergency procedures. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 688–92.

Riviello RJ. In: Roberts JR, Custalow CB, Thomsen TW, Hedges JR, editors. Roberts and Hedges' clinical procedures in emergency medicine. Philadelphia: Elsevier/Saunders; 2014). Otolaryngologic procedures. p. 1298–341.

Dental Procedures

29

Janice A. Townsend, Suzanne E. Fournier, and Brett J. King

Question 1

A 10-year-old child is an unrestrained back seat passenger in a motor vehicle accident. Physical examination reveals left-sided post-auricular ecchymosis. This is most indicative of:

A. Left-sided mandibular condylar fracture
B. Basilar skull fracture
C. Le Fort III fracture
D. Left-sided zygomaticomaxillary complex (ZMC) fracture
E. Left-sided ruptured tympanic membrane

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Correct Answer: B

Commonly called Battle's sign, a hematoma over the mastoid process behind the ears may indicate a basilar skull fracture. Other clinical signs of a basilar skull fracture are hemotympanum, cerebrospinal fluid (CSF) leak, rhinorrhea or otorrhea, and sub-scleral hemorrhage. In addition, seizure activity, loss of unconsciousness, abnormal mental status, and abnormal neurologic findings are all indications for obtaining a head CT scan. Basilar fractures suggest considerable impact force and are highly associated with underlying brain injury. An epidural hematoma should be suspected in patients with a temporal bone basilar skull fracture. Additionally, whenever a basilar skull fracture is suspected, a nasogastric tube should not be used because the tube may inadvertently pass into the cranial vault.

A mandibular condylar fracture often presents with swelling in the ipsilateral pre-auricular region over the temporomandibular joint (TMJ). This is often associated with trismus and a malocclusion. A mandible with a unilateral fractured condyle may displace to the ipsilateral side upon opening. A Le Fort III fracture can display signs of craniofacial skeletal separation associated with mobility of the midface segment bilaterally and bilateral soft tissue swelling as shown in Figs. 29.1 and 29.2. A unilateral zygomaticomaxillary complex (ZMC) fracture may also present with unilateral facial swelling over

M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_29

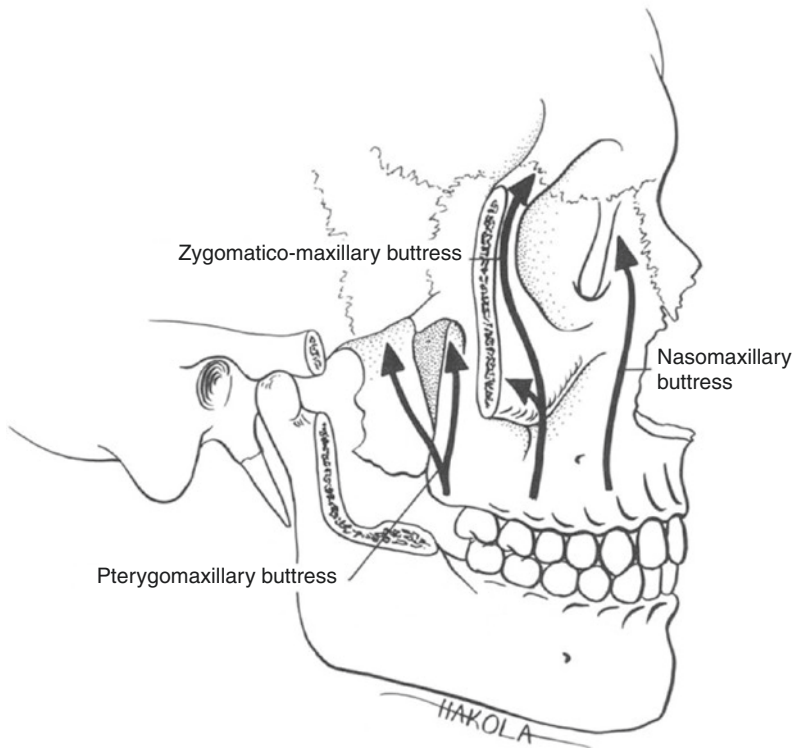

Fig. 29.1 Vertical buttresses of the midface. (Fig. 10.5 on page 207 of Ferraro JW. *Fundamentals of Maxillofacial Surgery*, 1996)

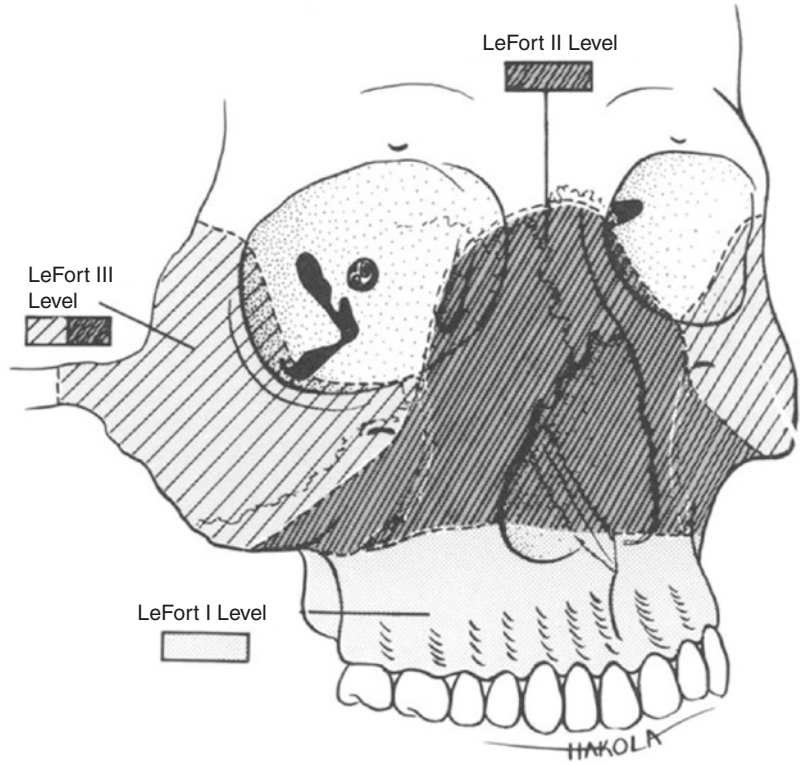

Fig. 29.2 LeFort maxi Ilary fractures. (Figs. 10.6 on page 207 of Ferraro JW. *Fundamentals of Maxillofacial Surgery*, 1996)

the malar and zygomatic arch region. A ZMC fracture may also display a concomitant trismus due to the fractured zygomatic arch mechanically impinging the coronoid process of the mandible upon opening. A ruptured tympanic membrane with associated hemotympanum may also be a sign of a basilar skull fracture; however, it would not be associated with a post-auricular ecchymosis if a fracture was not also present.

Take-Home Message
Post-auricular ecchymosis, or Battle's sign, secondary to trauma is a clinical sign of a basilar skull fracture.

ABP Content Specification
- Know common physical examination findings seen in facial fractures in children.
- Recognize urgent complications of facial, orbital, and nasal fractures (e.g., retro-orbital hematoma, cribriform plate fractures, and septal hematoma).
- Recognize and interpret radiographic evaluation of facial trauma.
- Recognize the physical examination findings and plan the management of mandibular fracture.
- Plan the management of common facial fractures in children.

Question 2

An 8-year-old unhelmeted child falls off his or her scooter and lands chin first. The child presents to the emergency department with a full-thickness chin laceration and multiple chipped teeth. The symphysis of the mandible is visualized, and there is no fracture noted. Injuries of this type are often associated with a high incidence of

A. Damage to the developing permanent dentition
B. Basilar skull fractures
C. Unilateral or bilateral mandibular condylar fractures
D. Le Fort I fracture
E. Palatal fracture

Correct Answer: C

Less than 5% of all facial fractures occur in children; however, fractures of the mandible are the second most common facial fracture in this population, and they account for approximately 1/3 of pediatric facial fractures. The discrepancy between children and adults is partially due to the greater elasticity of the pediatric mandible in comparison to the adult mandible. A high index of suspicion must be maintained when evaluating an injured child and the mechanism of injury should be taken into consideration. The thin neck of the mandibular condylar is susceptible to fracture secondary to a direct blow to the symphysis region as shown in Figs. 29.3 and 29.4. As a result of the blunt force to the symphysis region, the condyles often be propelled posteriorly and superiorly and contact the glenoid fossa(e). The resultant force may be absorbed by the condylar head and neck which are thus susceptible to fracture although they did not sustain the direct blow during the traumatic event. Mechanism of injury and clinical findings should lead the clinician to perform a complete evaluation including obtaining appropriate imaging for evaluation of condylar/sub-condylar mandibular fractures. It would be highly unlikely that an injury sustained in this manner would cause damage to the developing permanent dentition, a basilar skull fracture, a Le Fort I or palatal fracture, especially in a child.

Take-Home Message
Mechanism of injury plays a key role in the evaluation of the pediatric facial trauma patient. Mandibular condylar and sub-condylar fractures are frequently overlooked as they are distant to the site of contact and may pose a challenge to diagnose without obtaining appropriate imaging studies.

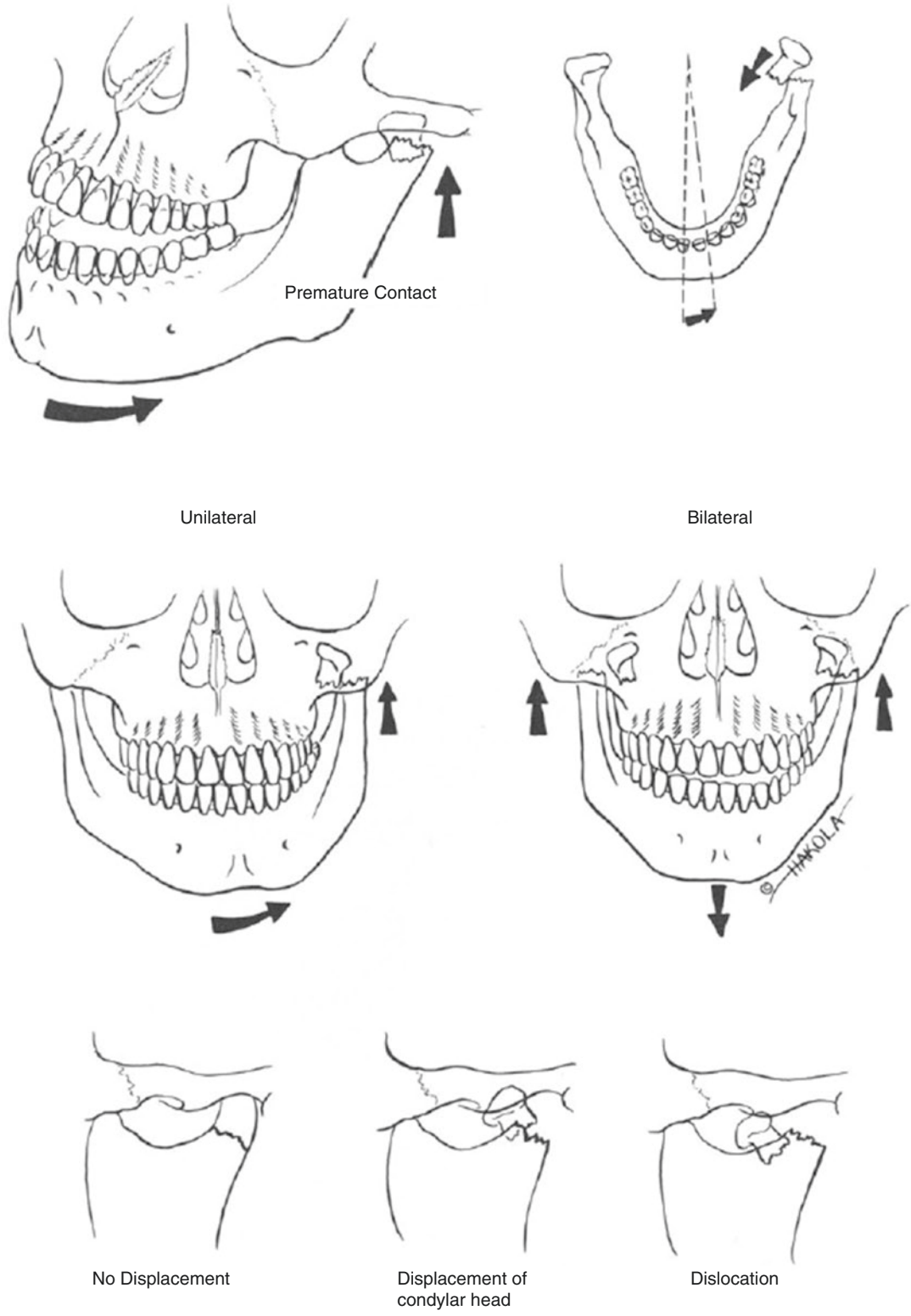

Fig. 29.3 Condylar fractures. (Fig. 9.2 on page 195 of Ferraro JW. *Fundamentals of Maxillofacial Surgery*, 1996)

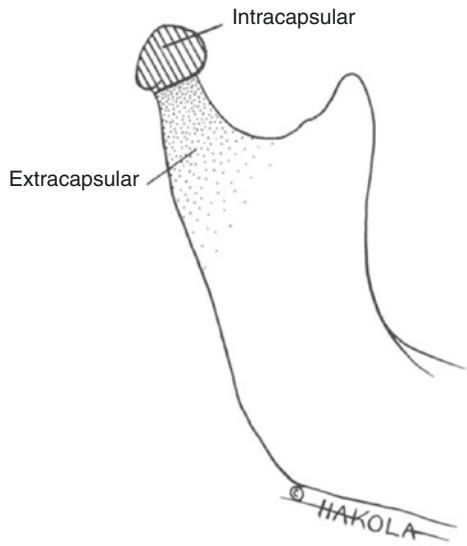

Fig. 29.4 Anatomic division of condylar fractures. (Fig. 9.3 on 196 of Ferraro JW. *Fundamentals of Maxillofacial Surgery*, 1996)

ABP Content Specification

- Recognize common patterns of injury in children with major trauma with respect to anatomic and physiologic differences by age.
- Know the importance of mechanisms of injury in the evaluation of children with major trauma.
- Recognize the physical examination findings and plan the management of mandibular fracture.
- Recognize and interpret radiographic evaluation of facial trauma.

Question 3

Among children less than 7 years old, orbital fractures most commonly occur in which location?

A. Floor
B. Medial wall
C. Lateral wall
D. Roof
E. Posterior wall

Correct Answer: D

In children of this age, the maxillary, sphenoid, ethmoid and frontal sinuses are not yet pneumatized and as a result fronto-basilar (roof) injuries most commonly occur. As the frontal sinus pneumatizes, the transmission of force from the superior orbital rim to the anterior cranial base is diminished. Concordantly, orbital roof fractures are rare in adulthood and are replaced by a predominance of frontal sinus fractures. In children, the most common fracture pattern extends along the frontal bone coursing through the supraorbital foramen, and then progresses along the orbital roof/anterior cranial base. Orbital wall or floor injuries rarely occur in young children. The lateral orbital wall is the only non-sinus boundary of the orbital cavity. Fractures of the lateral orbital wall are rare in children due to the strong zygomatic and frontal bones.

Take-Home Message

Orbital roof fractures are the most common orbital fracture in children. As the paranasal sinuses develop, the likelihood of an orbital roof fracture occurring diminishes significantly.

ABP Content Specification

- Know common physical examination findings seen in facial fractures in children.
- Recognize urgent complications of facial, orbital, and nasal fractures (e.g., retro-orbital hematoma, cribriform plate fractures, and septal hematoma).

Question 4

Branches of which cranial nerve should be anesthetized for dental procedures?

A. V
B. VII
C. IX
D. X
E. XII

Correct Answer: A

An understanding of the anatomy of the orofacial complex is necessary for appropriate local anesthesia for dental emergencies. The maxillary and mandibular divisions (V_2 and V_3, respectively) of the fifth craniofacial nerve or trigeminal nerve provide innervation to the orofacial complex as shown in Figs. 29.5–29.7 and Tables 29.1 and 29.2.

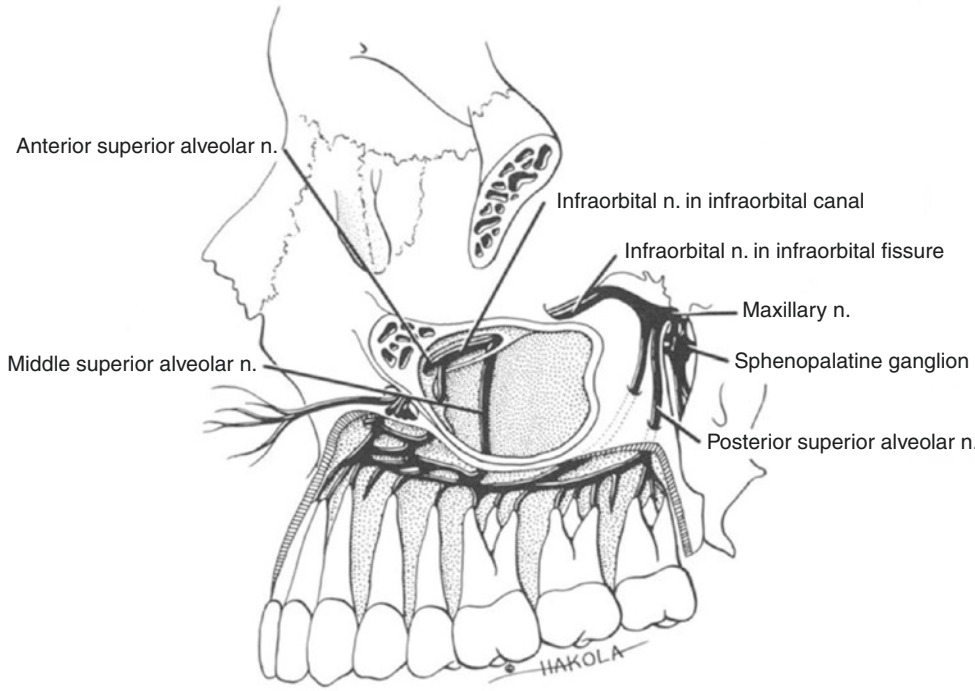

Fig. 29.5 Terminal branches of the infraorbital nerve from the maxillary division of the trigeminal nerve to the maxillary dentition. (Fig. 6.3 from Ferraro JW. *Fundamentals of Maxillofacial surgery*)

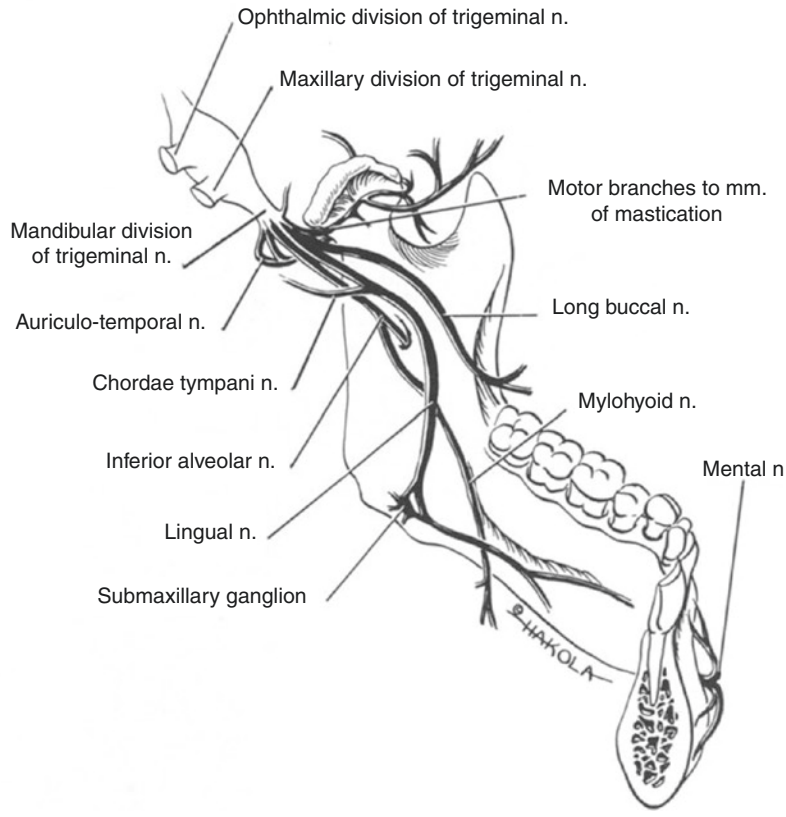

Fig. 29.6 Mandibular branch of trigeminal nerve. (Fig. 6.4 from Ferraro JW. *Fundamentals of Maxillofacial surgery*)

Take-Home Message

Knowledge of the anatomy of the innervation of the maxillary and mandibular division of the trigeminal nerve is necessary for proper anesthesia for dental emergency treatment.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to orofacial anesthesia techniques.

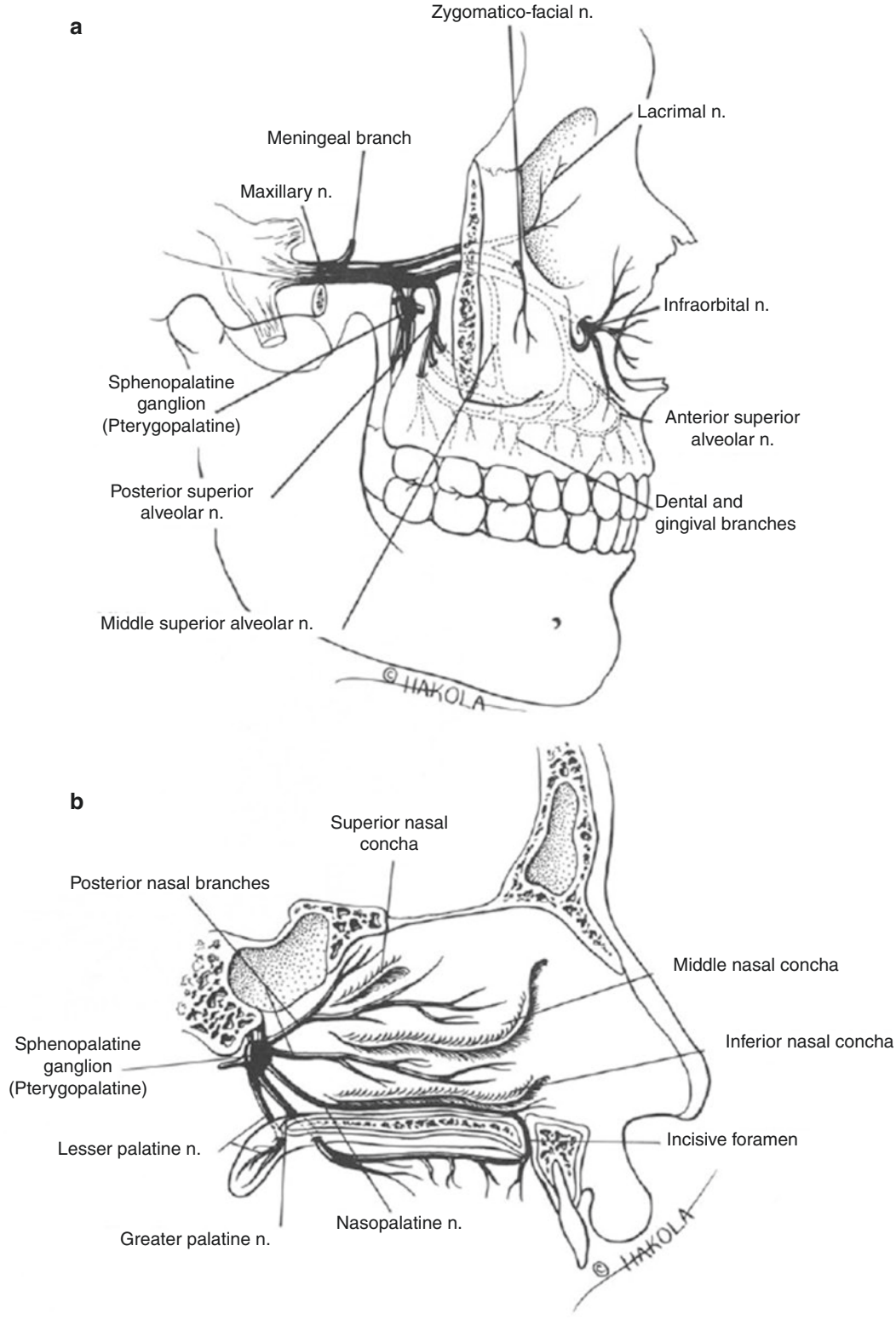

Fig. 29.7 (**a**) Maxillary division (v_2) of the trigeminal nerve. (**b**) Communicating branches from the maxillary division (v_2) of the trigeminal nerve to the sphenopalatine (pterygopalatine) ganglion. Continued (**c**) Terminal branches of the maxillary division (v_2) of the trigeminal nerve that innervates the anterior and posterior palate. (Fig. 6.2 from Ferraro JW. *Fundamentals of Maxillofacial surgery*)

Fig. 29.7 (continued)

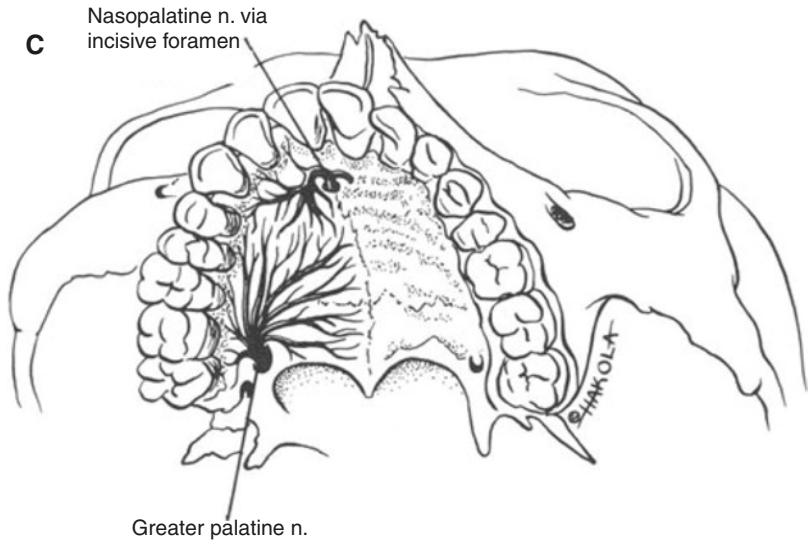

Table 29.1 Innervation of the teeth

Teeth innervation	Nerve
Maxillary incisors	Anterior superior alveolar (ASA)
Maxillary canines	Anterior superior alveolar
Maxillary premolars	Middle superior alveolar (may have some innervation from ASA and PSA)
Maxillary molars	Posterior superior alveolar (PSA)
Mandibular molars	Inferior alveolar nerve
Mandibular first premolar	Inferior alveolar nerve, mental branch
Mandibular incisors	Inferior alveolar nerve, incisal branch

Table 29.2 Innervation of the gingival tissues

Gingival innervation	Nerve
Facial of the maxillary incisors and canines	Anterior superior alveolar (ASA)
Lingual of the maxillary incisors and canines	Nasopalatine nerve
Maxillary premolars	Middle superior alveolar (may have some innervation from ASA and PSA)
Lingual to the maxillary premolars and molars	Greater palatine nerve
Maxillary molars	Posterior superior alveolar (PSA)
Lingual to the maxillary premolars and molars	Greater palatine nerve
Lingual of mandibular molars and premolars	Inferior alveolar nerve
Buccal and lingual of the mandibular canines and incisors	Inferior alveolar nerve, mental branch and incisal branch
Buccal of mandibular molars	Long buccal

Question 5

A patient presents with severe pain on a mandibular molar and you wish to administer local anesthesia for pain relief. Which injection is recommended?

A. Buccal supra-periosteal infiltration
B. Inferior alveolar nerve block
C. Lingual supra-periosteal infiltration
D. Long buccal nerve block
E. Mental nerve block

Correct Answer: B

Local anesthesia of the oral cavity may be indicated in the emergency department for repair of soft tissue lacerations, fractured teeth, repositioning teeth, or to relieve dental pain. Typically, lidocaine or articaine is recommended for most procedures. Bupivacaine may be used for lengthy surgical procedures and when long-lasting pain relief is necessary. Use of vasoconstrictor such as epinephrine is recommended to prolong duration of anesthesia and prevent systemic absorption. It is necessary to have a weight for all pediatric patients and calculate the manufacturer's recommended dosage (MRD) of anesthetic agent for that patient. If sedation is being used in conjunction with local anesthesia, the physician is advised to reduce the dosage below the MRD as shown in Table 29.3.

Topical anesthetic is recommended before administration of anesthetic and is generally more efficacious when used on loose mucosal tissues versus the hard palate. Absorption is better when tissue is dry. Twenty percent benzocaine is typically used in dentistry, although EMLA (a eutectic mixture of lidocaine 2.5% and prilocaine 2.5%) may be used. The concentration of local anesthetics in topical anesthesia should be considered when determining total local anesthesia dosages.

Local anesthesia is typically administered via a supra-periosteal infiltration injection or a nerve block injection. In supra-periosteal injection, local anesthesia is administered apical to the tooth near the apex of the roots. The anesthetic infiltrates through the cortical bone to anesthetize the nerve. This injection is most effective when the cortical bone is thin such as for the maxillary incisors, canines, and premolars. The maxillary molars have thicker cortical bone but this technique is typically effective. The mandibular teeth have dense cortical bone and this technique is unpredictable for older teenagers and adults. It may be more effective for children due to the porosity of the cortical bone but adequate anesthesia may not be achieved. Infiltration is only effective for one to two teeth, and the duration is 30–45 minutes. The physician should avoid giving local anesthetic into infected tissue. If this interferes with infiltration then the physician should consider block anesthesia or alternatives to local anesthesia such as sedation or general anesthesia.

Table 29.3 Characteristics of common injectable local anesthetics

Agent	MRD	Duration	
		Pulpal anesthesia (min)	Soft tissue anesthesia (min)
2% lidocaine w/ 1:100,000 epinephrine	7 mg/kg not to exceed 500 mg	60	180–300
4% Articaine w/ 1:100,000 epinephrine	7 mg/kg not to exceed 500 mg	60–75	180–360
0.5% bupivacaine w/ 1:200,000	1.3 mg/kg not to exceed 90 mg	>90	240–720

Malamed SF. Clinical action of specific agent. In: Malamed SF, (Ed.) Handbook of local anesthesia. sixth Edition. St. Louis: Elsevier; 2013. pp. 52–75

Block anesthesia requires the placement of local anesthetic adjacent to nerve trunks and anesthetizes all teeth innervated by that nerve. The mandibular inferior alveolar nerve block is the most commonly used block technique in dentistry. This nerve block will provide pulpal anesthesia to all of the teeth in the quadrant. This injection is commonly administered with a lingual nerve block which provides anesthesia to the anterior two-thirds of the tongue, the floor of the mouth, and the lingual mucous membrane as shown in Fig. 29.8. The duration of pulpal anesthesia after nerve blocks is longer than the duration for infiltration.

An aspirating syringe should always be used to deliver intraoral anesthesia, and aspiration is essential for the administration of nerve blocks. The vasculature is often adjacent to nerve trunks and aspiration prevents inadvertent intravascular injections. Some authors discourage the use of higher concentration local anesthetics such as 4% articaine and 4% prilocaine due to concerns of paresthesia upon block administration.

Following administration of a nerve block, the physician should allow 5 minutes for it to take effect and then check its success with a sharp instrument before commencing surgical procedures as there is potential to miss the block.

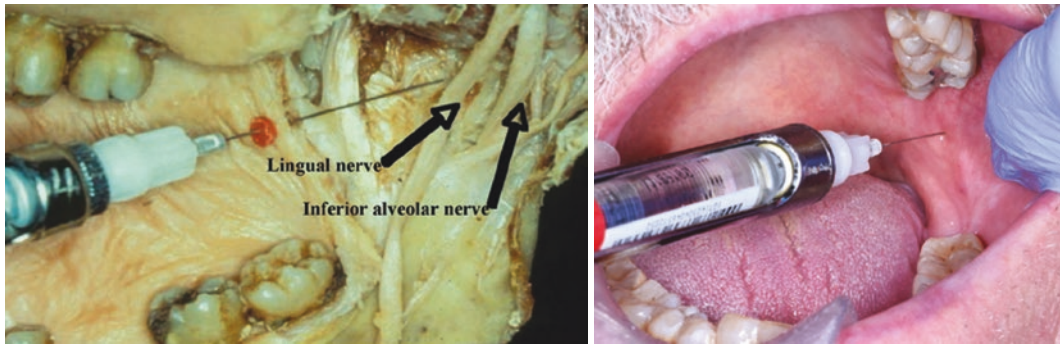

Fig. 29.8 Needle placement for inferior alveolar and lingual nerve blocks. (Fig. 18.10 by Kaye AD, Urman RD, Vadivelu N, *Essentials of Regional Anesthesia*)

Take-Home Message
Local anesthesia may help patients with traumatic injuries or dental pain but proper knowledge of technique is essential.

ABP Content Specification
- Know the indications and contraindications for orofacial anesthesia techniques.
- Plan the key steps and know the potential pitfalls of orofacial anesthesia techniques.

Question 6

You are administering a posterior superior alveolar nerve block. In less than a minute the patient has swelling and redness of their upper cheek. What is the most probable cause?

A. Allergic reaction
B. Hematoma
C. Needle breakage
D. Overdose
E. Intravascular injection

Correct Answer: B

Administration of intraoral local anesthesia does have the potential for the following complications.

Hematoma—This complication is typically encountered with block anesthesia, and the posterior superior alveolar nerve block is the most common. Ice and pressure should be applied immediately to reduce swelling.

Needle breakage—Breakage is rare but is encountered when a needle is bent and inserted to the hub and if there is unexpected movement during administration. This can be prevented through the use of needles of sufficient length so as not to go to the hub and use of 25- or 27-gauge needles and securing the patient's head to prevent unexpected movements.

Intravascular injection—This adverse event is associated with block anesthesia and can be prevented with the use of an aspirating syringe and aspiration.

Paresthesia—Persistent numbness is associated with block anesthesia. Its etiology is controversial, but some authors caution against the use of 4% anesthetic solutions.

Overdose—This complication is more common with children and can be prevented by calculating the MRD for each patient based on weight prior to anesthetic administration. Topical anesthetic dosages should be taken into account.

Take-Home Message
Adverse events can be associated with local anesthesia but most are preventable through proper technique.

ABP Content Specification
- Recognize the complications associated with orofacial anesthesia techniques.

Question 7

A 14-year-old girl presents to the emergency department with a fever of 101 °F and intraoral vestibular swelling in the left posterior maxillary buccal vestibule with overlying periorbital cellulitis. Which of the following decayed teeth is the most likely cause of the swelling and what is the best treatment?

A. Maxillary right canine/oral antibiotics
B. Maxillary left second molar/oral antibiotics
C. Maxillary right first molar/oral antibiotics
D. Maxillary left second premolar/incision and drain
E. Maxillary right central incisor/IV antibiotics

Correct Answer: D

Maxillary area swelling can spread toward the orbits and cause periorbital cellulitis that can progress intracranially and cause cavernous sinus thrombosis which could be fatal. If the swelling were extending from the inferior boarder of the auricle to the submental midline, it would most likely be due to a posterior mandibular tooth. Swelling lateral to the nose inferior to the orbit would originate from a maxillary incisor or potentially canine. Infection leading to surrounding cellulitis with abscess formation requires therapy with IV antibiotics and incision and drainage are indicated. However, not all dental infections require incision and drainage or oral antibiotics. Some dental infections are slow to progress and drain through fistulae, which are duct-like passages that connect the area of the infection through the alveolar bone to the oral cavity. Such infections do not require treatment other than to remove the source of the infection through either extraction or endodontic therapy. Mandibular tooth infections with surrounding spread can lead to difficulty in swallowing, mastication, proper mouth opening (trismus), and even respiratory distress. This is termed Ludwig's Angina and is potentially life threatening. The provider must ensure the patient does not become dehydrated and does not have a compromised airway. After a careful review of the patient's medical history, reduction in the swelling should be urgently accomplished. Due to the swelling, trismus may prevent the patient from being able to open more than 10 mm, and the infection may impede the provider's ability to ensure adequate local anesthesia. To remove the source of the infection either through extraction or endodontics, the patient will need a reduction in swelling so as to be able to obtain adequate local anesthesia, and incision and drainage is the treatment of choice.

Incision and drainage is accomplished by a small incision approximately 1 cm in length with an 11 or 15 blade after appropriate local anesthesia. Intraoral suction should be used upon incision to prevent the patient from swallowing the purulent exudate. The provider should then insert hemostats into the incision and open them after contacting bone to dissect the tissue allowing for complete drainage followed by irrigation with 60–100 mL of either chlorhexidine or sterile saline. A Penrose drain should be placed into the affected fascial space and sutured into place to allow for continued drainage and irrigation and removed in the following 24–72 hours. The patient should be treated with antibiotics (penicillin or clindamycin) for 7–10 days. Once the facial cellulitis is eliminated, the patient can proceed with either extraction or endodontic (i.e., root canal) therapy.

Take-Home Message

Understanding of the facial planes is important to know in order to correctly manage facial swellings. Drainage of facial swellings is imperative to prevent the spread of infection in cases of mandibular swellings that impede swallowing and respiration, and maxillary swellings impinging on the orbit.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to incision and drainage of a dental abscess.
- Know the indications and contraindications for incision and drainage of a dental abscess.

- Plan the key steps and know the potential pitfalls in performing incision and drainage of a dental abscess
- Recognize the complications associated with incision and drainage of a dental abscess

Question 8

A 10-year-old boy presents to the emergency department with the maxillary centermost tooth on the patient's right side in the front fractured. How would you most accurately communicate this tooth with a dental consultant?

A. Permanent right central incisor
B. Primary right central incisor
C. Permanent right lateral incisor
D. Primary right lateral incisor
E. Permanent right premolar

Correct Answer: A

Knowledge of the terminology to describe teeth can be very helpful when communicating with dental specialists and for accurate documentation. Permanent teeth are numbered from 1 to 32 (see Fig. 29.13), and the 20 primary teeth are identified by letters A–T (see Fig. 29.9). While in an ideal situation the physician would communicate these numbers or letters, it is understandable that the infrequency of use would make them difficult to recall. Therefore, identifying the tooth by the type of tooth and location within the arch is an acceptable method which is likely more accurate as shown in Figs. 29.9–29.12. Therefore, the physician may choose to identify the permanent maxillary centermost tooth on the right as the right permanent maxillary central incisor or by calling it tooth number 8.

Likewise, knowledge of dental terminology as shown in Table 29.4 and Figs. 29.14 and 29.15 to describe the location of injuries or decay on a tooth can help communication and documentation. These terms are summarized below:

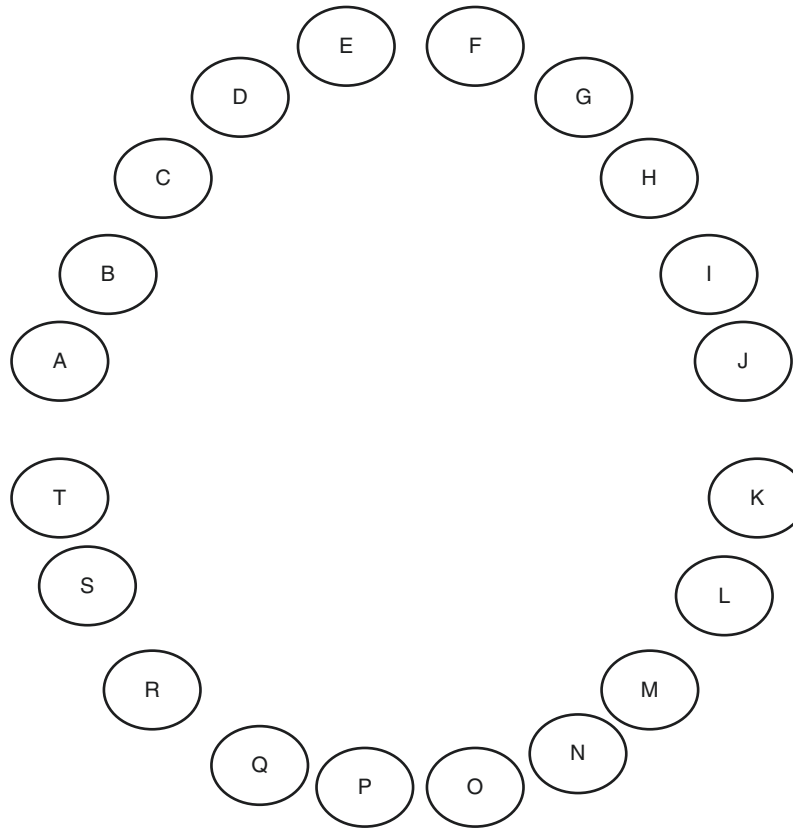

Fig. 29.9 Primary Dental Charting with Letters

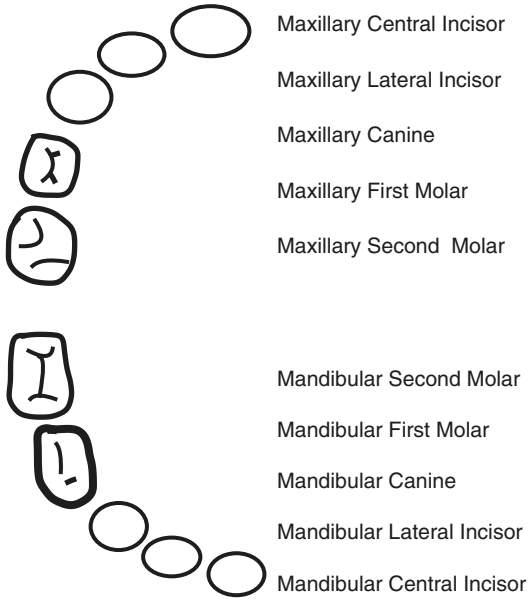

Fig. 29.10 Primary Dental Tooth Chart

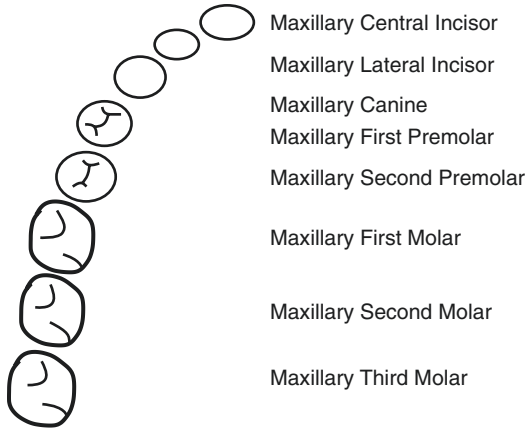

Fig. 29.11 Maxillary Permanent Teeth

Dental fractures of primary and permanent teeth are classified and treated similarly although every effort should be made to preserve a permanent tooth while an extraction may be more appropriate for a primary tooth, especially if it is nearing exfoliation. Typically, primary teeth can be differentiated from permanent teeth by the age, location, the smaller size, and the whiter appearance. If there is any question of where a tooth is primary or permanent it should be treated as a permanent tooth until radiographs or consultation with a dentist prove otherwise. Access to a dental development in chart as shown in Table 29.5 in the emergency department is advised.

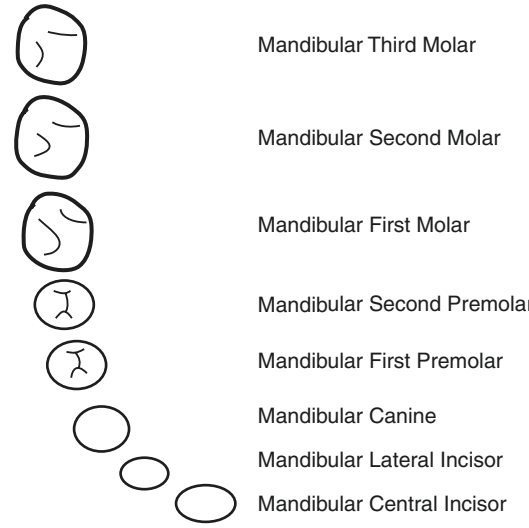

Fig. 29.12 Mandibular Permanent Teeth

Take-Home Message

Knowledge of the anatomy and terminology of teeth can improve communication, documentation, and is essential for appropriate treatment.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to management of dental fractures.

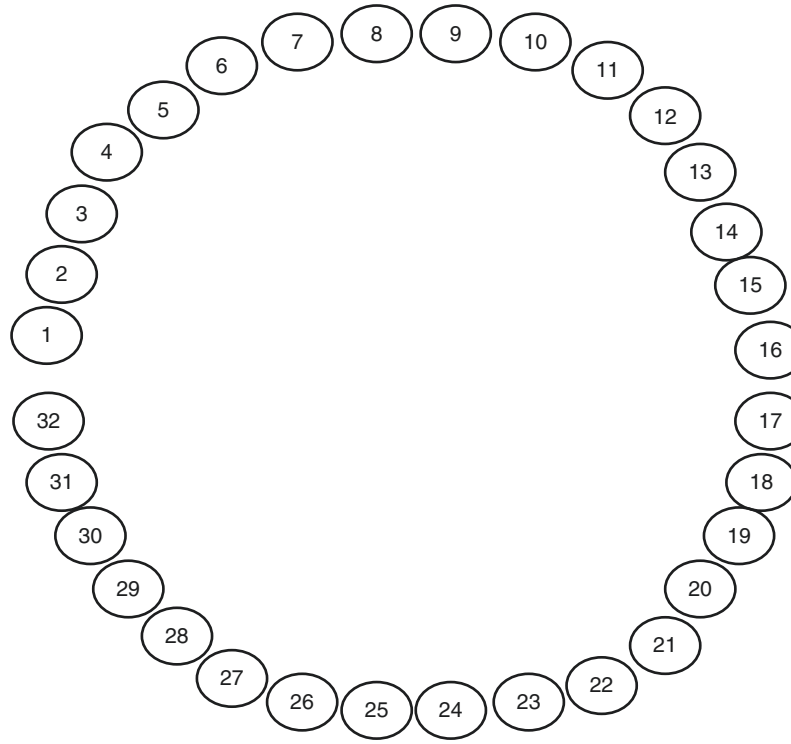

Fig. 29.13 Permanent Dental Charting with Numbers

Table 29.4 Dental terminology

Facial/ buccal/labial	Surface closes to the lips or cheeks
Lingual	Surface closes to the tongue
Occlusal	Biting surface of the back teeth
Incisal	Edges of the front teeth farthest from gingiva
Gingival	Portion of the teeth nearest the gingiva
Mesial	Closest to the midline
Distal	Furthest from the midline
Coronal	Toward the biting surface
Apical	Toward the end of the root of the teeth

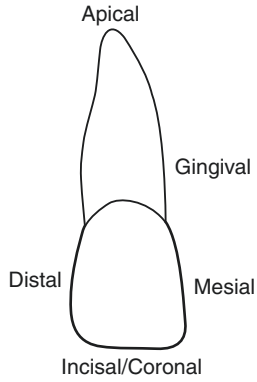

Fig. 29.14 Dental Terminology

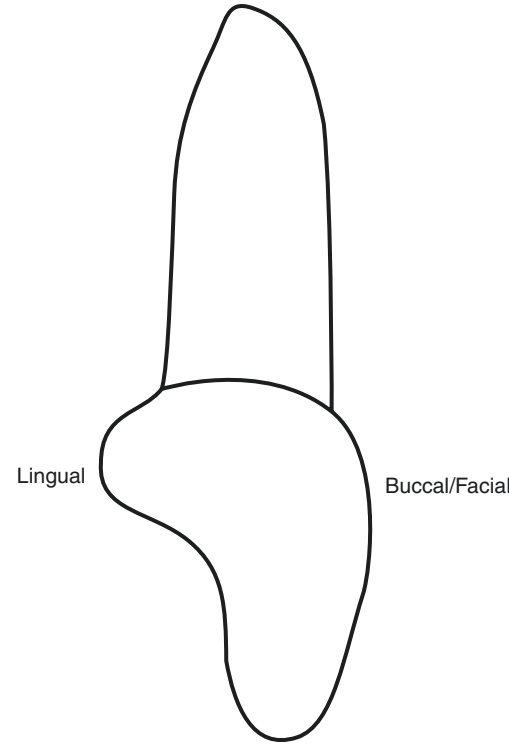

Fig. 29.15 Dental Terminology – Lateral view

Table 29.5 Dental development

Primary dentition				
	Eruption		Exfoliation	
	Maxillary	Mandibular	Maxillary	Mandibular
Central incisors	6–10 months	5–8 months	7–8 years	6–7 years
Lateral incisors	8–12 months	7–10 months	8–9 years	7–8 years
Canines	16–20 months	16–20 months	11–12 years	9–11 years
First molars	11–18 months	11–20 months	9–11 years	10–12 years
Second molars	20–30 months	20–30 months	9–12 years	11–13 years

	Permanent teeth	
	Eruption	
	Maxillary	Mandibular
Central incisors	7–8 years	6–7 years
Lateral incisors	8–9 years	7–8 years
Canines	11–12 years	9–11 years
First premolars	10–11 years	10–12 years
Second premolars	10–12 years	11–13 years
First molars	5.5–7 years	5.5–7 years
Second molars	12–14 years	12–14 years
Third molars	17–30 years	17–30 years

Question 9

A 12-year-old boy presents with a fractured tooth. When you examine the tooth, you can see red pulp tissue in the fractured area. What would be the best treatment of this patient?

A. Emergency referral to dentist for pulp therapy
B. Emergency referral to oral surgeon for extraction
C. Place a temporary restoration placed in the ED
D. Prescribe a 14-day regimen of amoxicillin therapy
E. Perform incision and drainage in the vestibule above the tooth

Correct Answer: A

Dental fractures are common dental injuries and timely diagnosis and management can prevent infection and premature loss of permanent teeth. Pulp exposure is a true dental emergency and dental consultation should be obtained in the ED. The tooth is made of layers of hard and soft tissue, namely, the enamel, dentin, and pulp, as shown in Fig. 29.16.

The enamel is the hard, white outer layer of teeth. The dentin is the yellowish, firm but slightly spongy tissue below the enamel. This tissue houses nerve endings and can be painful when it is exposed. The pulp tissue is the innermost layer of the tooth and is composed of vital connective tissue and nerve tissue. Traumatic injuries that expose the pulp with its compromise blood supply can result in pain, inflammation, necrosis, resorption of the hard tissue, and potential tooth loss. Dental fractures are classified by the dental tissue that is involved, and treatment varies by fracture type as in Table 29.6.

Evaluation and treatment by a dentist is optimal in the case of fractured teeth but it is understood that some patients may not have this access. In these cases, application of a protective dressing such as calcium hydroxide can be applied in the emergency department. This material should be covered by a hard setting glass ionomer cement or it will become dislodged. Tin foil has been recommended to cover the calcium hydroxide if glass ionomer is not available. The emergency physician should make no attempt to remove the pulp tissue. All patients, even those with minor exposures, should be advised to see a dentist immediately because the pulp tissue can lose vitality after any dental injury and treatment such as a pulpotomy or pulpectomy may be indicated to preserve the tooth.

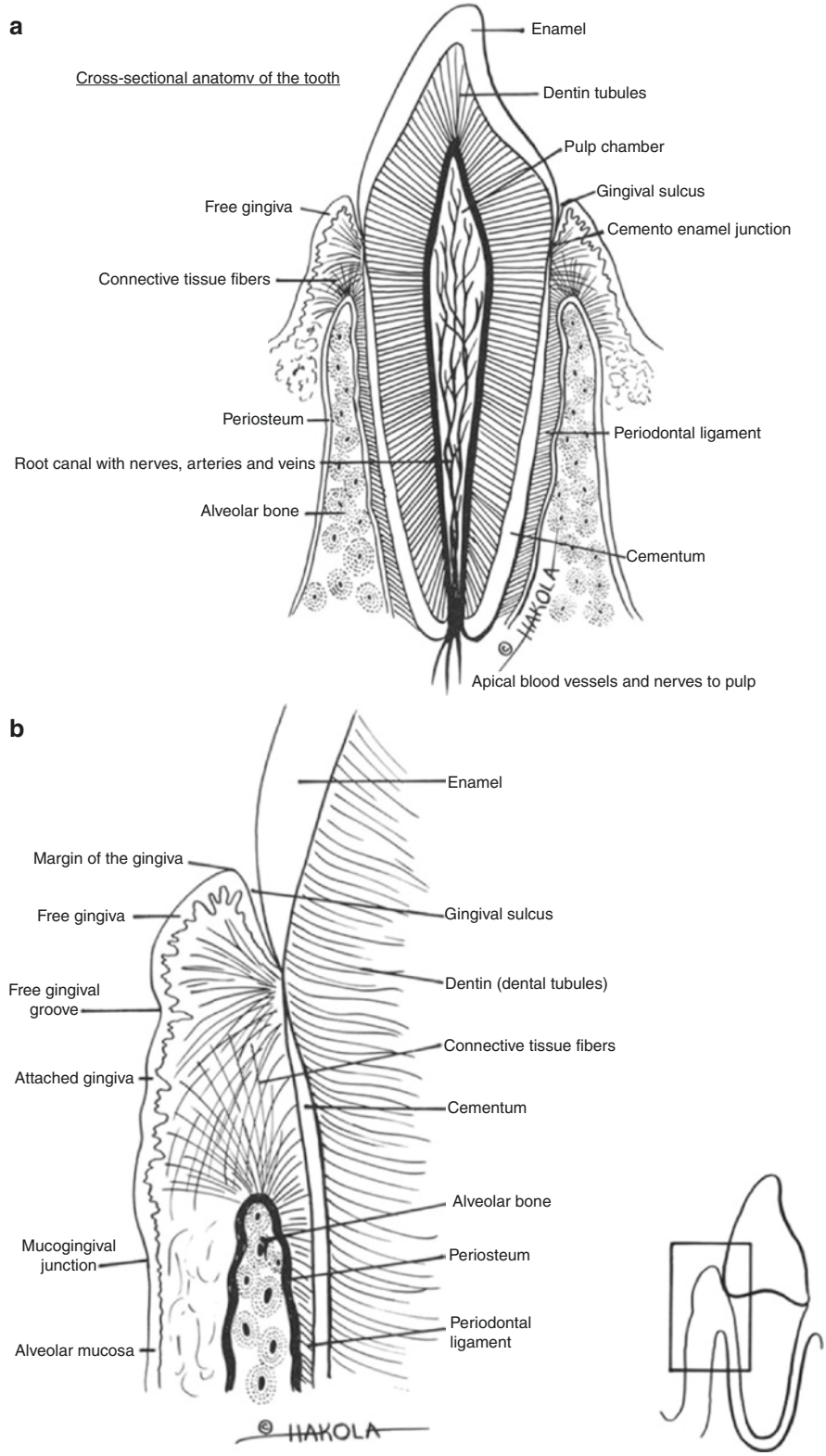

Fig. 29.16 Anatomy of the tooth and periodontium. (Figure page 130 Ferraro JW. *Fundamentals of Maxillofacial surgery*)

Table 29.6 Characteristics and classification of dental fractures

	Ellis classification	World Health Organization Classification	Description of appearance	Likely symptoms	Recommended treatment[a]
Enamel only fracture	Class I	Uncomplicated	Minor loss of tooth structure near the edge; underlying tooth is white	No symptoms	Treatment is primarily esthetic and can wait up until a week
Enamel dentin fracture	Class II	Uncomplicated	Moderate loss of tooth structure; underlying tooth is yellow	Acute sensitivity; air and cold can elicit pain	Urgent treatment (24–48 hours) by a dentist for a temporary restoration is recommended to ensure patient comfort
Enamel dentin pulp fracture	Class III	Complicated	Loss of tooth structure resulting in a pulp exposure; red tissue is visible in the fractured tooth	Symptoms vary from no pain to acute sensitivity to air and cold	Emergency treatment by a dentist is recommended to preserve the vitality of the pulp tissue. Treatment by a dentist may include temporizing pulp tissue with a medicament, partial removal of the pulp tissue, or root canal therapy

[a]It is ideal for all fractures to be evaluated by a dentist for assessment, baseline pulpal testing, and radiographs as indicated

Treating a traumatic dental injury before a diagnosis can lead to risk. For example, if a fractured tooth with a necrotic pulp or nonvital pulp receives a temporary restoration, then bacteria are sealed into the tooth and exudate is unable to drain. This may result in a cellulitis.

Evidence-based guidelines and up-to-date recommendations for the management of dental trauma are available at dentaltraumaguide.org.

Take-Home Message

Although dental fractures are best treated urgently by a dentist but proper knowledge by an Emergency physician is important.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to management of dental fractures.
- Know the indications and contraindications for management of dental fractures.
- Plan the key steps and know the potential pitfalls in managing dental fractures.

Question 10

An 8-year-old boy presents at 7 pm to the emergency department with avulsed maxillary central incisors (teeth #'s 8 and 9) in a cup of skim milk. The trauma occurred 30 minutes prior to presenting in the ED. What is the treatment of choice for this patient?

A. Replant and splint for 2 weeks.
B. Place the teeth in Hanks' Balanced Salt Solution. and page dentist on call.
C. Soak in doxycycline for 20 minutes; replant and splint for 2 weeks.
D. Soak in fluoride for 20 minutes; replant and splint for 2 weeks.
E. Do nothing.

Correct Answer: A

The main prognostic factor in the success of replanted avulsed permanent teeth is the duration

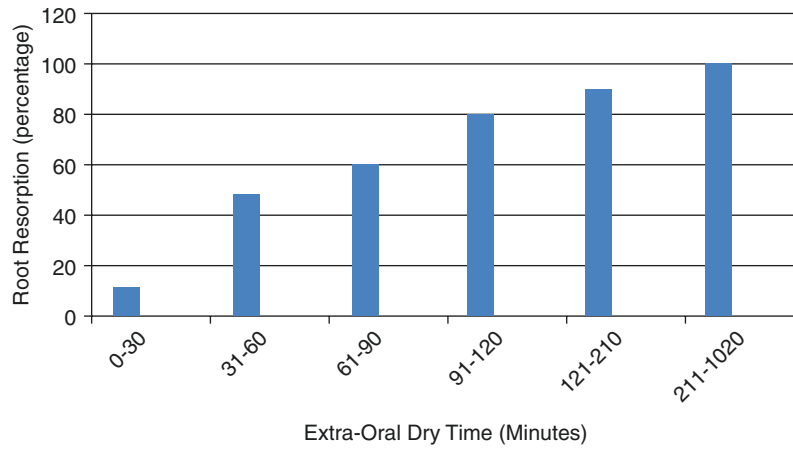

Fig. 29.17 Extra-Oral Dry Time in Minutes

of "dry time," i.e., how long the tooth has been avulsed and not placed in a physiologic solution such as Hanks' Balanced Salt Solution (HBSS) or milk. Studies have shown that extraoral dry time greater than 30–60 minutes significantly decreases the prognosis of the tooth as shown in Fig. 29.17. The longer the extraoral dry time, the greater the chance of ankylosis (or fusion of the tooth with the bone) of the replanted tooth and therefore a poorer prognosis. Storage media is also important in that HBSS is the best, followed by skim milk, then saline, saliva, and lastly water.

The stage of root development can influence the success or failure of replanting avulsed permanent incisors. An immature permanent tooth has a greater potential for success due to the progenitor cells present in the pulp. Roots continue to develop for 2 years after eruption. The maxillary central incisors typically erupt around age 7–8 and will continue to develop until the child is 9–10 years old. In this case, the patient is 8 years old, meaning the roots' development is incomplete. In this case, the patient has both immature roots and extraoral dry time of less than 60 minutes. There is always a chance of ankylosis of the avulsed teeth, but replantation should be attempted to preserve the alveolar ridge contour and prevent psychological trauma of losing a front tooth.

In the case of a mature permanent tooth with an extended extraoral dry time of over 60 minutes, the long-term prognosis is poor. Even with a poor prognosis, replantation can be attempted. The tooth would need to have the root debrided gently with gauze to remove the necrotic periodontal ligament cells and placed in a fluoride soak for 20 minutes. While the tooth is soaking in fluoride, the patient would need to be anesthetized and the socket irrigated with saline to remove the clot. This step would be critical in order to recreate the space for the tooth within the alveolar bone. The tooth would then need to be splinted for 4 weeks. Parents should be informed that root canal therapy would need to be initiated within the next 7 days. If the patient is older than 12 years, he or she should be placed on systemic doxycycline for 7–10 days and given a prescription for a chlorhexidine gluconate rinse with the instructions to rinse twice a day for the next week.

In this case, the patient is 8 years old with the trauma occurring 30 minutes prior to presenting to the ED, thus resulting in a much better prognosis. In this situation, it is advisable to clean the tooth with a gentle stream of saline, anesthetize the patient and irrigate the socket with saline. Replant the teeth while only handling the crown of the tooth. In the case that both central incisors have been avulsed, remember the lingual surface of the crown has a concavity, the mesio-incisal line angle is more square than the rounded disto-incisal line angle as shown in Fig. 29.14. The teeth should

replant with gentle finger pressure. If the teeth are positioned in the opposite sockets, they will not replant easily. Care must be made to not damage the periodontal ligament cells (PDL). Disruption of these cells will lead to a greater risk of ankylosis.

Parents and patients should be advised to seek dental care immediately after an avulsive injury. Root canal therapy should be initiated within 7–10 days of the injury in the case of a mature tooth to prevent periapical abscess. Root canal therapy should be initiated while the splint is in place for teeth with mature roots. In this case, the roots are immature and combined with a short extraoral time and, being placed in a physiologic medium, have a potential to heal without root canal therapy. These teeth should be monitored very carefully with follow-up appointments being in 1–2 weeks, 4 weeks, 2 months, 6 months, and yearly for 5 years. Meanwhile, the patient should be placed on antibiotics; Pen V or amoxicillin if the patient is younger than 12, and doxycycline if the patient is older than 12. The practitioner should also ensure the patient is up-to-date with their tetanus immunizations. Post-trauma instructions should include a soft diet for 2 weeks, maintenance of good oral hygiene, and avoidance of contact sports.

Primary incisors should never be replanted due to the proximity to the developing permanent tooth bud and potential for Turner's Hypoplasia, or brown discoloration, of the developing permanent tooth.

Take-Home Message

Successful management of an avulsion injury is dependent upon knowledge of extraoral dry time, storage media, and stage of root development.

ABP Content Specification

- Know the indications and contraindications for replanting an avulsed permanent tooth.
- Plan the key steps and know the potential pitfalls in replanting an avulsed permanent tooth.
- Recognize the complications associated with replanting an avulsed permanent tooth.
- Know the anatomy and pathophysiology relevant to replanting an avulsed permanent tooth.

Question: 11

An 8-year-old patient presents to the ED with a palatally luxated maxillary central incisor (tooth #9). What is the best treatment of choice for this patient?

A. Anesthetize the patient, reposition with finger pressure, and splint for 2 weeks.
B. Anesthetize the patient, reposition with finger pressure, and splint for 4 weeks.
C. Reposition by having patient bite on a tongue depressor, and page the dentist on call.
D. Splint for 2 weeks without repositioning.
E. Do nothing.

Correct Answer: A

Luxation injuries can prevent the patient from closing their mouth and occluding properly. Additionally, these teeth must be repositioned to improve the vascular profusion of the dental pulp. Luxation injuries, avulsions, alveolar fractures, and factures in the cervical third of the tooth root all require splinting to maintain the position in the mouth and physiologic healing. A dental splint should allow for some physiologic mobility; thus a semi-flexible splint should be placed in the incisal third of the tooth as shown in Fig. 29.18. The duration of splinting is dependent

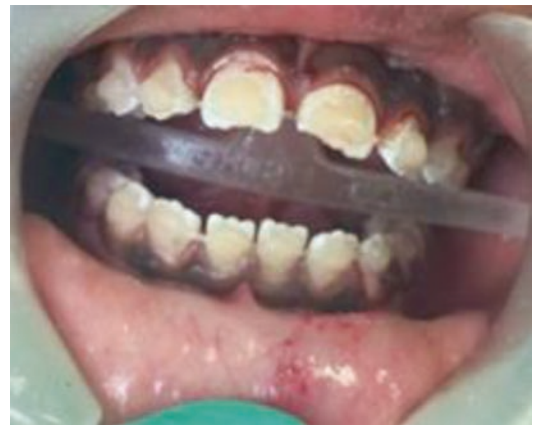

Fig. 29.18 Flexible dental splint bonded with composite resin to the teeth

upon the type of injury sustained. Tooth fractures in the cervical third, alveolar fractures, and for avulsions of permanent teeth with extraoral dry time over 60 minutes require splinting of 4 weeks. All other luxation and avulsion injuries require splinting for 2 weeks.

In the emergency department, splinting can be accomplished using a common periodontal dressing known as Coe-Pak in the event a dentist is not available for splinting. If a dentist is available, splinting can be accomplished with the use of a fishing line (50 lb monofilament line) and bonding composite resin. For bonding to be accomplished, a dry field must be maintained. This may be difficult if there is bleeding from the gingiva. Splinting requires suction, air-water syringe, cotton roll for isolation, 35% phosphoric acid etch, flowable composite resin, fishing line, and a curing light. If possible, injured teeth should have two teeth on either side of it incorporated into the splint.

If placing a splint poses a risk to the patient due to their medical history then it should not be attempted. For example, if the patient has spastic cerebral palsy, placing of a Coe-Pak splint may be an aspiration risk and should not be attempted.

Post-operative care instructions should include a soft diet for a week along with swishing with chlorhexidine gluconate (0.1%) rinse twice a day for a week. It is imperative to advise the parent if a splint comes off either partially or completely, to return to their dental provider for rebonding. Depending on the type of trauma sustained, root canal therapy may need to be initiated while the splint is in place. Therefore, follow-up with a dental professional is imperative to monitor the pulpal status of the traumatized teeth.

Take-Home Message

Splinting of teeth is imperative in avulsion, luxation, and fracture injuries.

ABP Content Specification

- Know the indications and contraindications for application of a dental splint
- Plan the key steps and know the potential pitfalls in application of a dental splint
- Recognize the complications associated with application of a dental splint
- Know the anatomy and pathophysiology relevant to application of a dental splint

Question 12

A 14-year-old boy presents to the ED with a complicated facture of a maxillary permanent central incisor. The family does not have the missing tooth fragment. There is a laceration of the lower lip opposite from the fractured incisor. What is the next step in his management in the ED?

A. Dissect the lower lip to look for the fragment.
B. Obtain a foreign body series.
C. Obtain a soft tissue radiograph of the lower lip.
D. Prescribe a computed tomography scan.
E. Suture the laceration with resorbable sutures.

Correct Answer: C

Orofacial trauma typically results in soft tissue injuries. Fortunately, these tissues are highly vascular and intraoral lesions pose minimal risk for esthetically objectionable scarring.

For correct documentation and communication with specialist's physicians should be familiar with the anatomy of the oral cavity soft tissue.

Lacerations are the most common injury. They should be carefully cleaned with saline and checked for a foreign body. Foreign bodies should be suspected if a tooth has been fractures or lost and cannot be accounted for. To rule out the presence of a tooth or tooth fragment a soft tissue radiograph should be taken with the exposure time reduced to ¼. If a foreign body is present it should be removed before suturing the laceration. This type of radiograph is most commonly indicated for the lower lip but occasionally is needed to rule out foreign bodies in the tongue.

Very small intraoral lacerations do not need to be sutured if hemorrhage control is adequate. For lacerations, greater than 1 cm they can be repaired with an absorbable suture such as 4–0 chromic gut. If the laceration is deep and requires repair of muscle and mucosal tissue, Vicryl sutures are indicated for the deeper portions.

Lacerations of the maxillary frenum can be common as children gain mobility and typically do not require sutures. However, laceration of the lingual frenum is an unusual accidental occurrence and may be suggestive of forced feeding in young infants and may warrant a child abuse screening.

Lacerations less than 1 cm on the dorsal surface of the tongue that do not gape do not require suturing. Lacerations on the border of the tongue and lacerations that go through the tongue typically require suturing. It can be difficult for patients to tolerate suturing of the tongue so clamps, a hemostat, or a suture may be required to stabilize it. Some type of sedation is often required in pediatric patients.

Prescription of a chlorhexidine 0.12% mouthwash should be considered for intraoral soft tissue injuries to minimize the bacterial load.

Take-Home Message

Soft tissue injuries are often lacerations. Small lacerations do not require management while larger ones typically require suturing.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to management of soft tissue injuries of the mouth
- Know the indications and contraindications for management of soft tissue injuries of the mouth
- Plan the key steps and know the potential pitfalls in performing management of soft tissue injuries of the mouth
- Recognize the complications associated with management of soft tissue injuries of the mouth

Question 13

A 14-year-old patient presents to the emergency department with a chief complaint that he cannot close his mouth. The most appropriate diagnosis and treatment is which of the following?

A. Posterior displacement of the coronoid process requiring dislocation
B. Dislocation of the temporomandibular joint requiring reduction
C. Lateral dislocation of the condyle requiring reduction
D. Condylar fracture requiring full-mouth bar splinting
E. Fracture of the coronoid process requiring splinting

Correct Answer: B

More commonly referred to as "lock jaw," this patient presents with a dislocation of the joint in an anterior position resulting in the inability to close his mouth. Diagnosis can be made by palpating the condyle anterior to the articular eminence. Depending on the mechanism of injury, imaging of the joint should be considered to rule out a concomitant fracture of the condyle. If the patient presents with multiple facial fractures, reduction of the dislocation is not advised. If the patient is in extreme pain or is anxious, sedation may be required in order to reduce the displacement. The situation outlined in the question above requires reduction by having the patient sit upright with his head braced against a chair, bed, or wall, and having the standing provider face the patient placing thumbs in the vestibule on the buccal side of posterior molars and fingers on the inferior boarder of the mandible. With pressure placed in a caudal and posterior motion, the jaw can be repositioned with the condyle on the correct side of the articular eminence. The mandible may reposition quickly, requiring the provider to be prepared and have their thumbs wrapped with gauze padding to minimize the force upon closing. By keeping one's thumbs in the vestibules,

however, one can hopefully avoid a biting accident. Occasionally the cause of the dislocation is the disk displaced anteriorly.

The patient should be made aware that once a dislocation has occurred, the dislocation is more likely to recur. If there has been a delay in repositioning, the patient should also be made aware that limited mobility may occur in the temporomandibular joint. Additionally, due to the proximity of the seventh cranial nerve to the temporomandibular joint, this may be damaged the facial nerve.

Take-Home Message

If a patient without other facial trauma has a dislocated jaw, reduction can be accomplished.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to reduction of temporomandibular joint dislocation
- Know the indications and contraindications for reduction of temporomandibular joint dislocation
- Plan the key steps and know the potential pitfalls in reducing temporomandibular joint dislocation
- Recognize the complications associated with reduction of temporomandibular joint dislocation

Suggested Reading

Question 1

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Pediatric Burns

30

Lui Caleon and Rebecca Hutchings

Questions 1–4 Are Based on this Case

A 5-year-old boy is rescued from a fire in a third-floor apartment of an urban building. He is found under his bed and has a decreased level of consciousness. His sister was found dead in her crib in the same room. He has carbonaceous sputum, and his nasal hairs are singed. His forehead and his right cheek are erythematous. His left cheek and is whole chin have blistered. The entire palmar surface of his right hand has blistered. He is wearing pajamas, but the firefighter who rescued him reported that the left sleeve and left pant leg of the pajamas are burned, and he appears to have significant burns to both of those limbs. He has suffered circumferential burns below the elbow and below the knee. The entire left foot and hand are involved. The firefighter estimates the boy's weight at 40 (18kg) pounds. The child arrives to the ED less than 1 hour after being burned.

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Question 1

Using the Lund and Browder criteria, calculate the percent burn for this child.

Lund and Browder chart is attached separately.

A. Most of the burns are first degree, with only the limbs appearing to be second degree, so 15.5%.
B. About 20% since most of the wounds appear to be second degree.
C. About 23.25% since all of the wounds appear to be second degree.
D. About 26% since some of the wounds appear to be third degree.
E. About 40% since some of the wounds appear to be second and third degree.

Correct Answer: B

Second- and third-degree burns are scored when assessing the percent body surface area of burn. First-degree burns, such as those to the forehead and right cheek, are not included in the calculation. Second- and third-degree burns are scored equally. While, clinically, third-degree burns are more severe, they do not receive a higher score when calculating total body surface area of burn. The burns for our patient who meet the criteria for second and possibly third-degree

M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_30

burns would be calculated based on his age as follows:

- Left cheek and whole chin is about ½ the face. This would be ½ of 6.5% =3.25%
- Right palm = 1.25%
- Left forearm front and back is 2.25% × 2 = 4.5%
- Left hand front and back is 1.25% × 2 = 2.5%
- Left lower leg front and back is 2.5% × 2 = 5%
- Left foot front and back is 1.25% × 2 = 3.5
- Total Burn Surface Area = 20%

Take-Home Message
First-degree burns are not included in the calculating of total body surface area burned.

ABP Content Specification
- Plan the appropriate evaluation and management of thermal burns
- Differentiate between depth and degree of thermal burns
- Know the importance of and methods for calculating total body surface area burned

Question 2

Which factors in this case would prompt you to refer to a burn center?

A. Evidence of inhalation injury and second degree burn to the hand
B. Mortality to another patient at the scene and second-degree burn to the hand
C. A decreased level of consciousness and partial-thickness burns to less than 10% of the body surface area
D. Evidence of inhalation injury and a decreased level of consciousness
E. Uncertainty regarding how long the patient was under the bed and a decreased level of consciousness

Correct Answer: A

The death of another patient at the scene raises concern for serious injury to our patient. This should prompt us to perform a thorough evaluation of the pediatric trauma patient with a high suspicion for severe injury. However, a death at the scene alone is not an indication for referral to a burn center. Similarly, while a decreased level of consciousness alone does not mandate a burn center referral, it should alert the physician to the possibility of smoke inhalation and prompt the treating physician to obtain a carboxyhemoglobin level. In patients with elevated carbon monoxide levels, the pulse oximetry levels remain normal. In this vignette, smoke inhalation is suggested by the singed nasal hairs and carbonaceous sputum, further supporting the suspicion that the decreased level of consciousness is likely due to smoke inhalation. This is an indication for referral to a burn center. The boy's total body surface area burned is greater than 10%, and he has a second-degree burn to the hand and face. All of these are indications for referral.

Burn Center Referral Criteria
The following are considered major burn injuries and warrant evaluation and treatment at a dedicated burn care facility.

- Partial-thickness burns >10% of the total body surface area
- Burns that involve the face, hands, feet, genitalia, perineum, or major joints
- Third-degree burns in any age group
- Electrical burns, including lightning injury
- Chemical burns
- Inhalation injury
- Burn injury in patients with preexisting medical disorders that could complicate management, prolong recovery, or affect mortality
- Any patients with burns and concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality. In such cases, if the trauma poses the greater immediate risk, the patient's condition

may be stabilized initially in a trauma center before transfer to a burn center. Physician judgment will be necessary in such situations and should be in concert with the regional medical control plan and triage protocols.
- Burned children in hospitals without qualified personnel or equipment for the care of children.
- Burn injury in patients who will require special social, emotional, or rehabilitative intervention.

Take-Home Message
Burn centers are better equipped to provide specialized care including complex wound care, psychosoical suppport, appropriate surgical interventions and longitudinal follow up.

ABP Content Specification
- Plan the appropriate evaluation and management of thermal burns
- Know which specific burn injuries should be transferred to a burn center for definitive management

Question 3

Calculate the fluid resuscitation for this child (including maintenance fluids).

(a) 90 mL/hour for the first 8 hours
(b) 56 mL/hour for the first 24 hours
(c) 146 mL/hour for the first 8 hours
(d) 116 mL/hour over 24 hours
(e) 1000 mL over 30 minutes

Correct Answer: C

The Parkland Formula or Hartmann's Solution is used to calculate the fluid resuscitation of the burn patient.

Parkland Formula :
4 X%BSA burned X weit in kilograms
= fluid in cc′s over 24 hours

In this case, the child is estimated to have suffered 20% burn of his TBSA. He weighs about 18 kg. The total fluid requirement for the first 24 hours is 1440 mL. Half the calculated volume will be given in the first 8 hours, and the remaining volume will be given in the next 16 hours. This works out to be 90 mL/hour in the first 8 hours and then 45 mL/hour in the next 16 hours. Burned children, in addition to burn resuscitation, require simultaneous administration of maintenance fluids, at the standard pediatric rate of 4 mL/kg/hour for the first 10 kg of body weight, plus 2 mL/kg/hour for the second 10 kg, plus 1 mL/kg/hour for any weight >20 kg. Maintenance fluids should be 5% glucose/0.45 normal saline solution. Since this child weighs 18 kg, he will require 56 mL/hour of maintenance fluid in addition to the burn resuscitation fluid of 90 mL/hour over the first 8 hours. In the next 16 hours, he will require 56 mL/hour of maintenance fluids plus 45 mL/hour of resuscitation.

Take-Home Message
The integumentary system is considered to be the largest organ of the body. It protects the body not only against infection but also against fluid loss and heat loss. Insensible fluid loss can be very rapid in the moderately to severely burned patient. The emergency physician must know how to calculate the fluid needs of patients and must begin fluid resuscitation promptly to minimize morbidity and mortality.

ABP Content Specification
- Know how to calculate fluid resuscitation and plan emergency management for a child with significant thermal burns
- Understand the pathophysiology of burn injuries

Question 4

Which of the following statements is TRUE?

A. Burns are the fifth leading cause of death in children.
B. Girls are more likely to be burned than boys.

C. Survival rates for burns are discouragingly low; at about 65%.
D. Children under the age of 4 years who suffer burn injury have a mortality rate that is six times the national average.
E. First-, second-, and third-degree burns are considered in calculating total body surface area for the Parkland formula.

Correct Answer: D

Burns are the third leading cause of death in children, accounting for over 1000 deaths per year and boys comprise more than two-thirds of all burn injuries. Survival for pediatric burn injuries is high, over 96%.

Take-Home Message
Younger children have higher morbidity and mortality due to burns compared with other age groups.

ABP Content Specification
- Know the epidemiology of minor and life-threatening burns in the pediatric population

Question 5

Regarding the ED management of pediatric burn patients:

A. Blisters are considered sterile, and those measuring 5 mm or less should be left intact.
B. All burns should be treated like frost-bite, with dead appearing tissue left intact until the area of burn is clearly demarcated.
C. Wet to dry dressings over an application of silver-based ointment are the optimal dressings.
D. A burn dressing consists of application of topical antibiotic covered by a first layer of nonadherent gauze, a second layer of dry gauze, and an outer layer of an elastic bandage.
E. Silver sulfadiazine is indicated for severe facial burns

Correct Answer: D

Proper wound care of burn injury is important to ensure proper skin re-epithelialization and decrease the likelihood of infection which delays wound healing. Burn dressing consists of application of topical antibiotic covered by a first layer of nonadherent gauze (Xeroform), a second layer of dry gauze, and an outer layer of an elastic bandage. Once daily dressing changes are usually adequate but the frequency depends on the size and degree of the burn wound. The management of blisters is controversial. Intact blisters should be left undisturbed. Current available evidence suggests that blisters should be left intact unless the anatomical position dictates intervention to obtain optimal functioning. Aspiration may be preferable to de-roofing. If the blister ruptures spontaneously, it should be debrided in order to adequately assess burn depth and to prevent any nidus for infection. Dedicated burn care centers perform this in sterile full-size water tubs in a process called "tubbing."

An enormous assortment of ointments and wound dressings exist for post-burn wound management care. Moist dressings are preferred over wet or dry dressing. Bacitracin topical ointment is usually preferred, while silver dressings are falling out of favor. Treatment with silver sulfadiazine can delay wound healing and require more frequent dressing changes.

Achieving adequate analgesia in burn care is difficult. Proper burn wound dressing is the primary line of treatment and offers a great degree of relief when adequately performed. Use of appropriate pharmacologic pain control with opiates and its analogues are secondary lines of treatment. Studies into alternative treatments such as intravenous administration of lidocaine or topical lidocaine for opiate refractory burn pain are underway.

Take-Home Message
Minor burns are exquisitely painful, while deeper burns damage nerve endings and become insensate. Proper wound care, adequate analgesia and appropriate determination of level of care are imortant in burn injury management.

ABP Content Specification

- Plan the key steps and know the potential pitfalls of burn management
- Know the indications and contraindications for burn management
- Plan the acute management of burns

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Snake Envenomation

31

Andrej Pogribny and Lisa A. Moreno-Walton

Question 1

A 10-year-old boy goes walking into a field in rural Texas, hears a sound, and immediately feels pain in his left calf. The boy's friend believes that he saw a snake. On examination, he has two punctures to his left lateral calf with an area of swelling around the calf. What are the two families of snakes in the United States that are most likely to cause envenomation in the wild?

A. Crotalidae and Elapidae
B. Viperidae and Colubridae
C. Viperidae and Boidae
D. Elapidae and Colubridae
E. Boidae and Colubridae

Correct Answer: A

Two main families of venomous snakes populate the United States, Crotalidae and Elapidae. Major members of the crotalid family include rattlesnakes, copperheads, and cottonmouths. They are also known as pit vipers because of the heat-sensing pits near their nostrils. All pit vipers are venomous and cause significant local pain, swelling, and ecchymosis. This may result in necrosis. Rattlesnakes (genera Crotalus and Sistrurus) are the most venomous, while copperheads (*Agkistrodon contortrix*) are the least. Pit vipers in the United States generally have earthen colors and a triangular shaped head and attack suddenly with two retractable fangs through which they exude venom. They are widely distributed across the United States.

Elapidae is another large family of snakes that famously houses the cobra. In the United States, the family Elapidae is represented by the coral snakes. Coral snakes are brightly colored with yellow, black, and red bands. They are smaller and thinner than pit vipers and possess a rounded nose with fixed, frontal hollow fangs. A familiar adage "red touches yellow kills a fellow" applies to coral snakes, because of the coral snake's close appearance to the scarlet king snake, which is not venomous but does exhibit similar band colors. They tend to be more neurotoxic with little or no local tissue damage.

The family Boidae houses pythons and boa constrictors, which do not possess venom. The family Colubridae is made of nonvenomous snakes and referred to as typical or common snakes. They are one of the largest families of snakes in the world. Some common snakes include the regular garden snake, common king snake, and scarlet king snake.

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_31

Take-Home Message

- All pit vipers are poisonous; the most common one in the United States is the rattlesnake. The two main families that can cause snake envenomation are the Crotalidae (e.g., rattlesnake) and Elapidae (coral snake) families.
- Pit viper (Crotalinae) envenomations = hematotoxicity
- Coral snakes (Elapidae) = neurotoxicity

ABP Content Specification

- Know which snake envenomation is liable to produce significant illness or injury in children

Question 2

An 8-year-old girl who lives in Florida runs inside crying to her mother. She thinks something bit her. She had been playing in her backyard near an area of high grass and states she felt a sting on her right hand. After washing the hand with soap and water, the mother noticed a small "scratch" but did not see any swelling or areas of redness. The child appears fine to the mother so she dismisses the report of a bite. Several hours later the child complains of changes in sensation in her left hand with some numbness where she thought she had been bitten. She now appears drowsier. In the ED, she is having tremors and significant salivation. What is the likely cause of these symptoms?

A. Organophosphate intoxication
B. Seizure disorder
C. Rattlesnake bite
D. Coral snake bite
E. Anaphylaxis

Correct Answer: D

As compared to the pit vipers, coral snakes are much less aggressive. They are elusive hunters that tend not to bite humans. Often, the bite of a coral snake is not obvious until symptoms begin to appear. In fact, one may not suspect a bite until several hours later. Coral snake venom is mainly neurotoxic. Unlike the bite of a pit viper, which produces significant local pain, the coral snake bite produces minimal pain but often produces paresthesia and weakness around the site. Later effects may include tremors, drowsiness, increased salivation, and euphoria. Other neurological effects may include cranial nerve palsies, ptosis, dysarthria, dysphagia, dyspnea, and respiratory paralysis.

Due to the somewhat vague symptoms that tend to appear with a coral snake envenomation, it is within the realm of possibility to consider an anaphylactic reaction. Although the muscarinic and CNS effects of organophosphate intoxication may have some similarities to a coral snake envenomation, it is unlikely in this scenario.

Of the three American species of coral snake, only the Eastern coral snake (*Micrurus fulvius*) possesses a significant and potent neurotoxic venom. Finally, unlike the pit viper, the Eastern coral snake largely resides in the Southeastern United States, with the majority of envenomation occurring in Florida.

Take-Home Message

Coral snake (Elapidae) bites are initially mild but later cause neurotoxicity. Since serious effects can be delayed, children with snake envenomation should be admitted to the hospital.

ABP Content Specification

- Recognize the signs and symptoms of life- and limb-threatening complications of snake envenomation

Question 3

Which of the following factors place children at greater risk for significant toxic effects from stake envenomation than adults?

A. Children are more likely to play with snakes due to natural curiosity.
B. There is an increased dose of venom based on volume of distribution.
C. Snakes will more likely attack an animal that is smaller and less threatening such as a child.
D. Children do not have the same reflexive capability to evade a snake as an adult.
E. A child's physiologic response to envenomation is different than an adult.

Correct Answer: B

Children have an increased risk for toxic effects of envenomation due to their relatively smaller size that results in a higher dose of venom relative to body surface area. While there is increased curiosity in children, there is no epidemiological evidence that this has resulted in more severe bites. Snakes bite when threatened regardless if the threat is coming from an adult or a child. A child's physiology and reflexive capability have no impact on the degree of envenomation. Rapid progression may occur due to relatively higher ratio of venom to body mass; therefore, smaller children and infants are more vulnerable to severe envenomation with systemic manifestations.

Take-Home Message
Children are at relatively higher risk to develop toxicity after venomous snake bite due to their smaller body surface area relative to the venom dose

ABP Content Specification
- Plan the management of snake envenomation by type and severity

Question 4

A 13-year-old girl and her father are out hiking in Arizona when the daughter is bitten by a rattlesnake on her right forearm. What is the most important next step in first aid management for the father to perform while in the wilderness?

A. Apply a tight tourniquet above the area of the bite to prevent the venom spread
B. Utilize a mechanical venom extractor on hand to suck out some venom
C. Apply ice to the area and immobilize the arm
D. Immobilize the arm and monitor for progression of swelling by marking the area of involvement
E. Give the child whisky to help combat the effects of the venom

Correct Answer: D

The initial first aid after a snakebite is to immobilize the extremity and mark the swelling or erythema to assess for progression. Application of tourniquet is controversial as it may reduce arterial supply to the limb and, if used, should be placed loose enough to only impede lymphatic flow. While mechanical venom extractors are commercially available, there is no evidence that they decrease the toxicity. Application of ice has limited value, and whisky ingestion has no role in the management of snakebites. Attention must be given to the airway and hemodynamic status. The bite area should be cleaned with mild soap water. First aid techniques have not shown to improve the outcome and rapid transport to a medical facility is extremely important.

Take-Home Message
Initial management consists of cleaning the wound, immobilization and transport to the nearest healthcare facility.

ABP Content Specification
- Plan the management of snake envenomation

Question 5

A 10-year-old boy is brought in by his father to a rural Texas emergency department. He is pale, drowsy, and ill-appearing. He is tachycardic to 130 beats/minute, the blood pressure is 80/50 mm Hg, respiratory rate is 15 breaths/minute, and temperature is 99.0°F and his oxygen saturations is 98% in room air. On examination, you notice that on his left calf, there are two distinct small puncture wounds with surrounding ecchymosis. There is exquisite tenderness to palpation over the area. You notice that the area of swelling and redness is spreading to his left knee and down to his left ankle. What is your next step in management?

A. Observe for improvement.
B. Provide Crotalid antivenin.
C. Fasciotomy.
D. Provide IM epinephrine.
E. Provide IV fluids and broad-spectrum antibiotics.

Correct Answer: B

Providing Crotalid antivenin is the most important and potentially a lifesaving step in treating this patient. Although severity scores have been developed based on the progression of swelling, systemic effects, and overall clinical picture, there is no clear consensus on when antivenin should be given. In this situation, where there is clear progression of swelling with tachycardia and hypotension, antivenin should be administered. Blood samples should be obtained to monitor coagulopathy. This should include CBC with platelet count, aPTT, PT/INR, fibrinogen, and D-dimer. These laboratory tests may need to be repeated during the hospital stay to monitor for delayed effects. Abnormalities in the laboratory tests should prompt the physician to treat with antivenin due to the risk of bleeding and DIC. Furthermore, it is important to understand that delayed hematologic and coagulopathic effects do exist even after several days. Fasciotomy was once utilized in order to relieve elevated compartment pressure due to local swelling effects. With appropriate use of antivenin early in the course, the swelling may resolve. The tetanus status should be updated; however, there is no need for antibiotics when the chance of an infection from a snakebite is low.

Take-Home Message

- Crotalid antivenin is indicated for worsening toxicity from snake envenomation.
- In children, the dose is not weight based and depends on potential venom load.

ABP Content Specification

- Plan the management of snake envenomation

Question 6

After a rattlesnake bite that is locally progressing, what systemic effects should you be most concerned about?

A. Septic shock
B. Coagulopathy
C. Anaphylactic shock
D. Neurotoxicity
E. Respiratory failure

Correct Answer: B

Coagulopathy is a major concern after pit viper envenomation, and particularly after a rattlesnake envenomation. Pit viper venom is hemotoxic and can cause bleeding, platelet destruction, and disseminated intravascular coagulation. The prompt administration of antivenin is the mainstay of treatment. Monitoring laboratory findings is important even if local swelling appears to go down. This is due to the concern for persistent envenomation and coagulopathy that may occur even after treatment, although studies suggest that the clinical findings are negligible even if the PT/INR are elevated or the patient is thrombocytopenic after treatment; thus, timing of discharge is based on clinical findings. A large envenomation in a small child may lead to cardiopulmonary arrest secondary to bleeding and DIC. Rattlesnake venom does have a component of neurotoxicity; however, this is not as important as coagulopathy. The risk of infection is very low following a snakebite, and prophylactic antibiotics are not recommended. Lastly anaphylaxis may assert itself in the event that the child has an allergy to CroFab.

Take-Home Message

Although pit viper envenomation causes some local effects and neurological symptoms, the most serious effects are due to its effect on the hematological system causing coagulopathy.

ABP Content Specification

- Know which snake envenomation is liable to produce significant illness or injury in children

Question 7

You have decided to provide antivenin to your patient in an attempt to counter the systemic effects of a large envenomation. What is the initial dose?

A. Give 4–6 vials in the first 24 hours for initial control of serum-derived whole antibody preparation antivenin (equine)
B. Give 4–6 vials in the first 24 hours for initial control with crotalid polyvalent immune Fab (ovine)
C. Give 4–6 vials every 1 hour until initial control is achieved with serum-derived whole antibody preparation antivenin (equine)
D. Give 4–6 vials every 1 hour until initial control is achieved with Crotalid polyvalent immune Fab (ovine)
E. Give 2 vial doses every 6 hours for up to three doses to achieve initial and lasting control with crotalid polyvalent immune Fab (ovine)

Correct Answer: D

The mainstay of treatment for snakebites is antivenin. Because pit viper bites are the both the most predominant and widespread, Crotalid polyvalent immune Fab antivenin (CroFab) derived from sheep is the standard and readily available. CroFab began to be used in 2001, and it has since mostly replaced the equine-derived polyvalent version of Crotalid antivenin due to the fact that the horse-derived antivenin has a high potential for serum sickness and anaphylaxis. When CroFab is used and allergic side effects do occur, they can generally be managed with antihistamines and corticosteroids. Furthermore, CroFab is safe and effective for children.

CroFab is distributed in vials. Dosing begins with an initial four to six vials. If after 1 hour, there is no slowing or cessation of envenomation as determined by clinical and laboratory evaluation, another 4–6 vials should be given each hour until control is obtained. Once envenomation control has been reached, maintenance doses of two vials every 6 hours may be given up to a total of three maintenance doses. Factors associated with difficult control include the presence of thrombocytopenia and neurologic effects.

Take-Home Message

CroFab antivenin, when used, should be titrated hourly until abnormalities caused by the venom are corrected. Antivenins can cause immediate anaphylactic or anaphylactoid reactions or serum sickness.

ABP Content Specification

- Plan the management of snake envenomation

Question 8

A 14-year-old boy is out on a Boy Scout expedition in the Ozark Mountains in Arkansas in July with his troop. While taking a break from hiking, the boy places his hand behind a log while sitting down. He is bit by a copperhead on his right arm and begins to feel immediate pain. The scout leader brings the boy to the nearest regional hospital. His initial vital signs are temperature 98.5°F, heart rate 90 beats/minute, respiratory rate 16 breaths/minute, and blood pressure 100/70 mm Hg. On examination, the boy has two distinct bite marks over his right forearm. There is mild swelling near the bites. He is able to move his wrist, forearm, and elbow without much discomfort. He feels pain at the area of the bite. What is the next step in management?

A. Provide Crotalid antivenin immediately
B. Update tetanus immunization and administer antibiotics immediately
C. Draw basic laboratory work, update tetanus, provide antibiotics, and transfer to a Children's Hospital for admission
D. Observe in the ED for 1 hour, update tetanus vaccine, and discharge home with close follow-up if symptoms have not progressed
E. Observe in the ED for up to 12 hours, provide tetanus update, and discharge with close follow-up if symptoms have not progressed

Correct Answer: E

Copperhead bites are the commonly reported venomous snake bite. They cause a moderate amount of swelling, which peaks 24–36 hours after the bite, and do not cause significant hematologic or neuropathic disturbances. Patients with minimal

or nonprogressive symptoms should not receive CroFab and should be carefully monitored.

Take-Home Message
Most copperhead bites do not require antivenom and can be withheld and monitor for systemic manifestations.

ABP Content Specification
- Plan the management of snake envenomation

Question 9

An 8-year-old girl in Georgia is playing in her backyard supervised by her mother. The mother thinks that the snake may have bit the girl and states that it was red, yellow, and black. The mother is fearful that the snake is poisonous and brings the girl to the ED. There the girl is comfortable and in no pain and has no obvious signs of a bite. She is smiling and playful with a temperature 98.3 °F, heart rate of 90 beats/minute, respiratory rate 16 breaths/minute, blood pressure 90/70 mm Hg, and oxygen saturation of 98% on room air. What is the next best course of action?

A. Observe the patient for several hours and discharge home because it is likely a king snake
B. Observe the patient for several hours and discharge home because there seems to be no effect from the bite of a coral snake
C. Immediately begin elapid antivenin
D. Immediately begin antibiotics and update tetanus studies
E. Admit the patient for overnight observation

Correct Answer: E

Any bite from a coral snake should prompt hospital admission and careful observation. These patients have limited swelling or local effects from the bite, but there is a potential for serious neurotoxic effects. Ptosis is often the first sign of envenomation. Other features include paresthesia, fasciculations, slurred speech, drowsiness, dysphagia, restlessness, increased salivation, nausea, and proximal muscle weakness. These patients often will need ICU management if systemic effects become apparent. The current recommendation is to administer antivenom only if symptoms develop.

Take-Home Message
The risk of progressive weakness and resulting respiratory failure is of greatest concern. Patients with coral snake bites may have no symptoms initially and can then develop neurotoxicity over the course of several hours.

ABP Content Specification
- Plan the management of snake envenomation by type and severity

Suggested Reading

Question 1

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Administration

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Geetanjali Srivastava, Usha Avva,
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Question 1

For a community or rural emergency department, the following resources are recommended **EXCEPT**

A. A nurse coordinator for pediatric emergency medicine
B. A pediatric care-review process built into the QI/PI plan of the ED
C. A physician coordinator for pediatric emergency medicine
D. Child abuse and sexual abuse specialist on call
E. Clear inter-facility transfer procedures

Correct Answer: D

In 2006, the Institute of Medicine recommended that the federal government support the implementation of national standards for emergency care performance, which include the regional categorization of all emergency care facilities with protocols in place for triage, treatment, and prehospital transport.

The recommended process for pediatric regionalization is divided into categorization, verification, accreditation, and designation. Regionalization is often disease-linked, like trauma, burn, acute MI, and stroke. There should be an evidence-based treatment protocol which delineates when non-specialty care centers could be by-passed. Examples of such successful regionalization are Neonatal Intensive care units (NICU) and perinatal services.

It is established that outcomes for critically ill and injured children are better when they are cared for in recognized specialty care centers. The Emergency Medical Services for Children (EMSC) program guides the state and local activities and provides performance measures like ensuring the availability of inter-facility transfer agreements and guidelines for hospitals.

The American College of Surgeons (ACS) conducts a site visit only to *verify* the existence of resources, whereas the hospitals should find resources to meet the specific criteria established by ACS. State law determines the eligibility of the individual institutions for Trauma Center designation, while ACS verifies if they meet the established criteria.

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_32

EMSC along with the state laws and local EMS set criteria to qualify an emergency department as pediatric specific. The emergency department must meet specific minimal criteria, including requirements for pediatric equipment and medications, physician coverage, ongoing pediatric education, and policies, as well as having a designated nurse/physician liaison.

Guidelines for Care of Children in the Emergency Department recommended a process for selecting the appropriate care facility for pediatric specialty services such as pediatric critical care, re-implantation of digits/limbs, trauma and burn care, psychiatric emergencies, and child/sexual abuse services if they are not available at a given hospital.

Take-Home Message

- Facilities providing emergency care for children should have a dedicated team of a physician and nurse coordinator, a good QI program, and inter-hospital transfer agreements for services not provided at the facility. Outcomes for critically ill children are superior when provided at designated regional centers.
- Regionalized specialty care centers reduce morbidity and mortality associated with severe illness or trauma. Through the collaborative work of organizations such as the EMSC, AAP, and EMS, evidence-based guidelines and protocols have been established.

ABP Content Specification

- Know the differential capacity of facilities that provide pediatric emergency care.
- Know the criteria for the categorization of facilities that provide pediatric emergency care.

Question 2

Which of the following statements regarding Emergency Department performance improvement activities are **TRUE**?

A. A target date is not essential
B. Choose goals collaboratively with the Board of Directors
C. Implement all changes recommended by the team
D. Invite everyone that would be affected by the changes proposed
E. PI activities should be aligned to the institutional goals

Correct Answer: E

The Joint Commission (JC) requires that hospitals prioritize patient safety and QI activities to meet the established national patient safety goals and quality indicators. Common ED quality indicators include deaths, transfers, ED return visits, ED throughput measures, pediatric resuscitations and intubations, transfers from inpatient unit to ICU, and time to administration of pain medications or antipyretics.

These quality and performance improvement QI/PI activities should model the domains of timeliness, effectiveness, efficiency, safety, patient-centeredness, and equity set by the Institute of Medicine. JC requires hospitals to perform and analyze data on specific measurable indicators. These reported indicators should be proactive, quantify inefficiencies, identify preventable errors, monitor performance, reduce variations, be evidence-based, and be multidisciplinary.

To accomplish these, hospitals are expected to identify key drivers (i.e., physicians, nurses, respiratory technicians, administrators), determine the goal, and develop a SMART aim and PDSA cycles:

- Specific: the desired outcome should be precise and concise
- Measurable: must have a quantifiable metric
- Actionable/Attainable: define the endpoints
- Relevant/Realistic: the aim should be important to patients, providers, and the overall goals of the department/hospital
- Time bounds: target date should be specified

Plan-Do-Study-Act (PDSA) cycle to develop a quality program:

- Plan: develop SMART AIM. Determine the aim and metric, create a plan for implementation, and develop a data collection plan
- Do: gather data and record observations (including unintended consequences)
- Study: compare the results with previous performance
- Act: (adopt, adapt, or abandon) consider the need for continued testing and develop a plan for sustainability

AAP recommendations for the emergency department are as follows:

1. QI/PI should interface with out-of-hospital, ED, trauma, inpatient, critical care, and hospital-wide activities.
2. Should include pediatric-specific indicators.
3. Pediatric age-specific clinical-competency evaluations should be developed as a part of the local credentialing process for all licensed ED staff.

Mechanisms should be in place to monitor professional performance, credentialing, continuing education, and clinical competencies, including the integration of findings from quality improvement audits and case reviews.

Take-Home Message

- Increasingly, accrediting organizations (JC) mandate that hospitals and physicians develop patient safety and quality improvement initiatives.
- The Physician Quality Reporting System (PQRS) is a quality reporting program that encourages individual eligible professionals (EPs) and group practices to report information on the quality of care to Medicare. CMS publishes the list of quality metrics and mandates their reporting. Beginning in 2015, the program will apply a negative payment adjustment to individual EPs and PQRS group practices that did not satisfactorily report data on quality measures.
- The introduction of "pay for performance" and PQRS programs by CMS and insurers means that there is a significant financial incentive and impact to meet these measures.

ABP Content Specification

- Know quality assurance activities relevant to pediatric emergency medicine.
- Know JCAHO regulations regarding the performance of quality assurance activities in emergency medicine.
- Know the elements that define quality assurance in the emergency care of children.

Question 3

Which one of the following statements is **TRUE** regarding provisions under EMTALA?

A. A patient's verbal request for transfer should be honored.
B. For a citation, the agency must prove that an adverse event or outcome occurred.
C. A patient can be transferred to the public hospital due to his/her inability to pay.
D. You must accept all transfers to your tertiary facility, even if you do not have bed capacity, because you will at least provide a higher level of care.
E. You must stabilize the patient to the best of your ability prior to transfer.

Correct Answer: E

Transfer is defined as the movement (including discharge) of an individual outside the hospital's facilities. Patients can make a written request for a transfer and this can be considered taking into account the patient's condition. The CMS does not have to prove an adverse event to cite an EMTALA violation. The patient's inability to pay is not a reason for transfer, and a higher-level facility can accept transfer if there is adequate bed capacity. Under the EMTALA law, the transferring hospital must ensure that the following four requirements are met prior to transfer:

1. A physician at the receiving hospital must accept the patient.
2. The receiving facility must be appropriate with qualified personnel to accept the patient.
3. The inter-hospital transport personnel and equipment must be appropriate for the patient's medical condition.
4. All relevant medical records must accompany the patient to the receiving hospital.

Take-Home Message

- The EMTALA law requires emergency departments to provide a medical screening exam and stabilize patients to the best of the institution's capability before transfer.

ABP Content Specification

- Know the requirements of the EMTALA legislation.

Question 4

What **BEST** describes the responsibility of a physician in an eight-bed rural emergency department with respect to caring for a critically ill pediatric patient?

A. Stabilize the patient and conduct at least a few laboratory and radiologic studies prior to transfer.
B. Stabilize the patient and inquire about transfer agreements available with children's hospitals with specialized tertiary care.
C. Stabilize the patient and then transfer the patient to the closest hospital.
D. Stabilize the patient to the best of his/her ability and then transport via BLS.
E. Stabilize the patient to the capability of the institution, determine the risk-benefit of transferring an unstable patient, and plan for transfer to a higher-level care.

Correct Answer: E

In 1986, an "anti-dumping" law was enacted by Congress called Emergency Medical Treatment and Active Labor Act (EMTALA) to ensure public access to emergency services regardless of the ability to pay and to govern the transfer of unstable patients. The law applies to all patients treated at hospitals in the United States that accept payment from the Centers for Medicare and Medicaid Services. Under EMTALA all patients receive a medical screening examination (MSE) to evaluate for an emergent medical condition; any such condition must be treated to the best of the ability of the institution regardless of the patient's ability to pay. There is no violation if a patient refuses examination and/or treatment as long as there is no coercion. Signs must be posted that notify patients/visitors of their rights to a MSE and treatment. The institution should be explicit about who responds to emergencies, what constitutes a MSE, identify personnel for providing such screening, and identify the geographical areas in the campus that qualify under EMTALA. Hospitals or institutions suffer heavy financial penalties if they are found to violate EMTALA rules. Any violation of the EMTALA law is reportable to the CMS. Triage is not considered a MSE.

EMTALA requirements for hospitals with an emergency department:

- Treatment must be provided until the emergency medical condition (including labor) is resolved or stabilized.
- The appropriate transfer should be undertaken if a hospital is unable to stabilize a patient within its capability or capacity or a patient requests a transfer. The transfer request must be in writing.
- Hospitals with specialized capabilities are obligated to accept transfers from hospitals that lack such capabilities.
- The treating physician is expected to document the reasons, risks, and benefits of transfer.
- The transfer of *unstable* patients must be appropriate. The transferring hospital must provide ongoing care until the patient's care is taken over by the receiving facility, which must provide confirmation that they have indeed accepted the patient. The transferring facility must provide copies of medical records

and appropriate documentation, and confirm that the receiving facility has space, qualified personnel, and appropriate medical equipment to treat the unstable patient.

Penalties for violating EMTALA:

- The 2-year statute of limitations for civil enforcement of any violation
- A violation can be cited even without an adverse outcome
- Termination of the hospital or physician's Medicare provider agreement
- Hospital fines up to US$50,000 per violation
- Physician fines of US$50,000 per violation, including on-call physicians
- The hospital may be sued for personal injury in civil court
- A hospital must report to CMS if it perceives a violation of EMTALA on the part of a transferring facility.
- A receiving hospital can file a lawsuit for financial loss as a result of another hospital's violation of EMTALA

Take-Home Message

- EMTALA requires hospitals to care for patients regardless of their ability to pay.
- A medical screening exam, as defined by the practice of the institution, is mandated to secure the safety and medical stabilization of the patient.
- Any transfer to another institution requires clear documentation as to the reason for transfer, the name of the accepting physician, and all pertinent medical documentation including all laboratory and imaging results.
- Failure to comply with EMTALA regulations can result in heavy fines to the institution and the provider, including possible termination of Medicare provider agreement.

ABP Content Specification

- Know the requirements of EMTALA legislation.
- Know the ramifications of failing to comply with EMTALA.

Question 5

HIPPA applies to all the following, **EXCEPT**:

A. Dentists
B. Physicians
C. Hospitals
D. Insurance companies
E. Public health officials

Correct Answer: E

HIPPA Privacy Rule and Security Rule

The Health Insurance Portability and Accountability Act of 1996 (HIPAA) requires the Secretary of the US Department of Health and Human Services (HHS) to develop regulations protecting the privacy and security of certain health information. The Privacy Rule establishes national standards for the protection of certain health information. The Security Rule operationalizes the protections and establishes a national security standard for protecting certain health information. A major aim of the Privacy Rule is to assure that individuals' health information is properly protected while allowing the appropriate flow of health information between healthcare providers.

The Privacy Rule protects all "Individually identifiable health information"called protected health information (PHI) that is held or transmitted by a covered entity or its business associate, in any form or media, whether electronic, paper, or oral. "Individually identifiable health information" refers to demographic data (i.e., name, address, date of birth) and social security number.

A person who knowingly obtains or discloses PHI inappropriately faces a fine of US$50,000 and up to 1-year imprisonment. The criminal penalties increase to US$100,000 and up to 5 years' imprisonment if the wrongful conduct involves false pretenses.

Take-Home Message

- Ensuring privacy of PHI of patients is required by law, which carries stringent penalties for non-compliance.

- Exceptions to sharing this information include public health officials to ensure the protection of community health.

ABP Content Specification

- Know the requirements of HIPPA regarding patient confidentiality.

Question 6

Which of the following statement is **TRUE** concerning minors and consent?

A. "Emancipated" minor and "mature" minor are synonymous
B. Medical emancipation is not a legal status
C. "Minor" is defined as an individual under age of 18 years in every US state
D. Minors can never consent to medical care for themselves
E. Unconditional confidentiality is guaranteed in a physician-patient relationship

Correct Answer: B

Consent of Minors In the United States, laws regarding consent and confidentiality as well as laws governing minor status vary from state to state. In every state, emergency medical treatment can be provided without consent to avoid delays in necessary treatment. The circumstance in which adolescents/minors may consent to their own care and the extent to which their confidentiality is protected also varies, depending upon the service involved, and the provider's level of concern regarding harm to self or others.

Definitions

- A minor is a person who is younger than the age of consent, and in *most* states, it is defined as age <18 years. Parents or legal guardians (or foster parents, probation officers, social workers, family courts) may provide consent for medical treatment for minors or to admit a minor child to an inpatient facility without the minor's consent.

  Most states allow minors to consent for contraceptive services, diagnosis/treatment for sexually transmitted infections (STIs), prenatal care, and services related to treatment for substance abuse. About half the states allow minors to consent for outpatient mental health counseling/treatment, and some states also allow for voluntary inpatient treatment. In some states, the minor must be at least 12 or 14 years old before being allowed to consent.
- *Mature minor* status is recognized in some states and allows minors >14 years of age to consent for medical and surgical treatment which does not involve serious risks, even if it is not truly emergent. According to the physician's judgment, the minor must be mature enough to understand the risks/benefits and treatment options of a given medical condition.
- *Emancipated minor* status can be attained by the legal ruling, marriage, military service, or living separately from one's parents and managing one's own financial affairs. Generally, emancipation enables minors to consent for medical care but usually cannot provide consent for services that benefit others (i.e., blood or organ donation). Many states consider a pregnant minor to be an emancipated minor who may consent for herself and her unborn infant.
- *Medical emancipation* is *not* a legal status. The following minors are often considered "medically emancipated" and are allowed to consent for medical care (it does vary from state to state): married minors, minors who have a child, high school graduates, homeless minors, or runaways.
- *Confidentiality* indicates the privileged nature of the information provided during a healthcare visit.
- *Conditional confidentiality* defines circumstances under which confidentiality must be broken. Patients can be assured that the information shared is confidential. It can be broken and be disclosed to parents when required by law; when there is a concern for suicide, homicide, or abuse; and when there are behaviors that represent a serious threat to the patient's safety. In about half the states, there are statutes that require mental healthcare providers to

disclose a patient's intent to do harm by warning the victim; the therapist has a duty to use reasonable care to protect the intended victim.
- *Unconditional confidentiality* is a process whereby the patient is assured of non-disclosure of medical/mental health information.
- *Judicial bypass* is a process where a minor petitions the court to bypass the notification or consent of the parents, as it may bring harm to the self.
- *Parental notificatio*n is required in some states for certain health services (i.e., abortion). In some states, the clinician is permitted to notify parents as it is in the best interest of the patient, whereas in others, it is unacceptable to betray confidentiality without a good cause.

Take-Home Message
- Most minors need consent for treatment except when they seek medical attention for prevention and treatment of STIs, pregnancy and its complications, and contraceptive services. Consent can be provided by surrogates in emergency situations.

ABP Content Specification
- Know the forms of consent related to the emergency care of minors.
- Know the circumstances in which minors can consent to their own examination and treatment.
- Know the circumstances in which confidentiality must be upheld in the care of a minor.
- Know the circumstances in which confidentiality can be breached in the care of a minor.

Question 7

A 15-year-old girl with leukemia needs an urgent blood transfusion. The family is a member of Jehovah's Witnesses and is refusing the blood transfusion. What is your **BEST** choice?

A. Ask the teenager what her wishes are and have her sign the consent
B. Obtain immediate assistance from your social work colleagues
C. Report the family to child protective services as they are endangering the welfare of their child
D. Take custody of the child and then transfuse blood
E. Transfuse without consent because of the dangers to the child's life

Correct Answer: B

Refusal to Consent
Parents should not be allowed to refuse life- or limb-saving interventions, including medications, transfusions, or procedures. Guardians cannot refuse treatment nor leave against medical advice in a life-threatening situation deemed by the emergency physician, or if the guardian is thought to be under the influence of alcohol or drugs. Most other reasons for refusal to give consent are related to religious beliefs. The approach to refusal to consent depends on the nature of the medical intervention. Legal intervention may be necessary when other means have been exhausted (including ethics consultation). If parents withhold consent for a life-threatening condition, the emergency physician should enlist the help of police in placing the child in protective custody or seek legal recourse when parental refusal places a child at clear and substantial risk. In a life-threatening emergency, it may be necessary to start evaluation and treatment before child protective services and the police are notified or even without parental consent. Failure to provide treatment in these circumstances may constitute negligence. The clinical vignette provided did not establish life threatening emergency.

***Parens patriae* Doctrine:**
State governments may not override parental decisions or terminate custody unless parents delegate their authority to the state voluntarily or the state demonstrates that there is clear and convincing evidence that the parents have triggered state *parens patriae* interests by *placing their children in clear and present danger*. The state will not allow a child's health to be seriously jeopardized because of the parent's limitations or convictions. A parent does not have the authority to forbid saving their child's life. The state also

looks to the child abuse and neglect statutes, which provide protective custody when the child has not received medically indicated treatment.

Take-Home Message

- In a life-threatening emergency, a physician may proceed with the necessary intervention without parental consent. The State may intervene on behalf of a child if it can demonstrate that the guardians are placing their child in clear and present danger.

ABP Content Specification

- Know the process by which parental refusal of treatment can be overruled.

Question 8

A 16-year-old girl is at home alone while her parents are on an airplane on their way to a funeral. The teenager calls 911 and arrives in the emergency department without her mobile phone; she cannot recall her address or phone number. She is intoxicated but her GCS is 15. What is the **BEST** course of action for the ED physician?

A. Call the police since the family has abandoned the teenager
B. Conduct drug and alcohol testing since she is underage and is intoxicated
C. No acute intervention is needed—have the social worker contact the family for consent and offer no treatment since there is no emergency
D. Start treatment as indicated and make efforts to contact the family
E. Triage and treat the adolescent as you would any other patient who presents to the ED

Correct Answer: D

In *loco parentis* means "in place of a parent." This doctrine entails a temporary delegation of parental power, which commonly applies to minors, but can apply to adult-age persons who are suffering from permanent and severe medical incapacity. The natural parent or guardian is free to limit the scope of the power delegated and direct the actions of the temporary caretaker. The doctrine has nothing to do with guardian's unfitness.

Application of the in *loco parentis* doctrine requires that (1) the minor's parents are absent (either voluntarily, by forbearance, or because of an incident beyond the parents' control), (2) the adult caretaker on the scene is not the minor's legal guardian or custodian, and (3) the adult caretaker on the scene has, for the relevant time period, assumed control over the routine care and basic control of the child (e.g., shelter, safety, food, medical care, bathing, clothing, transportation, education, nurturing).

Take-Home Message

- The concept of *loco parentis* allows consent by an adult caretaker in the treatment of minors in certain situations when the parents are not available or accessible to give consent.

ABP Content Specification

- Know the *loco parentis* concept in the setting of a minor in police custody.

Question 9

According to the law, what types of duties do you owe to your patient?

A. Duty to cure
B. Duty to report bad care
C. Duty to rule-out an emergency condition
D. Duty to stabilize
E. Duty to treat until properly terminated

Correct Answer: E

The physician does not owe any special duties to the patient until a patient-physician relationship is created. Once the relationship is established, the physician owes the patient a duty to:

- Provide a certain standard of skill and care. This can include diagnosing, treating, instructing, and referring as needed
- Obtain appropriate consent
- Maintain confidentiality
- Provide continuity of care
- The relationship may be terminated by mutual consent for reasons such as personality conflicts, uncomfortable or difficult situations, change in patient insurance, and disagreement with treatment plan. Federal and state laws allow termination of patient treatment for reasons under certain circumstances (e.g., religious, conscience).

Take-Home Message
- Physicians have no obligation to treat a patient unless there is a patient-physician relationship.
- Physician has the duty to continue treatment as long as the relationship exists or is properly terminated.

ABP Content Specification
- Know the definition of patient-physician relationship.
- Know your responsibility as a physician towards the patient.

Question 10

You see a child in the ED complaining of ear pain but the TMs are normal. You discharge the patient with pain medication to be taken as needed. The family wants a second opinion and goes to the urgent care center next door, where the child is diagnosed with an ear infection and started on antibiotics. The family is furious and has obtained a lawyer. In order to win the case against you, the lawyer must prove each of the following **EXCEPT**:

A. A breach of duty because you did not diagnose the ear infection
B. A professional duty you owed the patient
C. The family had two co-payments because they had to seek care in the ED and the urgent care
D. The injury was significant
E. The patient suffered unnecessarily because of the delay in diagnosis

Correct Answer: D

Duty to Treat:
Medical malpractice law in the United States varies from state to state. Every state mandate has a common-law duty to act in a non-negligent manner. To establish negligence, the medical malpractice suit must prove four elements or legal requirements to make a successful claim of medical malpractice: (1) a professional duty owed to the patient—the existence of a legal duty on the part of the doctor to provide care or treatment; (2) a breach of such duty by failure to adhere to the standards of the profession; (3) injury caused by the breach, a causal relationship between breach of duty and injury to the patient; and (4) resulting damages or injury to the patient. Physicians have a duty to act as a reasonably well-trained physician *in the same specialty* would act under similar circumstances to meet the standard of care. The "circumstances" include the physician's specialty and customary practices in the area ("the locality rule"). An attending physician is generally liable for any negligence on the part of residents and medical students under his/her guidance. *Negligence* is defined as a failure to act in such a manner. Physicians are required to provide reasonable care, not perfect care.

Take-Home Message
- A malpractice claim requires that there was a patient doctor relationship, negligence causing harm and injury leading to specific damages.

ABP Content Specification
- Know the concept of duty to treat.

Question 11

In legal parlance, the standard of care in the ED is:

A. Different for different pediatric emergency medicine physicians based on their years of experience
B. Different for various practitioners working in the ED based on their scope of practice
C. The same for nurses, nurse practitioners, pediatricians
D. The same for pediatricians, nurse practitioners, physician's assistants, and pediatric emergency medicine physicians
E. Different depending on which state the physician works in

Correct Answer: B

Standard of Care generally refers to a reasonable care provided by similarly situated professional or peer would have provided to the patient. Physicians are usually held to the same standard of care across the country which generally does not vary from state to state. Standard of care assumes that physicians possess knowledge of current management and treatments and should be able to determine when consultants are needed. To establish which standard is to be applied, a lawyer must present the testimony of another medical expert qualified in the same area of medicine as the defendant, who can testify as to the level of care provided.

Take-Home Message

- Physicians are liable for negligence if there is a breach of duty, this breach of duty that resulted in injury attributable to that breach, and the provided treatment did not meet the standard of care.
- The standard of care refers to what a prudent physician would have done under similar circumstances.

ABP Content Specification

- Know the concept of duty to treat.
- Know the ramifications of failure to uphold the principle of duty to treat.
- Know the concepts regarding medical malpractice: negligence, the standard of care, harm.

Question 12

The majority of institutional review boards require the following for minors to participate in research:

A. A consent form signed by the subject for ages 8 years and above
B. An assent form for the subject for ages 8 years and above
C. An assent form identical to a consent form
D. An assent form signed by the legal guardian
E. An oral consent if the child cannot read or write

Correct Answer: B

Informed assent is the process whereby minors as young as 8 years of age may agree to participate in clinical research trials with the consent of their guardians. Most international guidelines on the ethics of human research recommend that an assent is applied in pediatric research. There are no absolute regulatory or ethical standards for obtaining or documentation of the assent. In determining whether children are capable of assenting, the IRB considers the ages, maturity, and psychological state of the children involved. Assent should include a statement indicating the nature of the research, what the subject is being asked to do, and the risks/benefits and voluntary nature of the participation.

Take-Home Message

- Most children as young as 8 years old can assent to participate in research as subjects, as long as their psychological state and maturity are adequate

ABP Content Specification

- Know the appropriate procedures for obtaining consent for the participation of a minor in research.

Question 13

Regulations and procedures for reporting child abuse/neglect and sexual abuse:

A. Are identical in every state
B. Change regularly and need to be reviewed often
C. Do not apply to nurses and teachers and social workers
D. Include civil or criminal penalties for false reports
E. Require the reporter to be 100% certain that abuse has occurred

Correct Answer: D

Child abuse/sexual abuse/neglect

State statutes identify persons *required* to report suspected child abuse/neglect to child protective services or law enforcement. In almost every state, people like social workers, teachers, physicians including residents, nurses, healthcare workers, counselors, mental health professors, childcare workers, and law enforcement officers are required to report if they suspect abuse or neglect. Any person is *permitted* to report their suspicion. Almost all states impose penalties on mandatory reporters who knowingly or willfully fail to make a report and for any person who willfully or intentionally makes a false report of child abuse or neglect.

Take-Home Message

- Most professionals that interact with children are mandated to report a situation suspicious for child abuse or neglect, and failure to report may result in penalties. Willfully making false reports of child abuse can also result in penalties.

ABP Content Specification

- Know the regulations concerning the reporting of child abuse, child neglect, and sexual abuse.
- Know the procedures for reporting child abuse, child neglect, and sexual abuse.

Question 14

Which one of the following conditions is **NOT** required to be reported in a majority of the states?

A. Dog bites
B. Pertussis
C. Respiratory syncytial virus
D. Salmonella
E. West Nile virus

Correct Answer: C

Reportable Conditions: All states have a "reportable diseases" list, and it is the responsibility of the healthcare provider or institutions to report cases of these diseases. Many diseases on the lists must also be reported to the US Centers for Disease Control and Prevention (CDC).

Reportable diseases are divided into several groups:

- Mandatory written reporting: Examples are gonorrhea and salmonellosis.
- Mandatory reporting by telephone: Examples are measles and pertussis.
- Report on the total number of cases: Examples are chickenpox and influenza.
- Cancer: Cancer cases are reported to the state cancer registry.

The county or state health department will try to find the source of many of these illnesses especially during an outbreak such as food poisoning in the interest of public health. In the case of STIs, the county/state will try to locate sexual contacts of infected people to make sure they are disease-free or need to be treated. The information gained from reporting allows the county/state to make informed decisions and laws about activities and the environment, such as animal control, food handling, immunization programs, insect control, and STI tracking.

Take-Home Message

- There are several diseases that are required to be reported to the departments of health or CDC for epidemiological surveillance and public health reasons. These lists are available at the department of health websites and can change from time to time.

ABP Content Specification

- Know conditions that require reporting (communicable diseases, assaults, death).

Question 15

An autopsy is usually ordered for which of the following cases?

A. At the physician's request, even if the family does not wish one to be done
B. For every pediatric death
C. Suspicion for a highly contagious disease
D. The death of a teenager secondary to terminal cancer
E. When there is no guardian present at the time of death

Correct Answer: C

Autopsies are mandated for any unexpected death or when there are suspicious circumstances surrounding the death. Any death involving injury, trauma, poisoning, or deaths that are unexplained, sudden, or suspicious in nature or something other than a natural cause should be reported to the medical examiner. A police investigator can have an autopsy done against a family's wishes if foul play is suspected. Death due to violence or suicide should also be reported to the coroner. If it is suspected that a person died as a result of a disease, an autopsy can be ordered for public health purposes, i.e., to stop further spread of the disease. The family of the deceased patient may request an autopsy.

Take-Home Message

- In cases of unexpected death where the cause of death is not apparent, it should be reported to the medical examiner. The medical examiner may mandate an autopsy to rule out a crime or identify a condition which may have public health implications.

ABP Content Specification

- Know the appropriate procedure for obtaining authorization for an autopsy.
- Know when an autopsy is required in emergency medicine

Question 16

Which of the following is a federal regulation after the death of a patient?

A. Consenting the family for organ donation is to be done by the physician.
B. Every organ/tissue will be harvested if consent is obtained.
C. The death is reported to the organ procurement organization/team.
D. The medical examiner should be called after the family has consented for organ procurement.
E. The patient must be on the donor registry for the procurement of organs.

Correct Answer: C

Many states have laws mandating a request for organ/tissue donation. In compliance with federal regulations, a hospital notifies its local organ procurement team of every patient that has died or is nearing death and confirm his/her potential to be a donor. The notification can be made by either a nurse or a physician. Trained specialists from organ procurement agencies can be dispatched to the facility to make the request in person. The ED physician may introduce the idea to the family, but the person obtaining consent should not be part of the patient care team. If the diseased has prior enrollment in the state donor's registry, it can serve as a legal consent; otherwise the organ procurement representative will seek consent from the next of kin.

Take-Home Message

- Given the large need for organs for potential transplantation, most states mandate that the regional organ procurement agency is informed after any death. Transplant coordinators can provide family support and answer questions that arise from the medical team.

ABP Content Specification

- Know the appropriate procedure for obtaining authorization of organ and tissue recovery for transplantation.
- Know when organ and tissue recovery must be requested.

Question 17

A "do not resuscitate" (DNR) order needs to have all the following components, **EXCEPT**

A. An expiration dates
B. Family member's signature as a witness
C. Patient or parent/guardian signature
D. Physician signature
E. Date DNR was signed

Correct Answer: B

Each hospital accredited by The Joint Commission is required to have a do not resuscitate (DNR) policy in place. DNR order is a written order by an attending physician in the chart. DNR orders are written when in the attending physician's judgment resuscitation is deemed to be futile. A parent/guardian can request a DNR if he/she has the mental capacity to make such a decision when the patient is terminally ill and the treatment team agrees that further resuscitative efforts would be futile. The family has the option to rescind the DNR order at any time. Family members cannot be witness to the DNR order as the witness should be unrelated to the family.

If a physician has written a DNR order at the patient's request, the family cannot override it. If the patient has a healthcare proxy, then that person may request a DNR order for the patient.

Take-Home Message

- The Joint Commission requires that advance directives are documented for all patients; this may include a DNR order for patients in whom resuscitation is deemed futile.
- It is prudent to inquire about the advance directive, including DNR, when terminally ill patients present to the ED

ABP Content Specification

- Know the appropriate procedure for initiating a do not resuscitate order.

Question 18

A 15-year-old boy is medically stable with a few scrapes and bruises after jumping in front of a car. He states he wants to die, and that is why he jumped in front of the car. Which of the following is **TRUE** about the process of getting him admitted to a psychiatric facility?

A. An appropriate parental consent must be signed, even if the patient is a threat to self or others.
B. If the child disagrees, the parent can petition the court for psychiatric admission.
C. If the family and the patient do not want him admitted, there is nothing you can do.
D. Since he is clearly suicidal, an evaluation by a psychiatry is not necessary prior to psychiatric admission.
E. Since there was no significant injury, it was more likely a gesture and he does not need psychiatric inpatient hospitalization.

Correct Answer: B

Psychiatric hospitalization may be necessary for patients who pose a threat to themselves or others. There are multiple reasons for inpatient psychiatric hospitalizations or commitments in children such as severe depression, threats to self or others, drug overdoses, psychosis, and the inability to provide basic care for oneself. A parent or guardian can enlist the assistance of a court, therapist, or police officer to have their child evaluated by a psychiatrist and possibly institutionalized against his/her will when it is demonstrated that the child poses a *threat to self or others.* There must be evidence or other witnesses to the relevant behavior. The three typical paths to commitment are a recommendation by a mental health provider, parental petition to the court, or law enforcement viewing the person as a danger. Inpatient psychiatric treatment may be

voluntary if the parent/guardian agrees or involuntary if such agreement is not given. Child protective services could be enlisted if parents are not in compliance with the psychiatrist. Every state has a process for involuntary commitment of an emancipated child or an adult.

Take-Home Message

- Patients that are assessed to be suicidal or homicidal or suffering psychosis can be committed to an involuntary psychiatric admission by mental health providers. The court or law enforcement agents can request such an assessment under very specific circumstances.

ABP Content Specification

- Know the appropriate procedure for initiating the psychiatric commitment of a child.
- Know the conditions under which a child requires a psychiatric commitment.

Question 19

The ethical principles of medicine which are relevant to emergency medicine include all the following **EXCEPT:**

A. Respect for autonomy
B. Beneficence
C. Cordiality
D. Non-maleficence
E. Justice

Correct Answer: C

Ethical principles are timeless and universal, whereas laws vary state by state and change over time. When the law is unhelpful or silent on a matter, then ethical principles should guide conduct. These ethical principles provide an analytical framework for the discussion of ethical dilemmas in healthcare and are straightforward enough to be understood by people of various backgrounds. The ethical principles of respect for autonomy (allowing free choice by the patient), beneficence (best interest of the patient), non-maleficence (doing no harm to the patient), and justice (be fair and equitable) pertain to all aspects of clinical medicine, including emergency medicine.

Take-Home Message

- The core principles of ethical behavior are autonomy, beneficence, non-maleficence, and justice.

ABP Content Specification

- Know the application of ethical principles pertaining to the practice of emergency medicine.

Question 20

The end-of-life legal document usually relevant to pediatric patients is which of the following:

A. Advance directive
B. A durable power of attorney
C. Healthcare proxy
D. Living will
E. None of the above

Correct Answer: E

An advance directive is a living will that documents your wishes about end-of-life medical treatment in the event you lack the capacity and understanding to make sound decisions for yourself. A healthcare proxy names a surrogate decision-maker to guide healthcare decisions if the patient is unable. From a legal perspective, they are not intended to be written by, or used for children. A living will is a legal document outlining your preferences if you are seriously ill, in a coma, with dementia, or incapacitated. It delineates what treatments you would or would not want, including organ donation. Topics usually covered include resuscitation (CPR), mechanical ventilation, dialysis, antibiotics, palliative care, and tube feeding. A durable power of attorney for healthcare or a healthcare proxy is a type of advance directive in which you name a person who will decide on your behalf when you are unable to do so. This is use-

ful even if you have an advance directive since you cannot anticipate every possible event/circumstance.

Take-Home Message
- An advance directive, living will, and durable power of attorney are not applicable to children but are important concepts to understand.
- Advance directives may include a living will or directives related to resuscitation, intubation, ventilation, and organ donation.
- Healthcare proxy and surrogates are authorized to make medical decisions when a patient loses functional and mental capacity.

ABP Content Specification
- Know the terms advance directive, living will, and durable power of attorney for healthcare.

Question 21

EMS is called to the home of a child with trisomy 18 who is unresponsive. Paramedics begin to provide life-saving interventions, including CPR. The mother states that she and her husband signed a "Do Not Resuscitate" order just a few weeks ago and wants paramedics to stop CPR. What is the correct course of action?

A. Continue CPR and stop when the document is produced
B. Continue CPR and transport the patient to the hospital regardless of the mother's objections
C. Stop CPR and have the mother produce the document
D. Stop CPR only after the document has been reviewed by medical command
E. Stop CPR since that was the mother's wish

Correct Answer: A

Do-Not-Resuscitate orders are written to withhold CPR in the event that the child suffers a fatal event that is the culmination of the dying process of a child who has a terminal illness or poor quality of life.

It is written when in the judgment of the treating physician an attempt to resuscitate a child is not in the best interest of the child. One should take the preference of the parent and guardian as well as the assent of the child if appropriate before making the DNR order as long as this is in accordance with the child's best interest. The paramedics should honor the order once the parents produce the necessary document at the time of the event.

When patients are minors, decisions are made using the best interest standard. The best interest standard means that the decision is the one with the greatest net benefit to the patient. Ideally, this should be formulated from a shared decision-making process that involves the family, the patient when appropriate, and the medical team. In the case of an emancipated minor, the patient has the legal decision-making authority.

Decisions regarding end-of-life care and use of aggressive, potentially life-prolonging but burdensome therapies are most challenging. The AAP endorses withdrawing or withholding burdensome therapies in the interest of maximizing a child's quality of life. Specifically, the AAP states: "Although a child's life may be shortened by forgoing burdensome interventions or providing adequate sedation in the face of otherwise unrelieved symptoms, the goal of palliative care is to optimize the quality of the child's experience rather than hasten death." Providing the best care for a particular patient may include withdrawing or withholding life-sustaining therapies, which are ethically supportable practices.

Take-Home Message
- The end-of-life and palliative care issues in pediatrics are complex. The PEM physicians should be familiar with legal and ethical issues involving emergency care.

ABP Content Specification
- Know the application of ethical principles pertaining to end-of-life and palliative care in pediatrics.

Question 22

A pharmaceutical company completed a large multicenter drug trial that showed improved outcomes using their drug over placebo. Discrepancies in the records indicate that the company possibly changed some of the data. This is known as:

A. Falsification of data
B. Fabrication of data
C. Plagiarism
D. Conflict of Interest
E. Scientific validity

Correct Answer: A

Falsification of data is to change data from what it actually is, while fabrication is to concoct data. Plagiarism is when someone takes the work of another and claims it is his/her own, including claiming ideas, words, or data.

A conflict of interest exists when an individual or institution has contradictory interests that relate to research, such as financial gain. Other definitions are as follows:

- Conflicts of interest are "situations in which financial or other personal considerations may compromise, or have the appearance of compromising, an investigator's judgment in conducting or reporting research" (AAMC, 1990).
- A conflict of interest in research exists "when the individual has interests in the outcome of the research that may lead to a personal advantage and that might, therefore, in actuality or appearance compromise the integrity of the research" (NAS, Integrity in Scientific Research).

If conflicts of interest exist, this does not mean a study is unethical. Researchers are obligated to ensure this does not affect the experiments or results and they must disclose any conflicts of interests to other researchers.

Scientific validity is the principle that research should be expected to produce useful results and increase knowledge.

Take-Home Message

- Any digression from honest, original data is an ethical breach in research. Researchers must also be careful to report any conflicts of interest and ensure that they do not affect planning, analysis, or results.

ABP Content Specification

- Conflicts of interest and understand ways to recognize and manage conflict of interest.
- Professionalism and misconduct in research.
- Identify forms of research misconduct (e.g., plagiarism, fabrication, falsification).
- Differentiate honest error and differences of opinion from research misconduct.

Question 23

Which of the following is consistent with a breach in medical research ethics?

A. A pharmaceutical company is conducting a clinical trial for a medication that was previously shown to decrease mortality in patients with heart disease but also increased depression in many patients.
B. An investigator that contributed to the study concept and design, but did not revise or review the final draft of the manuscript is listed as the first author on a paper.
C. An IRB does not approve a study that proposes a trial of antidepressants in a population of prisoners at a state penitentiary.
D. A study at a children's hospital is researching the possible use of ultrasound to identify swallowed foreign bodies. Enrolled patients still receive standard of care x-rays in addition to an ultrasound by study personnel.
E. A therapeutic device found to be beneficial in certain populations is studied using public funds but is very expensive. The device is subsidized so that lower-income patients may have access to the same care as wealthier patients.

Correct Answer: B

The author in choice B did not meet all four criteria for authorship based on the International Committee of Medical Journal Editors recommendations:

- Substantial contributions to the conception or design of the work, or the acquisition, analysis, or interpretation of data for the work
- Drafting the work or revising it critically for important intellectual content
- Final approval of the version to be published
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Answer A describes a situation in which benefits have been judged to outweigh the risks; in this case, a decrease in mortality outweighs the side effect of depression. In research, risks and benefits must be weighed and described to participants to ensure that the benefits outweigh the risks.

Answer choices C, D, and E illustrate the three basic ethical principles outlined in the Belmont Report. The Belmont Report was published in 1979 and sought to identify the basic ethical principles that should underlie the conduct of biomedical and behavioral research involving human subjects and to develop guidelines to ensure these principles are adhered to.

The three basic principles are respect of persons, beneficence, and justice.

- *Respect for "persons" states* that individuals should be treated as autonomous agents and that persons with diminished autonomy are entitled to protection. This is illustrated in answer choice c as children and prisoners are protected as a special population in research as they are vulnerable to coercion.
- *Beneficence describes the treatment of people* in an ethical manner not only by respecting their decisions and protecting them from harm but also by making efforts to secure their well-being. This is described in choice D as well as A. In choice D, the study does not immediately benefit the study participants but seeks to benefit future patients, which is described in the principle of beneficence.
- *Justice* describes the principle that benefits of research should be equitable and no vulnerable population should by unduly burdened as the subjects of the research if the research is unlikely to benefit the specific population.

Take-Home Message

- Benefits should always outweigh the risks in medical research, and investigators must maintain the three principles outlined in the Belmont Report.

ABP Content Specification

- Understand the criteria for authorship of clinical research publications
- Understand and apply the three main principles of research ethics articulated in the Belmont Report, which are respect for persons, beneficence, and justice.
- Understand the role of analysis of risks/benefits in the ethical conduct of research

Question 24

A retrospective study is proposed to the IRB that will use de-identified data from a database but will also require chart review and protected health information. Which of the following is true about informed consent?

A. Participants in research are not permitted to withdraw once they have consented to participation in a study.
B. While obtaining informed consent from a patient, investigators should use the same medical terms and descriptions they would use when speaking with other physicians or researchers.
C. If parents consent to a child participating in a study, but the child refuses, the child, even though a minor, is still required to participate in the study and does not have legal decision-making power.

D. A retrospective study involving chart review may be eligible for a waiver of informed consent.
E. It is permitted for students in a psychiatry class who participate in a study to receive a better grade for their participation.

Correct Answer: D

The study in choice D may meet the criteria for a waiver of informed consent. An IRB may waive the requirement for informed consent under the following conditions: research involves no more than minimal risk to the subjects, the waiver will not adversely affect the rights and welfare of the subjects, the research could not practically be carried out without the waiver, and subjects will be provided with additional pertinent information after participation, if applicable.

The informed consent process involves the following:

- Disclosing information needed to make an informed decision
- Facilitating the understanding of what has been disclosed
- Promoting the voluntariness of the decision about whether or not to participate in the research.
- Subjects should be in a position to freely decide whether to initially enroll in the research or, later, to withdraw or continue participating in the research; this is why answer A is incorrect. All critical information about a study should be completely disclosed, and prospective subjects or their legally authorized representatives should adequately understand the research so that they can make an informed decision. Information must be conveyed in language understandable to those being asked to participate as subjects in the research, thus making answer B incorrect.
- Children are unable to legally provide informed consent; however, they may provide assent, meaning they agree to participate in the research. The age determining ability to give assent varies between states. The IRB is responsible for deciding whether child assent is required in proposed research activities. Answer C is incorrect for this reason.
- Answer E brings up the concept of coercion and protected populations. Certain populations, such as children, prisoners, pregnant women, mentally disabled, or students are vulnerable to coercion or undue influence, and additional safeguards must be included to protect the rights and welfare of these subjects. The students in question E are under the undue influence and may not be able to give free consent.

Take-Home Message

- The IRB has the responsibility to ensure that all provisions of informed consent are met and that there are safeguards in place that protect the rights of vulnerable populations such as children or prisoners.
- Research studies should be conducted in a transparent, fair, and easy-to-understand manner without any coercion and undue burden on the participants.
- Participation in research should be a voluntary process irrespective of the age of the patient. Consent and assent are both required based on the cognitive abilities of the subject.

ABP Content Specification

- Understand what constitutes informed consent in research
- Understand when an exemption from review by the IRB is permissible.
- Understand how undue influence and/or coercion can affect obtaining consent for research
- Distinguish among consent, assent, and permission in research involving children
- Recognize the rights of protected populations.
- Understand the concept of minimal risk as it applies to research involving children

Question 25

Which of the following constitutes an unethical breach of confidentiality?

A. A psychiatrist discloses to an adolescent patient's parents that the patient is having worsening suicidal thoughts.
B. A pediatrician reports to the state a newly diagnosed case of measles in a 2-year-old.
C. An inpatient hospital team is rounding and continues the discussion of a patient's diagnosis and plan in a public elevator.
D. A physician reports bruising in an elderly patient to the department of protective services.
E. Research data containing de-identified protected health information (PHI) are kept in an encrypted document on a password-protected computer within the health system.

Correct Answer: C

Choice C is likely an unintended disclosure; however, it violates confidentiality because the discussion involving PHI is being held in a public space. In accordance with the Health Information Portability and Accountability Act of 1997 (HIPAA), institutions are required to have policies to protect the privacy of patients' electronic information, including procedures for computer access and security.

Statement E describes a correct safeguard protecting PHI.

Choice A is an example of a protected breach in confidentiality that requires physicians to protect identifiable individuals from any serious, credible threat of harm if they have information that could prevent this.

State law requires the report of certain communicable/infectious diseases to the public health authorities, and suspected cases of child, dependent adult, and elder abuse are reportable, making B and D incorrect.

Additionally, in many states adolescents can seek treatment for pregnancy, sexually transmitted infections, mental health concerns, and substance abuse without parental permission.

Take-Home Message

- Every effort must be made to maintain patient confidentiality, however, there are exceptions to this rule. Exceptions include when confidentiality may affect the safety of the patient or members of the community.

ABP Content Specification

Understand federal regulations that protect patients' right to privacy of medical information.

- Understand the conditions in which a breach of patient confidentiality is allowable.
- Understand reporting regulations regarding certain communicable diseases and suspected child or elder abuse.
- Parental consent for the treatment of adolescents with pregnancy, substance use, STD, and mental health concerns is regulated by state law.

Suggested Reading

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Epidemiology

33

Monica Gaddis

Question 1

A 12-year-old boy presents to the emergency department with anorexia, two episodes of diarrhea, and diffuse abdominal pain that has migrated to the right lower quadrant. Your clinical estimate of the probability of acute appendicitis is approximately 70%. (This probability would be higher if not for the presence of diarrhea.) You decide to perform a bedside abdominal ultrasound to evaluate the child for appendicitis.

You have audited your own ultrasound performance and are aware of the sensitivity and specificity of your own ultrasound performance. You have scanned 45 patients with abdominal pain who actually had appendicitis. Your scans were positive for appendicitis in 42 of those patients. You have scanned 150 patients with abdominal pain who did not have appendicitis. The results from those scans led you to falsely diagnose appendicitis in 15 cases.

What is the sensitivity of your ultrasound test performance?

A. 0.90
B. 0.93
C. 0.74
D. 0.97
E. 0.82

Correct Answer: B

If there were 42 of 45 patients with true positive results, then there were 3 patients with false-negative results.

Sensitivity is calculated as TP/(TP + FN). Thus, 42/ (42 + 3) = 42/45 = 0.933

Sensitivity is also known as the true positive rate. This means that your ultrasound performance for the diagnosis of appendicitis is correct 93.3% of the time.

	Truth = yes	Truth = no
Test result = yes	True + (TP)	False + (FP)
Test result = no	False − (FN)	True − (TN)

	Appendicitis +	Appendicitis−	Total
Ultrasound +	42 (TP)	15 (FP)	57
Ultrasound −	3 (FN)	135 (TN)	138
	45	150	195

ABP Content Specification

- Calculate and interpret sensitivity and specificity.

Linda M. Gerber has helped in editing this chapter.

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_33

Question 2

Using the scenario in Question 1, what is the specificity of your ultrasound test performance?

A. 0.933
B. 0.737
C. 0.90
D. 0.978
E. 0.82

Correct Answer: C

If there were 15 false-positive results in your ultrasound scans of patients without appendicitis, then there were 135 (150 − 15) patients with true negative results.

Specificity is calculated as TN/(TN + FP). Thus, 135/(135 + 15) = 0.90.

This means that the probability of scanning negative if the disease is truly absent is 90%.

Specificity is also defined as the true negative rate. Thus, the true negative rate is 90.0%

ABP Content Specification

- Calculate and interpret sensitivity and specificity.

Question 3

Using the scenario in Question 1, calculate the positive predictive value of your ultrasound performance for the diagnosis of appendicitis.

A. 0.737
B. 0.978
C. 0.933
D. 0.90
E. 0.82

Correct Answer: A

There are 42 true positive ultrasound findings, and there are 15 false-positive ultrasound findings in your performance history.

The positive predictive value is calculated as TP/(TP + FP). Thus 42/(42 + 15) = 0.7368.

This means that the probability of the patient having appendicitis when the patient tested positive for appendicitis with your ultrasound is 0.737.

ABP Content Specification

Calculate and interpret positive and negative predictive values.

Question 4

Using the scenario in Question 1, calculate the negative predictive value of your ultrasound performance for the diagnosis of appendicitis.

A. 0.933
B. 0.737
C. 0.90
D. 0.978
E. 0.82

Correct Answer: D

There are 135 true negative ultrasound findings, and there are 3 false-negative ultrasound findings in your performance history.

The negative predictive value is calculated as TN/(TN + FN). Thus, 135/(135 + 3) = 0.978.

This means that the probability of the patient not having appendicitis when the patient tested negative for appendicitis with your ultrasound is 0.978

ABP Content Specification

- Calculate and interpret positive and negative predictive values.

Question 5

Consider the situation in scenario 1 when your ultrasound test reveals apparent acute appendicitis. What is the likelihood ratio of a "positive" test result? (What is the value for the "+LR"?).

A. 12.86
B. 9.33
C. 9.68
D. 10.33
E. 10.5

Correct Answer: B

The positive likelihood ratio is calculated as the probability of a positive test in patients who actually have the disease in question (TP) divided by the probability that a person without the disease tested positive for the disease (FP) or sensitivity/(1-specificity).

Thus, the positive likelihood ratio is 0 0.933/(1 − 0.9) = 0.933/0.1 = 9.33.

A positive likelihood ratio of approximately 10 or greater indicates a highly useful test. Thus, your ultrasound performance is somewhat highly useful in the determination of the presence of appendicitis. Likelihood ratios offer the advantage of not being dependent on the prevalence rate.

ABP Content Specification
- Calculate and interpret likelihood ratios.

Question 6

Consider the situation in scenario 1 when your ultrasound test is "negative" for acute appendicitis. What is the likelihood ratio of a "negative" test result? (What is the value for the "− LR"?)

A. 1.42
B. 0.107
C. 0.074
D. 0.74
E. 0.04

Correct Answer: C

The negative likelihood ratio is calculated as the probability that a person with the disease tested negative (FN) divided by the probability that a person without the disease tested negative for the disease (TN) or (1 − sensitivity)/specificity.

Thus, the negative likelihood ratio is (1 − 0.933)/0.9 = 0.074.

A negative likelihood ratio of approximately 0.1 or less indicates a highly useful test. Thus, your ultrasound performance is highly useful in the determination of the lack of the presence of appendicitis. Likelihood ratios offer the advantage of not being dependent on prevalence.

ABP Content Specification
- Calculate and interpret likelihood ratios.

Question 7

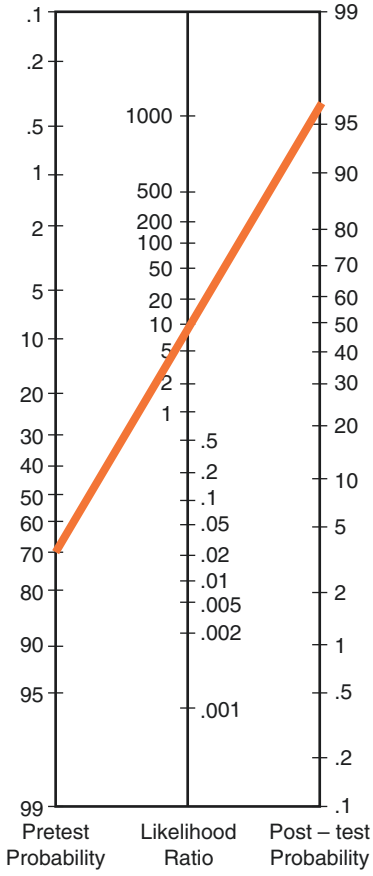
If the ultrasound for the child from scenario 1 yielded a positive result for the presence of appendicitis, what is the post-test probability of this child having appendicitis? Recall that the pre-test probability of having appendicitis was estimated to be 70% and the positive likelihood ratio was 9.33.

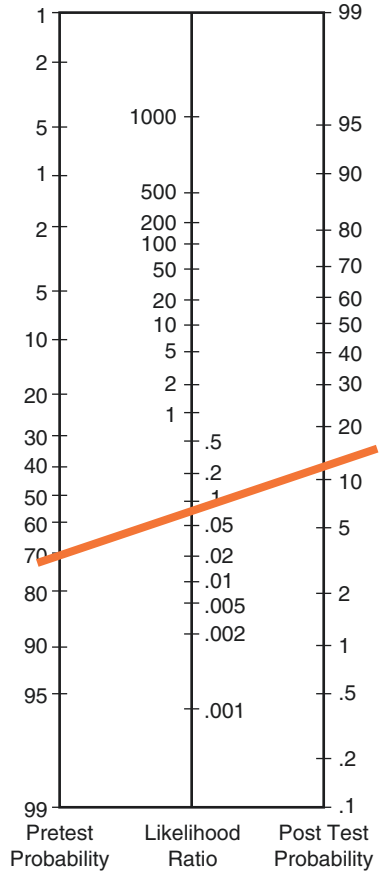
A. 0.98 or 98%
B. 0.14 or 14%
C. 0.95 or 95%
D. 0.65 or 65%
E. 0.78 or 78%

Correct Answer: C

There are two ways to determine this answer.

Method 1: Fagan nomogram: The Fagan nomogram is a tool that is used to estimate the post-test probability of the presence of a disease from the pre-test probability of the presence of that disease along with the likelihood ratio (+ or −) (NEJM 1975; 293: 25).





Given a pre-test probability of having appendicitis of 70%, and a positive likelihood ratio of 9.33 calculated after receiving an ultrasound finding indicating appendicitis, using the Fagan nomogram, the post-test (post-ultrasound) probability of this child having appendicitis is approximately 0.95% or 95%.

Method 2: Calculation: The manual calculation requires converting probabilities into odds: ODDS = probability/1 -probability

Given: pre-test probability = 70% (0.70)
Positive likelihood ratio = 9.33

- Step 1: Calculate pre-test odds

Pre-test odds = pre-test probability/(1 − pre-test probability)
= 0.70/(1–0.70) = 0.70/0.30 = 2.33

- Step 2: Calculate post-test odds

Post-test odds = pre-test odds × likelihood ratio
= 2.33 × 9.33 = 21.7389

- Step 3: Calculate post-test probability

Post-test probability = Post-test odds/(1 + post-test odds)
= 21.7389/22.7389 = 95.60

Compare the Methods

- Method 1, the Fagan nomogram, found a post-test probability of the child having appendicitis of approximately 95%.
- Method 2, the calculation, found a post-test probability of the child having appendicitis of 95.60%.

ABP Content Specification
- Estimate the post-test probability of a disease, given the pre-test probability of the disease and the likelihood ratio for the test.

Question 8

Using the scenario in Question 1, when the ultrasound was not indicative of appendicitis, what is the post-test probability of this child having appendicitis?

A. 0.75 or 75%
B. 0.14 or 14%
C. 0.21 or 21%
D. 0.50 or 50%
E. 0.30 or 30%

Correct Answer: B

Method 1: Fagan nomogram: Given the 70% pre-test probability of having appendicitis prior to testing and a negative likelihood ratio of 0.074 calculated after receiving an ultrasound finding not indicating appendicitis and using the Fagan nomogram, the post-test (post-ultrasound) probability of this child actually having appendicitis is approximately 0.14 or 14%.

Method 2: Calculation: Given: Pre-test probability = 70% (0.70)

Negative likelihood ratio = 0.074

- Step 1: Calculate pre-test odds

Pre-test odds = pre-test probability/(1 − pre-test probability)
= 0.70/(1–0.70) = 0.70/0.30 = 2.330

- Step 2: Calculate post-test odds

Post-test odds = pre-test odds × likelihood ratio
= 2.33 × 0.074 = 0.1724

- Step 3: Calculate post-test probability

Post-test probability = post-test odds/(1 + post-test odds)
= 0.1724/1.1724 = 0.1470 = 14.71

Compare the Methods

- Method 1, the Fagan nomogram, found a post-test probability of the child having appendicitis of approximately 14%.
- Method 2, the calculation, found a post-test probability of the child having appendicitis of 14.71%.

ABP Content Specification
- Estimate the post-test probability of a disease given the pre-test probability of the disease and the likelihood ratio for the test.

Question 9

Using the scenario in Question 1, what are the criteria against which a diagnostic test is compared?

A. Autopsy
B. Sensitivity of the diagnostic test
C. Specificity of the diagnostic test
D. Gold standard
E. Hypothesis

Correct Answer: D

The gold standard is the benchmark by which diagnostic tests are evaluated. A gold standard represents the best and most correct information, the test that is the most accurate. With diagnostic testing, the gold standard is assumed to provide the correct outcome.

ABP Content Specification

- Recognize the importance of an independent "gold standard" in evaluating a diagnostic test.

Question 10

A study of teenage patients (n = 180) with symptoms suggestive of systemic lupus erythematosus (lupus) and a positive antinuclear antibody titer (ANA) was conducted to determine the positive and negative predictive values of ANA as a diagnostic criterion for lupus. The prevalence of lupus in this cohort was 60%. There were 90 patients who tested positive for ANA who really had lupus. There were 64 patients who had a negative ANA test who really did not have lupus.

Calculate the sensitivity of using a positive ANA as an indicator of lupus

A. 0.833
B. 0.889
C. 0.918
D. 0.781
E. 0.722

Correct Answer: A

- Step 1: Calculate the number of patients who were known to have lupus

  #Patients with lupus = Prevalence × total number of patients in cohort

  = 0.60 × 180 = 108

- Step 2: Calculate the number of false negatives

  #False negatives = #patients with lupus − #true positives

  = 108 − 90 = 18

- Step 3: Calculate sensitivity

  Sensitivity = TP/(TP + FN)

  = 90/(90 + 18) = 90/108 = 0.8333

ABP Content Specification

- Calculate and interpret sensitivity and specificity.

Question 11

Using the scenario in Question 10, calculate the specificity of using a positive ANA as an indicator of lupus.

A. 0.918
B. 0.833
C. 0.781
D. 0.889
E. 0.722

Correct Answer: D

- Step 1: Calculate the number of people who were known to not have lupus

  #Patients without lupus = Total number of patients in cohort − patients with lupus = 180 − 108 = 72

- Step 2: Calculate the number of false positives

#False positives = #patients without lupus − #true negatives
= 72 − 64 = 8

- Step 3: Calculate specificity

Specificity = TN/(TN + FP)
= 64/(64 + 8) = 64/72 = 0.8889

ABP Content Specification
- Calculate and interpret sensitivity and specificity.

Question 12

Using the scenario in Question 10, what is the probability of the patient having lupus when the patient has a positive ANA titer?

A. 0.781
B. 0.833
C. 0.889
D. 0.918
E. 0.755

Correct Answer: D

The probability of the patient having lupus when the patient has a positive ANA titer is called the positive predictive value (PPV).

The PPV is calculated as the true positives/(true positives + false positives)
PPV = TP/(TP + FP)
= 90/(90 + 8) = 90/98 = 0.9184

ABP Content Specification
- Calculate and interpret positive and negative predictive values.

Question 13

Using the scenario in Question 10, what is the probability of the patient NOT having lupus when the patient has a negative ANA titer?

A. 0.918
B. 0.781
C. 0.833
D. 0.889
E. 0.790

Correct Answer: B

The probability of the patient NOT having lupus when the patient has a negative ANA titer is called the negative predictive value.

The NPV is calculated as the true negatives/(true negatives + false negatives)
PPV = TN/(TN + FN)
= 64/(64 + 18) = 64/82 = 0.7805 = 0.780

ABP Content Specification
- Calculate and interpret positive and negative predictive values.

Question 14

Using the scenario in Question 10, what is the proper term for the number calculated in Question 13?

A. Positive predictive value
B. Positive likelihood ratio
C. Negative predictive value
D. Negative likelihood ratio
E. Accuracy

Correct Answer: C

The probability of the patient NOT having lupus when the patient has a negative ANA titer is called the negative predictive value (NPV).

ABP Content Specification
- Interpret negative predictive values.

Questions 15

The same ANA test for the diagnosis of lupus from Scenario 2: Part 1 was applied in a community based private pediatric rheumatology prac-

tice. The prevalence of lupus in this practice is 10% over a 5-year period. Recall that the prevalence in the large Referral Hospital was 60%. The physician who treats the lupus patients in this practice has evaluated 300 patients over this 5-year time period. Recall that the sensitivity of the ANA test was found to be 0.8333 and the specificity was found to be 0.8889.

Calculate the number of true positives in this new cohort of 300 patients.

A. 25
B. 5
C. 240
D. 30
E. 42

Correct Answer: A

- Step 1: Calculate the number of patients who were known to have lupus

#Patients with lupus = prevalence × total number of patients in cohort

$$= 0.10 \times 300 = 30$$

- Step 2: Calculate the number of true positives

#True positives = #patients with lupus × sensitivity

$$= 30 \times 0.8333 = 25$$

ABP Content Specification

- Understand how disease prevalence affects the positive and negative predictive value of a test.

Question 16

Using the scenario in Question 15, calculate the number of false negatives in this new cohort of 300 patients.

A. 240
B. 30
C. 25
D. 5
E. 42

Correct Answer: D

#False negatives = #patients with lupus – #true positives

$$= 30 - 25 = 5$$

ABP Content Specification

- Understand how disease prevalence affects the positive and negative predictive value of a test.

Question 17

Using the scenario in Question 15, calculate the number of true negatives in this new cohort of 300 patients.

A. 267
B. 240
C. 25
D. 30
E. 190

Correct Answer: B

- Step 1: Calculate the number of patients known to NOT have lupus

#Patients without lupus = #patients in cohort – #patients known to have lupus

$$= 300 - 30 = 270$$

- Step 2: Calculate the number of true negatives

#True negatives = #patients without lupus × specificity

$$= 270 \times 0.8889 = 240$$

ABP Content Specification

- ‘and negative predictive value of a test.

Question 18

Using the scenario in Question 15, calculate the number of false positives in this new cohort of 300 patients.

A. 30
B. 25
C. 5
D. 240
E. 182

Correct Answer: A

False positives = #patients without lupus − #true negatives
= 270 − 240 = 30

ABP Content Specification
- Understand how disease prevalence affects the positive and negative predictive value of a test.

Question 19

Using the scenario in Question 15, calculate the positive predictive value for this cohort of 300 patients.

A. 0.455
B. 0.979
C. 0.833
D. 0.889
E. 0.621

Correct Answer: A

The PPV is calculated as the true positives/(true positives + false positives)
PPV = TP/(TP + FP)
= 25/(25 + 30) = 25/55 = 0.4545

ABP Content Specification
- Understand how disease prevalence affects the positive and negative predictive value of a test.

Question 20

Using the scenario in Question 15, calculate the negative predictive value for this cohort of 300 patients.

A. 0.455
B. 0.979
C. 0.833
D. 0.889
E. 0.901

Correct Answer: B

The NPV is calculated as the true negatives/(true negatives + false negatives)
NPV = TN/(TN + FN)
= 240/(240 + 5) = 240/245 = 0.9796

ABP Content Specification
- Understand how disease prevalence affects the positive and negative predictive value of a test.

Question 21

How did the lower disease prevalence seen in the community-based private pediatric rheumatology practice as compared to the tertiary pediatric referral hospital impact the positive predictive value?

A. Disease prevalence is unrelated to positive predictive value.
B. This lower disease prevalence was too small to influence positive predictive value.
C. The lower disease prevalence resulted in an increase in positive predictive value.
D. The lower disease prevalence resulted in a decrease in the positive predictive value.
E. Disease prevalence is inversely related to the positive predictive value.

Correct Answer: D

The PPV for the ANA test used in the tertiary pediatric referral hospital was calculated as

0.9184. The PPV for the ANA test used in the community based private pediatric rheumatology practice was calculated as 0.4545.

Thus, for the same test, a prevalence of 60% resulted a PPV of 0.9184, while a prevalence of 10% resulted in a PPV of 0.4545.

This example illustrates direct relationship of prevalence to PPV. As prevalence increases, so does PPV. As prevalence decreases, so does PPV.

ABP Content Specification

- Understand how disease prevalence affects the positive and negative predictive value of a test.

Question 22

How did the lower disease prevalence seen in the community-based private pediatric rheumatology practice compared with the tertiary pediatric referral hospital impact the negative predictive value?

A. Disease prevalence is unrelated to negative predictive value.
B. This lower disease prevalence was too small to influence negative predictive value.
C. The lower prevalence resulted in an increase in the negative predictive value.
D. The lower prevalence resulted in a decrease in the negative predictive value.
E. Disease prevalence is inversely related to the negative predictive value.

Correct Answer: C

The NPV for the ANA test used in the tertiary pediatric referral hospital was calculated as 0.7805. The NPV for the ANA test used in the community based private pediatric rheumatology practice was calculated as 0.9796.

Thus, for the same test, a prevalence of 60% resulted in a NPV of 0.7805, while a prevalence of 10% resulted in a NPV of 0.9796.

This example illustrates the inverse relationship of prevalence to NPV. As prevalence increases, NPV decreases. As prevalence decreases, NPV increases.

It is important to note that PPV and NPV are not generalizable when the prevalence of the disease in question is very different between locations. In a setting with a high prevalence of the disease in question, it is more likely for a patient who tests positive for that disease to actually have that disease. If the same test is employed in a setting with low prevalence of the disease in question, it is less likely that a person with a positive test result actually has the disease. Thus, the PPV and NPV should not be used to assess whether or not a patient actually has a disease based on a test that was assessed at a location with a different prevalence.

ABP Content Specification

- Understand how disease prevalence affects the positive and negative predictive value of a test.

Questions 23

Two teenage girls present to the ED complaining of shortness of breath and chest pain. Both girls have recently begun a fitness program in preparation for high school sports season, which includes weight lifting.

Upon presentation to the emergency department, Girl A had a resting heart rate of 110 beats per min and Girl B had a resting heart rate of 67 beats per min.

Both girls report using oral contraceptives. Neither girl has a history of prior pulmonary embolism or hemoptysis or malignancies. Girl A recently experienced a tibia-fibula fracture (6 weeks prior to ED visit) and was in a cast until 3 days prior to ED visit. This leg is now swollen and painful upon palpation. Girl B has no extremity swelling. You believe that the chest pain in both girls may be due to the weight lifting regimen.

Prior to invasive testing, the physician decides to use a clinical prediction rule to assess the probability that Girl A has a pulmonary embolus.

The Wells Criteria Predictive Rule list and the Geneva Criteria are used to assess for the pre-test probability of the presence of pulmonary embolism. Both tests have been validated in emergency and inpatient settings.

Use the Wells Criteria to estimate the pre-test probability of Girl A having a PE.

Criteria	Yes	No
Clinical signs and symptoms of DVT	+3	0
PE is #1 diagnosis or equally likely	+3	0
Heart rate >100	+1.5	0
Immobilization at least 3 days, or surgery in the previous 4 weeks	+1.5	0
Previously, objectively diagnosed PE or DVT	+1.5	0
Hemoptysis	+1	0
Malignancy with treatment within 6 months, or palliative	+1	0

http://www.mdcalc.com/wells-criteria-for-pulmonary-embolism-pe/
Interpretation standards:
Score >6.0 = high probability of PE (59.9%)
Score 2.0–6.0 = moderate probability of PE (29%)
Score <2.0 = low probability of PE (15%)

Answer Choices:

A. Score >6.0 = high probability of PE (59.9%)
B. Score 2.0–6.0 = moderate probability of PE (29%)
C. Score <2.0 = low probability of PE (15%)
D. The Wells Score is not appropriate for this clinical situation.
E. There is insufficient data to calculate probability

Correct Answer: B

Wells Criteria:

Criteria	Yes	No
Clinical signs and symptoms of DVT	**+3**	0
PE is #1 diagnosis or equally likely	+3	0
Heart rate >100	**+1.5**	0
Immobilization at least 3 days, or surgery in the previous 4 weeks	**+1.5**	0
Previously, objectively diagnosed PE or DVT	+1.5	0
Hemoptysis	+1	0
Malignancy with treatment within 6 months, or palliative	+1	0

Score = 6. Moderate probability of PE (29%)

ABP Content Specification

- Interpret and apply a clinical prediction rule.

Question 24

Use the Geneva Criteria to estimate the pre-test probability of Girl A having a PE.

Geneva Criteria

Category	Criteria	Yes	No
Risk factors	Age >65	+1	0
	Previous DVT or PE	+3	0
	Surgery (under general anesthesia) or lower limb fracture in past month	+2	0
	Active malignant condition	+2	0
Symptoms	Unilateral lower limb pain	+3	0
	Hemoptysis	+2	0
Signs	Heart rate <75	0	0
	Heart rate 75–94	+3	0
	Heart rate ≥95	+5	0
	Pain on lower limb deep venous palpation and unilateral edema	+4	0

http://www.mdcalc.com/geneva-score-revised-for-pulmonary-embolism/

Score 0–3 points = low probability of PE (8%)

Score 4–10 points = intermediate probability of PE (28%)

Score ≥11 points = high probability of PE (74%)

Answer Choices

A. Score 0–3 points = low probability of PE (8%)
B. Score 4–10 points = intermediate probability of PE (28%)
C. Score ≥ 11 points = high probability of PE (74%)
D. The Geneva Criteria is not appropriate for this clinical situation.
E. Inadequate data to calculate probability

Correct Answer: C

Geneva Criteria

Category	Criteria	Yes	No
Risk factors	Age >65	+1	0
	Previous DVT or PE	+3	0
	Surgery (under general anesthesia) or lower limb fracture in past month	**+2**	0
	Active malignant condition	+2	0
Symptoms	Unilateral lower limb pain	**+3**	0
	Hemoptysis	+2	0
Signs	Heart rate <75	0	0
	Heart rate 75–94	+3	0
	Heart rate ≥95	**+5**	0
	Pain on lower limb deep venous palpation and unilateral edema	**+4**	0

Score = 14 = high probability of PE

ABP Content Specification

- Interpret and apply a clinical prediction rule.

Question 25

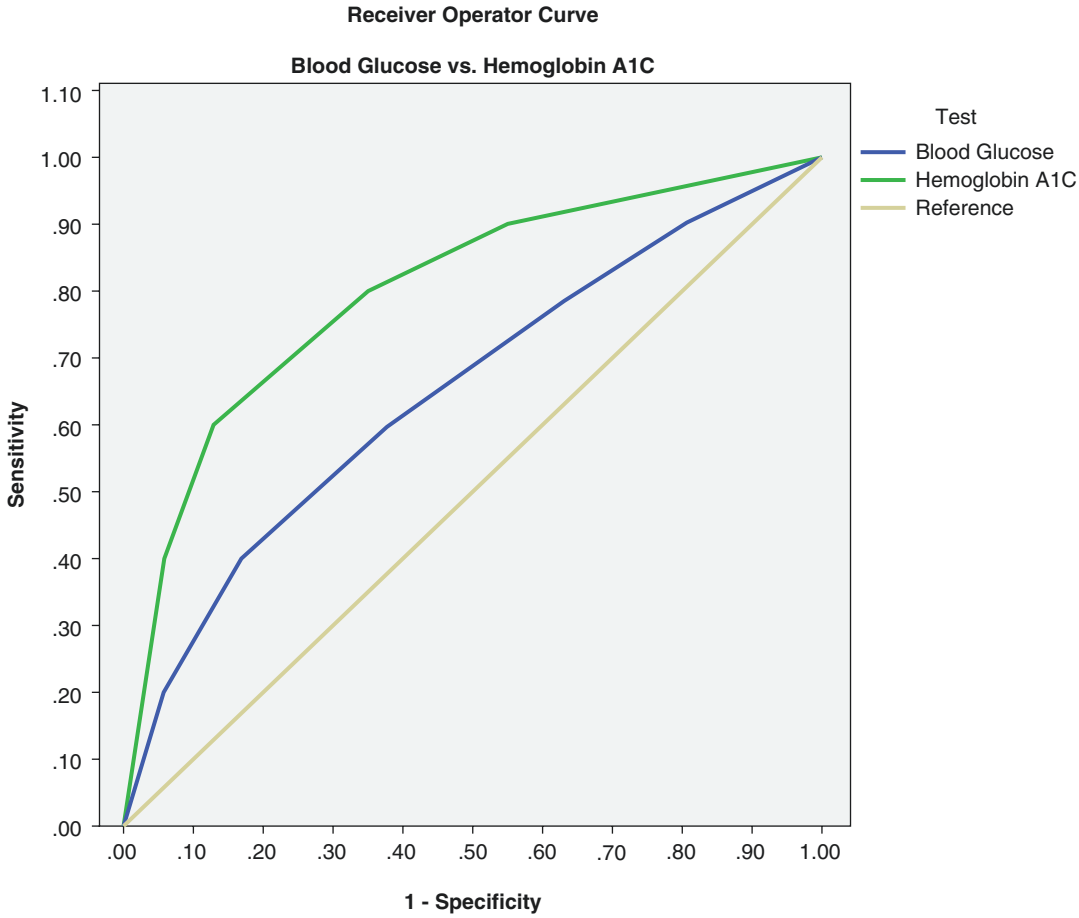
A random blood sugar test and hemoglobin A1C level can both be useful for the diagnosis of diabetes mellitus. The tables below depict the sensitivity and specificity of various cut points for these test results.

Hemoglobin A1C

	Sensitivity	Specificity	1-Specificity
1	0.2	0.97	0.033
2	0.4	0.94	0.06
3	0.6	0.82	0.18
4	0.8	0.56	0.44
5	1.0	0.25	0.75

Blood glucose

	Sensitivity	Specificity	1 − specificity
1	0.2	0.94	0.06
2	0.4	0.83	0.17
3	0.6	0.62	0.38
4	0.8	0.30	0.70
Page 235	1.0	0.20	0.80



Which test, blood glucose or hemoglobin A1C, appears to be the better test?

A. Blood glucose
B. Hemoglobin A1C
C. This does not help determine the better test
D. Neither is a good test
E. Both are equally good tests

Correct Answer: B

A receiver operator curve is a graphic depiction of the effectiveness of a diagnostic test. Sensitivity (true positive rate) is plotted on the *Y*-axis and 1 − specificity (false-positive rate) is plotted on the *X*-axis. Two or more ROCs can be placed on the same graph to allow for comparison of the diagnostic test that each represents. The ROC with the greatest area under the curve is considered to be the most effective or better test.

In this example, the hemoglobin A1C appears to be the better test to diagnose diabetes mellitus. Hemoglobin A1C test has a larger area under the curve than the blood glucose test.

ABP Content Specification
- Interpret a receiver operator characteristic curve.

Question 26

More American children are becoming obese every year. In one particular state, the height and weight of all children in 15 public school corporations were assessed and recorded. At the end of 2013, 18,900 of 31,500 children were classified as either overweight or obese. Also, 8450 of those 31,500 children were classified as obese. At the end of 2014, 19,100 of those same 31,500 children were classified as either overweight or obese and 9000 of those 31,500 were classified as obese.

Calculate the prevalence of those children who were classified as either overweight or obese in 2013.

A. 28.6%
B. 61%
C. 60%
D. 26%
E. 67%

Correct Answer: C

Prevalence is the percentage or proportion of people in a defined group who have the indicated condition. Prevalence is calculated as the number of subjects experiencing the condition/total number of subjects at a given point in time: in 2013, 18,900/31,500 = 0.60 = 60% of children are overweight or obese.

ABP Content Specification
- Distinguish disease incidence from disease prevalence.

Question 27

Calculate the prevalence of those children who were classified as obese in 2013.

A. 61%
B. 26.8%
C. 60%
D. 28.6%
E. 44%

Correct Answer: B

Prevalence is the percentage or proportion of people in a defined group who have the indicated condition.

Prevalence is calculated as:

#number of subjects experiencing the condition/total number of subjects

8450/31,500 = 0.268 = 26.8% of children are obese.

ABP Content Specification
- Distinguish disease incidence from disease prevalence.

Question 28

Calculate the absolute incidence and incidence risk of the condition of overweight and/or obese children in this state during the year 2014.

A. 200/1 year and 1.59/100 at risk
B. 350/1 year and 2.78/100 at risk
C. 350/1 year and 2.82/100 at risk
D. 550/1 year and 4.37/100 at risk
E. 774/1 year and 5.9/100 at risk

Correct Answer: A

Absolute incidence is the number of occurrence of new cases of disease or condition per unit time # of overweight or obese/1 year. *Incidence risk* = Incidence # /The number of the population at risk for the condition.∗ (∗This is the same as the number not overweight or obese for the year prior).

- Absolute incidence = (# overweight or obese in 2014 − # overweight or obese in 2013)/1 year
- (19,100 − 18,900)/1 = 200 new cases/1 year
- Incidence risk = absolute incidence/total − number overweight or obese = 200/(31,500–18,900) = 200/12,600 = 0.0159 = 1.59 new cases per 100 at risk for becoming overweight or obese

ABP Content Specification
- Distinguish disease incidence from disease prevalence.

Question 29

Calculate the absolute incidence and incidence risk of the condition of obese children in this state during the year 2014.

A. 200/1 year and 1.59/100 at risk
B. 350/1 year and 2.78/100 at risk
C. 350/1 year and 2.82/100 at risk
D. 550/1 year and 2.38/100 at risk
E. 550/1 year and 2.68/100 at risk

Correct Answer: D

Absolute incidence is the number of occurrence of new cases of disease or condition per unit time # of obese/1 year. *Incidence risk* = absolute incidence/the number of the population at risk for the condition.∗ (∗This is the same as the number not obese for the year prior).

- Absolute incidence = (# obese in 2014 − # obese in 2013)/1 year
- (9000–8450)/1 = 550 new cases/1 year
- Incidence risk = absolute incidence/total − number overweight or obese = 550 / (31,500–8450) = 550/23,150 = 0.0238 = 2.38 new cases per 100 at risk for becoming obese

ABP Content Specification
- Distinguish disease incidence from disease prevalence.

Question 30

Systematic reviews provide a summary of a treatment regimen for a specific healthcare problem. While the systematic review is a very powerful and useful tool for the practice of evidence-based medicine, it is not without weaknesses. Which of the following is a weakness of a systematic review?

A. The guidelines for which studies included in a systematic review are considered too stringent.
B. Systematic reviews are too expensive to conduct because they include too many randomized trials.
C. Systematic reviews often consider benefits more often than harms.
D. Systematic reviews consider a more specific question about a healthcare issue as opposed to a broad question.

E. Systematic reviews are often biased in their outcomes by the author's opinions.

Correct Answer: C

Systematic reviews consider benefits more often than harms. The majority of medical research is designed to assess the benefit of the studied treatment. Physicians and other healthcare providers look for options for improved treatment in their medical practice. Thus, studies of harm are seemingly less desired. Additionally, medical research is very expensive. According to the Cochrane Consumer Network[2]:

- "Studies generally have a relatively short designated time period. Any possible harms of an intervention may be expected to occur less frequently and over a longer period of time than the studies cover."

Additionally:

- "Randomized controlled trials are very time consuming and multiple factors may limit how many participants are involved, the outcomes measured and the length of the trial. Therefore, many studies are conducted to identify benefits that may be financially rewarding."
- Thus, "Participants of studies are carefully selected to reduce the risk of other problems interfering with the effectiveness of an intervention. Therefore, the selective nature of this process needs to be carefully considered when assessing a systematic review."

ABP Content Specification
- Understand the purpose of a systematic review.

Question 31

Systematic reviews represent a highly controlled process of analyzing medical literature. All of the following are limitations of a systematic review Except:

A. A systematic review is not a guide for treatment.
B. A systematic review is very stringent in its inclusion of prior medical literature.
C. A systematic review may include only studies from a single healthcare location or setting.
D. A systematic review may be limited in the conclusions one can draw from it.
E. A systematic review can include a variety of literature.

Correct Answer: B

A systematic review is very stringent in its inclusion of prior medical literature.

The quality of the evidence provided in a systematic review is the main determinant of the quality of the systematic review itself. The evidence included is assessed for strength of design and bias. This stringent assessment contributes to the overall reliability and generalizability of the information provided in the review.

ABP Content Specification
- Identify the limitations of a systematic review.

Question 32

The quality of the evidence provided by the studies included in a systematic review is paramount to the validity of that systematic review. Which one of the following study types is considered weak evidence and may more likely be limited in or omitted from a systematic review?

A. Randomized controlled study
B. Quasi-randomized controlled study
C. Non-randomized control study with statistical precision
D. Single case study
E. Observational study

Correct Answer: D

A single case study represents the lowest level of evidence in medical research and may not be considered for inclusion in a systematic review. A case study represents a single patient who may not reflect the typical response to a selected treatment. A case study is not quantitative research. A case study is a biased design, selected due to the known information it provides. A case study should not be used to establish reliability or to generalize to the population.

ABP Content Specification

- Identify the limitations of a systematic review.

Question 33

The confidence interval is a valuable statistical tool used in the assessment of medical research. What information can be found with the 95% confidence interval for a variable?

A. The confidence interval is a range that includes true mean value within a 95% chance.
B. The confidence interval is a range that includes the effect size of the sample of the study.
C. The confidence interval is the effect size of the population.
D. The 95% confidence interval is 95% of the sample of the study.
E. The 95% confidence interval contains 95% of the effect.

Correct Answer: A

A confidence interval (CI) is a range of values of a variable that has a chance of including the true population mean value of the variable in question. The confidence interval is calculated from sample data. The standard confidence interval is the 95% CI. This means that there is a 95% chance that the true population mean value of the variable in question falls within the range of the confidence interval. This also means that there is a 5% chance that the true population mean of the variable in question does not fall within the range of the confidence interval.

ABP Content Specification

- Interpret a confidence interval.

Question 34

All of the following are strengths of a meta-analysis **except**:

A. The results of the meta-analysis can be generalized to the population from which the studies were drawn.
B. The statistical power to find a significant effect size is increased with a meta-analysis
C. Hypothesis testing is a follow-up procedure of the meta-analysis
D. A meta-analysis of small studies can be used to predict the results of a subsequent large study
E. A meta-analysis improves the precision of the effect size

Correct Answer: D

A meta-analysis is a statistical method used to combine the results of a common outcome measurement from multiple, already-published research studies. A meta-analysis is generated to improve the statistical power and the precision of the effect size estimate of a given outcome measurement, and help to eliminate the uncertainty arising from multiple studies with differing outcome measurements. Meta-analyses can also combine the available data from published studies in a way that allows for additional statistical testing. It is important to remember that meta-analyses use data from previously published research studies. The majority of published research includes studies with positive findings.

A meta-analysis of small studies *cannot* be used to predict the results of a large study. Meta-analyses are based upon already published literature. This creates an inherent limitation of meta-analyses, that of publication bias. Studies with positive results are typically accepted for publication as opposed to those with negative results. Thus, a meta-analysis generated from published studies with positive results might not yield the same outcome as a large clinical trial, which may produce negative results.

ABP Content Specification

- Interpret the results of a meta-analysis.
- Identify the limitations of a meta-analysis.

Question 35

The most common cause of deaths among adolescents in the United States is:

A. Suicide
B. Accidents
C. Homicides
D. Infections
E. Cancer

Correct Answer: B

The leading cause of death among adolescents aged 15–24 years old is accidents, the most common being motor vehicle collisions. The motor vehicle death rate for male drivers and passengers aged 16–19 is almost two times that of females. Furthermore, among male drivers who were involved in fatal crashes, 37% were speeding and 25% had been drinking. Other accidental causes of deaths in this age group are drowning, poisoning, firearms, fires, and falls. Homicide is the second leading cause of death and most involve firearms. The third most common cause of death in this age group is suicide. The top three methods used in suicides of young people include firearms, suffocation, and poisoning.

ABP Content Specification

- Know the common causes of death in childhood.

Suggested Reading

Basic and Clinical Biostatistics, 2nd ed. In: Dawson-Saunders B, Trapp RG. Appleton and Lange Publications; 1994.

http://consumers.cochrane.org/.

Discovering Statistics Using IBM SPSS Statistics, 4th ed. In: Field A. Sage Publishing; 2013.

Walker E, Hernandez AV, Kattan MW. Meta-analysis: its strengths and limitations. Cleve Clin J Med. 2008;75(6):431–9.

Biostatistics

34

Sergey Kunkov

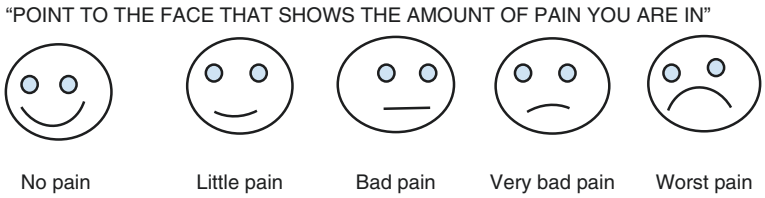
Principles of Use of Biostatistics in Research

*(Please note that all the studies quoted in the questions of this chapter are **Hypothetical** and are not based on real scientific data)*

Question 1

You are approached by a resident who would like to design a study on pain perception in the pediatric emergency department. The participants are asked to point to the face that represents the amount of pain they are feeling. To evaluate the pain perception, the resident will be using a Likert-type scale depicted below:

> Point to the face that shows the amount of pain you are in



The type of variable the resident intends to use to quantify pain is

A. dichotomous
B. continuous
C. ordinal
D. nominal
E. arbitrary

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_34

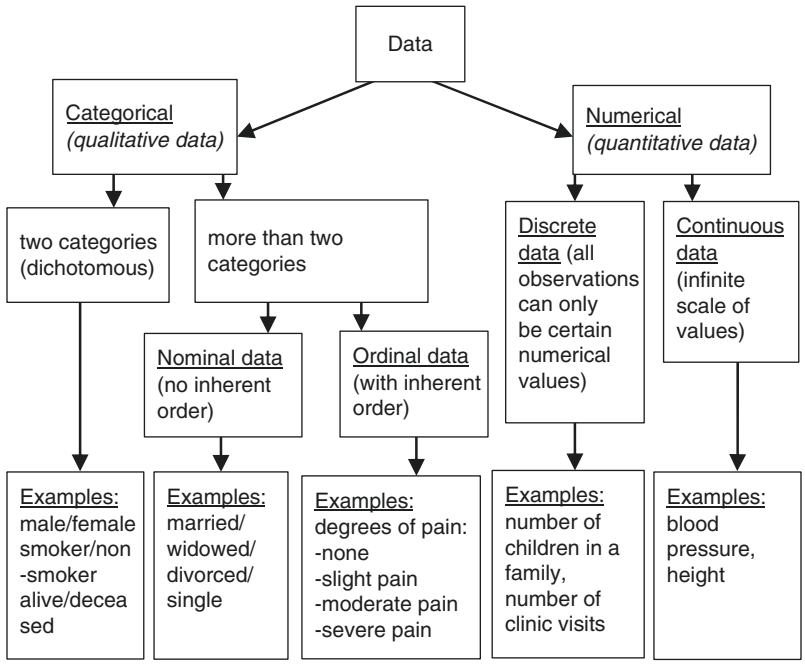
Correct Answer: C

The type of variable the pediatric resident will be using is ordinal.

All scientific data can be divided into categorical and numerical data. *Categorical data*, as the name implies, assigns observations to defined categories. In case of only two categories, the observations can be assigned to, for example, female/male, alive/deceased, pregnant/not pregnant, yes/no, etc.; such data are called *dichotomous* (or binary). In case of more than two categories, categorical data can be further subdivided into *nominal* (no inherent order) data (such as employed/unemployed/partially employed / retired; blood types, etc.) and *ordinal data* (such as degrees of pain).

Numerical data can be divided into *discrete* (such as counts of events, like number of children in a family, number of prior asthma exacerbations over the past year, etc.) or continuous (an infinite scale of values, such as blood pressure, hemoglobin concentration, etc.).

The diagram below depicts classification of data.



ABP Content Specification

- Distinguish types of variables (e.g., continuous, categorical, ordinal, nominal).

Question 2

You are interested in studying the relationship between wearing a helmet while bicycling and incidence of severe head injuries requiring neurosurgical intervention in "bicycle-struck-by car" trauma patients. You intend to classify such patients into "wearing helmet" and "not wearing helmet" groups, with the outcome variable "requiring neurosurgical intervention" and "not requiring neurosurgical intervention."

After collecting the data, the most appropriate test to analyze your findings would be

A. t-test
B. chi-squared test
C. correlation
D. survival analysis
E. ANOVA test

Correct Answer: B

The most suitable test for analyzing categorical data presented from the choices given is chi-squared test.

In general, categorical data, such as presented in the vignette, should be analyzed using *nonparametric* (i.e., "distribution assumption"-free) *methods of analysis*. Data of this type can be depicted in a frequency table, or by cross-tabulation (e.g., 2 × 2 table). *Chi-squared test* is one of the most frequently used nonparametric tests. Another nonparametric test is Fisher's exact test.

Parametric methods of analysis (methods that use assumptions about parameters of the population distribution, from which the data were drawn) involve the assumption that the data being analyzed have a normal distribution. These methods are most suitable for analysis of continuous variables (blood pressure, hemoglobin concentration, etc.). Some of the most frequently used parametric tests are *t-test and ANOVA test*.

Correlation is used to examine the association between two continuous variables (e.g., daily caloric consumption and percentage of the subcutaneous fat) and is unsuitable for analysis of the data presented.

Survival analysis is used to study the length of time until the outcome of interest occurs and is also unsuitable for analysis of the data presented.

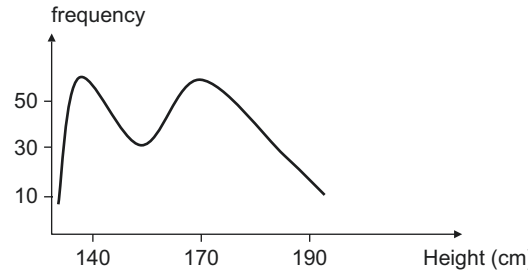
ABP Content Specification

- Understand how the type of variable (e.g., continuous, categorical, nominal) affects the choice of statistical test

Question 3

A pediatric resident was collecting data for her research project—a retrospective study involving evaluation of the relationship of inhaled steroid use for asthma ("used at least once/never used") and the height of the subjects at the age of 15 years. She intends to use a t-test to analyze the height of the subjects.

Here's a graph depicting the height distribution in her sample:



You explain to her that

A. she can use the t-test because the data she collected are discrete
B. she cannot use the t-test because the data she is about to analyze are not normally distributed
C. she cannot use the t-test because steroid use variable is categorical
D. she can use the t-test because it is a most widely used and understood statistical test
E. she cannot use the t-test because the data were collected retrospectively

Correct Answer: B

The t-test cannot be used because the data to be analyzed are not normally distributed.

Although the t-test is one of the most widely used statistical tests, it is one of the parametric tests, with the distributional assumption of normally distributed continuous data.

The data collected by the resident are continuous (the height of the subjects) (see more detailed explanation of the type of data in question 1), but bimodally (and therefore, not normally) distributed, precluding t-test use.

The grouping variable for the test (inhaled steroid use) can be categorical and does not preclude the use of t-test for analysis of normally distributed continuous data.

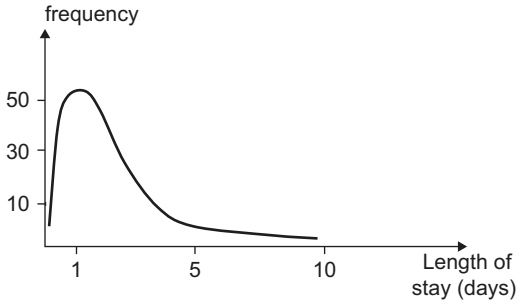
Both prospectively and retrospectively collected data allow the use of parametric or nonparametric statistical tests.

ABP Content Specification

- Understand how distribution of data affects the choice of statistical test

Question 4

A medical student is approaching you with a request to help her better understand the results of the study she just reviewed in a medical journal. One of the graphs in the article depicts the distribution of the length of hospital stay of the patients admitted for bronchiolitis.



You explain to her that the distribution of the data depicted in the graph is

A. positively skewed
B. negatively skewed
C. normally distributed
D. bimodally distributed
E. unevenly distributed

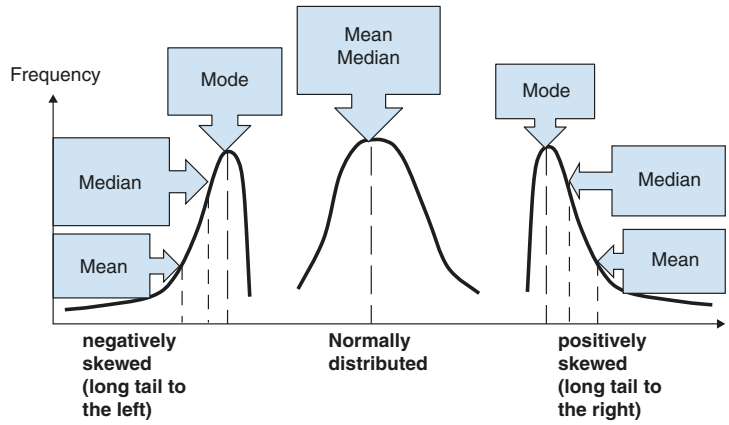
Correct Answer: A

Distribution depicted in this graph is positively skewed.

With *normally distributed data,* mean, median, and mode are the same number.

With *negatively skewed data* ("skewed to the left," or the long tail to the left), the mean moves to the leftmost position, followed by the median and mode. Mean < median < mode.

With *positively skewed data* (or "skewed to the right," with long tail to the right), the opposite relationship of mean, median, and mode is observed, with mean > median > mode.



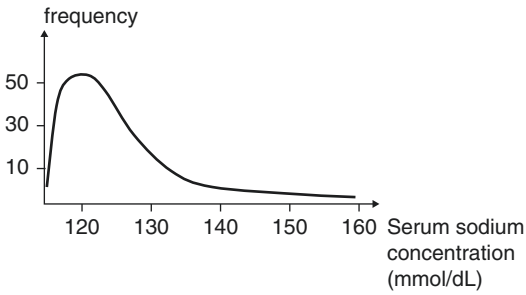
ABP Content Specification

- Differentiate normal from skewed distribution of data

Question 5

You are collecting data on the serum sodium concentration of the children presenting to your Emergency Department with severe dehydration. You noticed that several patients enrolled in the study had very high values of the initial serum sodium concentration (see graph below). Your Division Chief asks you what measure you would use to describe your collected data. You answer to her that to describe the central tendency of your data

A. you would use the mean
B. you would use median
C. you would use standard deviation
D. you would use average
E. you would use a *p*-value



Correct Answer: B

To describe central tendency (which is a typical value of the dataset), mean, median, and mode are used. *Mean (or average)* is one of the most widely used measures of central tendency.

Here is the formula for calculation of the mean, where x_1, x_2, … x_n are the individual observations (values), and n is the number of observations.

$$\overline{x} = \frac{\left(x_1 + x_2 + \ldots + x_n\right)}{n}$$

In cases of skewed distributions, where there are several extreme values (outliers), such as patients with extremely high sodium concentration (like the one presented in the vignette), *mean is **not** the best measure of the central tendency*, as it would be influenced by these extreme values.

A better measurement of central tendency in such cases is *median,* which is a middle value for the dataset that has been arranged in the order of magnitude.

Standard deviation and a *p-value* cannot be used to describe central tendency.

ABP Content Specification

- Understand the appropriate use of the mean, median, and mode

Question 6

A pediatric resident working with you on a Quality Improvement project is collecting data on the length of stay in hours (LOS) of pediatric patients with an acute asthma exacerbation in the emergency department. She would like to quantify variability of LOS, but not sure what measure of variability to use. You suggest to her that the best measurement of variability would be

A. *p*-value
B. standard deviation
C. average length of stay
D. correlation
E. approximation

Correct Answer: B

The best measure of variability (or how disperse or "spread out" the data points are) from the choices presented is a standard deviation (SD). Typically, you may hear or read about two types of standard deviations: sample standard deviation (for problems similar to the one presented in the vignette) and a population standard deviation.

Sample SD (s) is calculated as

$$S = \sqrt{\frac{\Sigma\left(X - \overline{X}\right)^2}{n-1}}$$

where X is each individual observation, Σ is the sample mean (and Σ means "the sum," so that the upper portion of the equation could be read as "squared sum of the differences between each individual observation and the sample mean"), n is the number of observations in the sample

Now, *the population SD* (σ, or "sigma") is

$$\sigma = \sqrt{\frac{\Sigma\left(X - \mu\right)^2}{n}},$$

where μ (or "mu") is a population mean, and n is the number of observations in the sample.

Generally speaking, sample SD is used when a researcher attempts to generalize the results of the study to the larger population, while the population SD is used when the study results will concern only the study population (i.e., would describe only the study subjects). Sometimes the terms "sample" and "population" SD can be confusing (as the "sample" SD may be perceived as applicable only to the sample). However, the sample SD is used to estimate the SD of the population.

The *p*-value, correlation, and approximation cannot be used to assess variability.

The average length of stay can serve as the measure of central tendency, but not variability.

ABP Content Specification

- Understand the appropriate use of standard deviation

Question 7

You collected data on the serum sodium concentration of the children presenting to your Emergency Department with severe dehydration and are now preparing for analysis. Your Division chief now asks you about how certain you are that your sample mean of the serum sodium is a true representation of the mean serum sodium of all severely dehydrated kids in the United States.

You reply to him that to answer his question, you will need to calculate

A. *p*-value
B. t-test
C. standard deviation of the sample
D. standard error of the mean
E. interquartile range

Correct Answer: D

To evaluate how well your sample mean represents the mean of the larger population, *standard error of the mean (SE)* is used. SE provides a measure of variability of repeated sample means from a larger population.

SE is calculated as

$$SE = \frac{\sigma}{\sqrt{n}} \cdots,$$

where σ is the population standard deviation, and n is the number of observations in the sample.

SE can be estimated from a single sample using "s," standard deviation of the sample, instead of σ (sigma), the standard deviation of the population.

For example, if the mean serum sodium concentration of severely dehydrated children was 145 mEq/dl in your sample, with the SD of the sample = 7.5 mEq/dl, with 135 subjects and the study, then SE can be estimated as $\frac{7.5}{\sqrt{135}} = 0.65$.

Closely related to SE but a more widely used concept is *confidence interval*, which will be discussed in further vignettes.

ABP Content Specification

- Understand the appropriate use of standard error

Question 8

A group of residents is planning a research project evaluating the effect of racemic epinephrine and hypertonic saline nebulization on hospitalization rate of children with bronchiolitis treated in the emergency department.

They are asking you for your advice on what the null hypothesis should be for this study.

You advise them that

A. null hypothesis cannot be generated for the study as there are two different treatments involved
B. null hypothesis for this study should be that one treatment is somewhat superior than the other in reducing the admission rates
C. null hypothesis for this study should be that there is no difference in effect of racemic epinephrine and hypertonic saline nebulization on admission rates
D. null hypothesis should be generated after initiation of the study
E. null hypothesis cannot be generated as there is an appreciable effect expected from one of both treatments

Correct Answer: C

Statistical hypothesis states a belief (or an assumption) about certain population parameters.

Null hypothesis (often abbreviated as H_0) assumes that the effect (i.e., the difference in out-

come variable between two groups) a researcher sets out to investigate is zero.

In the problem presented in the vignette, the null hypothesis would be that *there is no difference* in hospitalization rates between two groups of patients receiving different treatments.

A closely related concept is *alternative hypothesis,* postulating that *there is an effect*, that is, the hospitalization rates **are** different for two groups of patients receiving different treatments.

The probability of obtaining the effect observed in the study (or greater) if the null hypothesis were true is called a *p-value*. More on that is given in further vignettes.

ABP Content Specification

- Distinguish null hypothesis from an alternative hypothesis

Question 9

A study conducted by residents to examine the effect of racemic epinephrine versus hypertonic saline is conducted, and the data were analyzed. It appears that patients receiving hypertonic saline nebulization are 15% less likely to be hospitalized than those receiving racemic epinephrine, with a *p*-value less than 0.001. The residents ask you to help them interpret this result.

You tell them that

A. there is not enough information to interpret this result
B. results are equivocal
C. null hypothesis can be rejected
D. null hypothesis can be accepted
E. alternative hypothesis can be rejected

Correct Answer: C

During the hypothesis-testing phase of the analysis, the null hypothesis is either rejected or not rejected (for more information on null hypothesis, see the critique to question 8). It is done using various statistical tests (for the overview of statistical tests, please see critique to question 2), with the test of *statistical significance*.

A statistically significant event is the one unlikely to occur due to chance alone (please note that statistical significance has NOTHING to do with everyday or clinical significance). Most commonly, *p*-value is used for the purpose of measuring the probability of the effect seen in the study occurring if the null hypothesis was true. A *p*-value of 0.001 means that the effect seen in the study has 0.1% probability of occurring if the null hypothesis was true. Traditionally, the accepted cutoff point of a *p*-value is 0.05 (or 5%) for statistically significant results.

Once we establish the low probability of the effect seen in the study occurring by chance alone, the null hypothesis can then be rejected.

ABP Content Specification

- Interpret the results of hypothesis testing

Question 10

You are approached by a fellow who would like to study mean arterial blood pressures (MAP) of the patients with a diagnosis of septic shock at the time of transfer of such patients to the pediatric intensive care unit from the pediatric emergency department. She would like to assess the difference in MAP between the two groups of patients: those who received early goal-directed therapy and those who did not. She expects the data to be normally distributed.

You advised her that the best statistical test to compare MAP in these two groups would be:

A. chi-squared test
B. t-test
C. correlation
D. Wilcoxon test
E. Mann-Whitney U test

Correct Answer: B

The t-test is the most appropriate statistical test for analyzing a difference of the normally

distributed continuous variable between two groups. The other choices presented in the vignette represent nonparametric tests and are not suitable for the analysis of the data presented.

ABP Content Specification

- Understand the appropriate use of the chi-squared test versus a t-test

Question 11

The results of a study on mean arterial blood pressures (MAP) of the patients with a diagnosis of septic shock at the time of the transfer to the pediatric intensive care unit from the pediatric emergency department are submitted for publication. The fellow who conducted this study approaches you again with another question: now he would like to conduct the study examining MAP in three groups of patients with septic shock: those who received standard therapy, those who received early goal-oriented therapy, and those who received the experimental protocol involving intravenous hypertonic saline administration.

You advise her that the best statistical test to analyze the differences in MAP among these three groups of patients is:

A. t-test
B. chi-squared test
C. ANOVA
D. Mann-Whitney U test
E. correlation

Correct Answer: C

The ANOVA, or analysis of variance, is used to compare the means of three or more groups of subjects. The null hypothesis applicable to ANOVA (sometimes called omnibus null hypothesis) assumes that there is no difference in means among all groups (for more discussion of null and alternative hypotheses, please see critique to question 8).

An easier way to understand ANOVA is to imagine "multiple" t-tests. However, ANOVA testing does not give the indication of which two means are different, so if the null hypothesis is rejected, the conclusion is that at least one mean is different than at least one other mean.

ABP Content Specification

- Understand the appropriate use of analysis of variance (ANOVA)

Question 12

You are approached by a group of residents asking to help them interpret the results of the study of hospitalized pediatric patients with acute asthma they were reviewing for the journal club. They presented you with the following table:

	Discharged home	Hospitalized	Total
Received steroids in the emergency department	40	10	50
Did not receive steroids in the emergency department	15	35	50
Total	55	45	$n = 100$

Results were analyzed using chi-squared test, with the resultant p-value of less than 0.001.

You explained to the residents that

A. patients receiving steroids in the emergency department are more likely to be hospitalized
B. patients receiving steroids in the emergency department are less likely to be hospitalized
C. conclusions cannot be drawn from the table presented without additional data
D. chi-squared is an incorrect test for the analysis of the data presented
E. results are invalid because the number of hospitalized patients is less than patients who were discharged home

Correct Answer: B

The chi-squared test is an appropriate and one of the most commonly used tests for the analysis of categorical data, such as presented in the

vignette. We are asked to analyze whether or not administration of steroids in the emergency department had an association with being discharged home or hospitalized.

Out of 50 patients who received steroids in the emergency department, only 10 were hospitalized. Out of 50 patients who did not receive steroids in the emergency department, 35 were hospitalized.

The exact calculation of the chi-squared test is beyond the scope of this text. Interested readers are referred to the Suggested Readings for the complete explanation of such calculations. In broad terms, calculation of the chi-squared test involves calculation of "expected frequencies" of each cell of the table, reflecting values of each cell if the null hypothesis were true and comparing them with the "observed," or real, values. Almost all statistical software packages, as well as numerous online calculators, include options for the calculation of chi-squared tests.

We are told that the observed results are statistically significant (with a *p*-value of less than 0.001).

Therefore, we can state that patients receiving steroids in the emergency department are less likely to be hospitalized.

ABP Content Specification

- Interpret the results of chi-squared tests

Question 13

You are working on the results section of the study of mean arterial blood pressure (MAP) in pediatric patients with septic shock. The statistician you are working with reports that MAP in patients treated with standard therapy was 60 mm Hg versus 66 mm Hg in patients who were treated with early goal-directed therapy. She also reports that she used a t-test for comparison of the means and that the *p*-value is equal to 0.001.

You reply to her that

A. t-test is not appropriate for these data
B. although the t-test is appropriate for these data, results are not valid
C. there is no statistically significant difference in MAP between the two groups
D. there is a statistical difference in MAP, but it is not significant
E. there is a statistically significant difference in MAP between the two groups

Correct Answer: E

The t-test is one of the most widely used parametric tests for any analysis of normally distributed continuous data and is suitable for use for the analysis of differences in MAP between two groups of subjects as presented in the vignette.

Detailed description of the precise t-test calculations is beyond the scope of this text, but the general formula for t-test calculation is

$$t = \frac{\text{mean}_1 - \text{mean}_2}{\text{standard error}\left(\text{mean}_1 - \text{mean}_2\right)}$$

Then the t statistics obtained is compared to t-distribution with $n_1 + n_2 - 2$ degrees of freedom.

Again, almost all statistical software packages come standard with t-test calculation tools, and it is unlikely that a clinical researcher would need to calculate the t-test by hand.

A very low *p*-value indicates the fact that the observed difference in MAP is unlikely seen due to chance alone.

ABP Content Specification

- Interpret the results of t-tests

Question 14

The fellow conducting a study of mean arterial blood pressures (MAP) of the patients with a diagnosis of septic shock at the time of transfer to the pediatric intensive care unit from the pediatric emergency department asks you about the best test to compare the mean arterial blood pressure (MAP) within each group of patients. She would like to compare patients' MAP at the time of triage to the MAP after the initial therapy was administered.

You reply to her that the best test for such a comparison would be

A. chi-squared test
B. two-sample t-test
C. paired t-test
D. one-sample t-test
E. Mann-Whitney U test

Correct Answer: C

For the analysis of repeated measurement of continuous variables (such as comparison of the means of blood pressure measurements in the same group of subjects before and after treatment), *paired* t-test is the best test. As with chi-squared test, full discussion of calculations of paired t-test is beyond the scope of this text. We will indicate however, that during calculation, observed mean difference value (difference in means of initial and posttreatment MAP) is compared with a hypothetical value of zero, testing the null hypothesis that there is no difference in pre- and posttreatment MAP. Again, most statistical software packages will include an option for paired t-test.

Two-sample (non-paired) t-test is not appropriate for this situation, as the measurements are taken on the same group of subjects as opposed to comparison of two groups of subjects. One-sample t-test is not an appropriate test either, as it tests the difference between the mean value of the group and the theoretical value of zero.

Nonparametric tests, such as the chi-squared or Mann-Whitney U test, will not be appropriate for this situation.

ABP Content Specification

- Understand the appropriate use of a paired and non-paired t-test

Question 15

A fellow is conducting a study of mean arterial blood pressure (MAP) in pediatric patients with septic shock. She would like to find out whether the treatment with standard therapy is better, worse, or the same as early goal-oriented therapy as measured by changes in MAP. She asks you whether she needs to use a one-tailed or two-tailed test of significance (such as *p*-value) to conduct her analysis.

You reply to her that she needs to be using

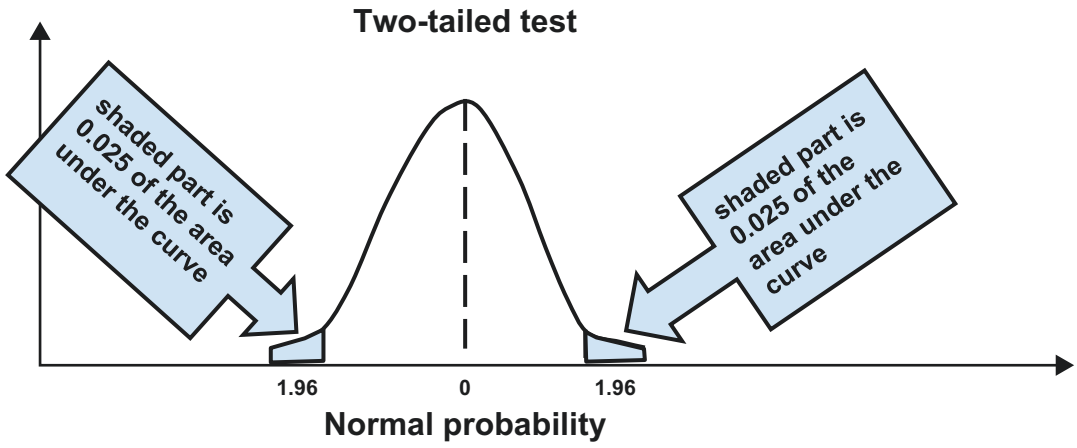
A. one-tailed test
B. two-tailed test
C. if a two-tailed test failed to show significance, she needs to use a one-tailed test
D. this decision should be made once all data are collected and preliminary analyzed
E. this decision is not important as if there is a true statistical significance, it will be shown with either test

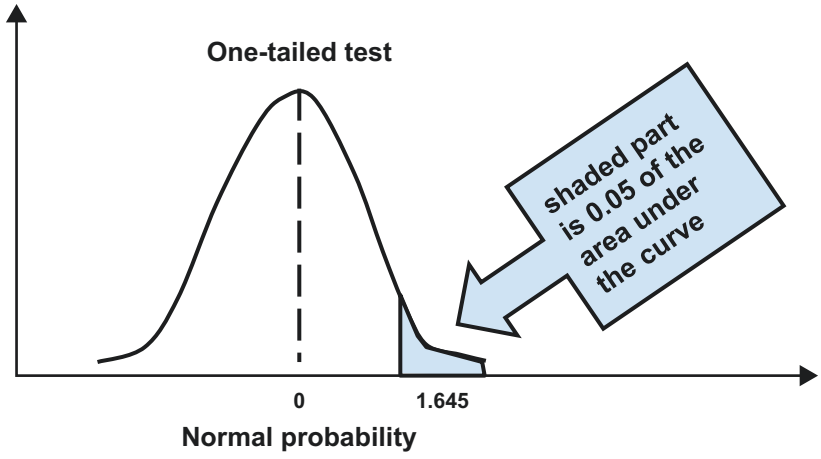
Correct Answer: B

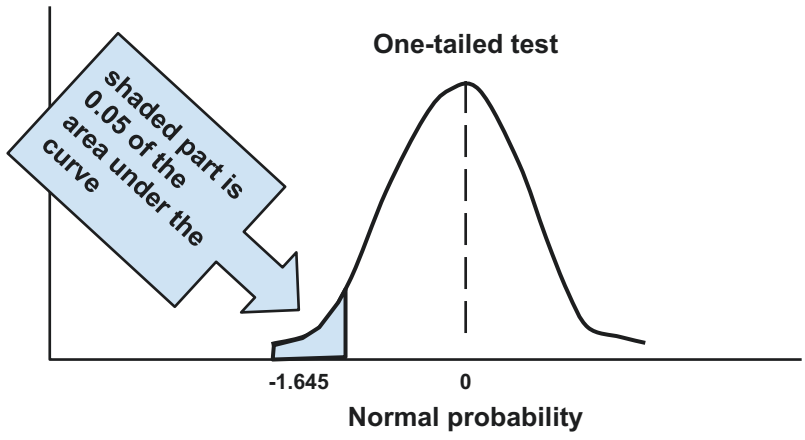
The decision of using one-tailed test or two-tailed test is an important one and should be made prior to commencing data collection. Once such decision is reached, it should not be changed based on the results of the analysis of the data.

A clinical researcher is well advised to use a two-tailed test of significance in almost all circumstances. In general, a two-tailed test is used to test the possibility of the new treatment to be *better* ***or*** *worse* than the standard treatment. If one is set to compare the standard therapy with the novel one without knowing whether the novel therapy is better, worse, or the same as it is stated in the vignette, two-tailed test is the test of choice.

p-value of 0.05 is split into two halves (0.025) on each side of the probability curve. Choosing a one-tailed test, while maximizing chances of finding a statistical significance, will only allow a researcher to test whether the new treatment is better, neglecting the possibility that the new treatment might be worse than the standard treatment. The reverse is also true: a one-tailed test use for assessing whether a new treatment is worse than the standard treatment will maximize the chances of finding a statistical significance, neglecting the possibility that the new treatment is better than the standard treatment.


Two-tailed test
shaded part is 0.025 of the area under the curve
shaded part is 0.025 of the area under the curve
1.96
0
1.96
Normal probability


One-tailed test
shaded part is 0.05 of the area under the curve
0
1.645
Normal probability


One-tailed test
shaded part is 0.05 of the area under the curve
-1.645
0
Normal probability

ABP Content Specification

- Determine the appropriate use of a one- versus two-tailed test of significance

Question 16

A group of residents approaches you after a recent review of the study of the mean arterial blood pressure (MAP) in pediatric patients with septic shock. The study reported a difference in MAP between the two groups of patients treated with standard therapy and early goal-oriented therapy. The reported *p*-value was 0.06.

One resident states that results of the study can be disregarded as no statistically significant difference was demonstrated. The second resident stated that statistical significance is not important and one should consider clinical significance of results.

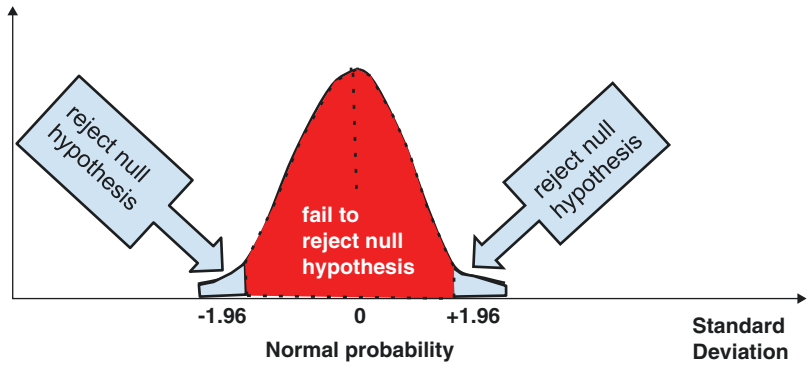
You reply to them that

A. statistical significance and clinical significance are very closely related measures
B. first resident is right and study results can be disregarded as there is no statistically significant difference demonstrated
C. the second resident is right as clinical significance is much more important for a clinical researcher
D. *p*-value reflects the probability of the null hypothesis to be true given the size of the effect observed in the study
E. *p*-value reflects the magnitude of the difference in MAP between two groups

Correct Answer: D

The *p*-value reflects the probability of the null hypothesis to be true given the size of the effect observed in the study (brief reminder: null hypothesis—as applicable to this study described, presumes that there was no true difference in MAP between the two groups of patients treated with different therapies—for more discussion of null and alternative hypotheses, please refer to the critique of question 9).

To obtain a *p*-value, a test statistic is calculated, which is then compared with the known distribution where the null hypothesis is known to be true. Almost all statistical software packages include options for *p*-value calculations.



Traditionally, the cutoff for this probability is selected to be 0.05 (or 5%); this cutoff is completely arbitrary, and when the *p*-value is below it, results are called statistically significant. A reader of scientific research articles can decide for him- or herself whether the probability of the null hypothesis to be true is acceptable or not, given the *p*-value.

Again, as it was stated in the critique of question 9, statistical and clinical significance have *nothing* in common. Indeed, the difference in MAP between two groups can be 1 mm Hg but statistically significant with a *p*-value of 0.04. But is it a clinically significant difference in MAP? It is up to a reader of medical literature to decide whether the effect shown in a study is clinically significant.

ABP Content Specification

- Interpret a *p*-value

Question 17

You are approached by a resident who conducted the study of pediatric patients with asthma, experiencing acute exacerbations. He was analyzing the relationship of the amount of intake of five different food categories to the frequency of the acute asthma exacerbations. He tells you that he found statistically significant associations of increased intake of two food categories with higher frequency of acute asthma exacerbations, each with p-value of less than 0.05.

You advised him

A. to perform a correction for multiple comparisons
B. that he is on to something, these results need to be further explored
C. to select the most significant association and report it in the manuscript
D. to repeat the study to confirm results prior to reporting
E. to compare these results with ones reported in the literature

Correct Answer: A

Correction of the *p*-value should be performed due to multiple comparisons undertaken by the researcher. The *p*-value (or alpha, α) reflects the probability that the null hypothesis is true, and its conventional cutoff is 0.05, or 5%. While performing multiple comparisons, this probability rises with the numbers of the tests performed. This researcher performed five tests, increasing the likelihood of finding statistical significance due to chance alone.

One way to deal with the issue of multiple comparisons is to perform a correction. One such correction, a *Bonferroni correction,* is named after the Italian mathematician who described it.

To do it, alpha can be divided by the number of tests taken, or $\frac{\alpha}{m}$, where m = number of tests. Therefore, the *p*-value for these five tests should become 0.05/5 = 0.01, rendering the "significant" test insignificant.

For in-depth discussion of the Bonferroni correction and its criticism (one being that it's too "conservative" when large number of comparisons is made), readers are referred to comprehensive texts on statistics.

ABP Content Specification

- Interpret a *p*-value when multiple comparisons have been made

Question 18

The resident working with you on the research project reports that the mean arterial blood pressure (MAP) of the pediatric patients with septic shock is 90 mm Hg in the sample of patients from your hospital. You helped him to calculate 95% confidence interval (CI) of the mean, which is 73–99 mm Hg. The resident asks you to explain to him what this CI means.

You reply to him that

A. a true population MAP of the pediatric patients with septic shock lies somewhere between 73 and 99 mm Hg 95% of the time
B. you are 95% confident that the true population MAP is 90 mm Hg
C. there is a 47.5% chance that the true MAP is 73 mm, and 47.5% chance that it's 99 mm Hg
D. in repeated experiments, the MAP will be 90 mm Hg 95% of the time
E. only 5% of measurements of MAP will be outside of 90 mm Hg range

Correct Answer: A

The confidence interval (CI) is a range of values which includes a true population value. A 95% CI will include a true population value 95% of the time.

CI for the estimated mean is calculated using a sample mean and standard error of the mean (for more discussion of the standard error of mean, please refer to critique of question 7).

For example, a 95% CI will be calculated as

$$\mu = \pm 1.96\ SE,$$

where μ is a sample mean, SE is a standard error of the mean.

A 99.7% CI will be calculated as = ±3 SE.

ABP Content Specification

- Interpret a confidence interval

Question 19

A group of medical students was reviewing an article for the journal club. There is a statistically significant result reported with a *p*-value of less than 0.05. One of the medical students asks you what the probability of type I error is given the results.

You reply to her that

A. statistical errors of any kind are hard to quantify
B. you need to know more about the results of the study to answer this question
C. the probability of type I error is 5%
D. one needs to know the alternative hypothesis to determine the possibility of type I error
E. one needs to know the sample size to determine the possibility of type I error

Correct Answer: C

Two types of errors can arise when interpreting the *p*-value (for more information on *p*-value, please refer to the critique of question 16). Because statisticians are known for their vivid imagination, they named these errors as:

Type I error, which is rejecting the null hypothesis when in fact the null hypothesis is true. The maximum probability of type I error (or alpha) should be determined in advance, and is usually set at 0.05 (reflected by the *p*-value). Type I errors are so-called "false positives." One doesn't need to know the alternative hypothesis, or sample size, or entire results of the study to determine alpha.

Type II error involves the failure to reject the null hypothesis despite the fact that the null hypothesis is not true.

ABP Content Specification

- Identify a type I error

Question 20

A fellow approaches you after reviewing a new article about hospitalization rates in children with viral croup. According to the results of this article, children receiving oral steroids within the first hour of their emergency department stay had lower admission rates compared to children who did not. The *p*-value of the statistical comparison, however, was 0.1.

A fellow was wondering if there is a real difference in admission rates, but this study failed to find the statistical significance for this difference.

You reply to her that

A. there is no reason to question the validity of this study, as the *p*-value exceeds 0.05
B. there is not enough information to answer her question
C. it is possible that type II error was committed
D. it is possible that type I error was committed
E. it is possible that both type I and type II errors were committed

Correct Answer: C

Type II error involves the failure to reject the null hypothesis despite the fact that the null hypothesis is not true. In the article reviewed by the fellow, the *p*-value was 0.1, and therefore the null hypothesis was not rejected. If type II error was committed in the study, there was a statistically significant difference that the researchers failed to detect. The probability of committing type II error is called "beta" (β), and it depends on sample size and the size of the effect.

A closely related concept is *power* of the study to detect a specific size of the effect, which is calculated as $1–\beta$, or $100(1–\beta)\%$.

Committing both types of errors at the same time is impossible, as type I error involves rejecting the null hypothesis when in fact it is true, while type II error involves not rejecting it.

ABP Content Specification

- Identify a type II error

Question 21

A group of residents approaches you regarding a published study of two groups of patients with acute asthma exacerbation: those who received steroids in the emergency department and those who didn't. The residents are asking you to help them calculate a relative risk of being hospitalized after receiving steroids in the emergency department.

	Received steroids in the emergency department	Did not receive steroids in the emergency department	Total
Hospitalized	15	35	50
Discharged home	40	10	50
Total	55	45	$n = 100$

You advise them that the relative risk is

A. 0.10
B. 0.35
C. 0.43
D. 1.22
E. 4.0

Correct Answer: B

Relative risk (RR) (or Risk Ratio) measures an increased risk of the outcome of interest in one group of subjects over another group and is mostly used in prospective studies.

- RR = 1 means that there was no difference in risk between two groups
- RR < 1 means that there is less risk for the event to occur in the experimental group
- RR > 1 means that there is more risk for the event to occur in the experimental group

	Group X	Group Y	Total
Outcome present	a	b	a + b
Outcome absent	c	d	c + d
Total	a + c	b + d	

Here are risks of the outcome for Group X: a/(a + c) and Group Y: b/(b + d). S*election of the subjects is based on the group they belong to* (as opposed to the outcome-based, which is used for odds ratio (OR) calculation).

Then RR is:

$$RR = \frac{a/(a+c)}{b/(b+d)}$$

For the case presented, a proportion of *hospitalized patients receiving steroids* in the emergency department (15/55) will be divided by a similar proportion of *hospitalized patients who did not receive steroids* in the emergency department (35/45).

$$RR = \frac{15/55}{35/45} = 0.35$$

In other words, the risk of being hospitalized after receiving steroids in emergency department is only about 35% of such risk for those who did not receive steroids.

ABP Content Specification

- Calculate and interpret a relative risk

Question 22

The residents continue to review the study described in question 21. They now would like to calculate the odds ratio (please refer to the table depicted in question 21).

You reply to them that the odds ratio is:

A. 0.11
B. 4.0
C. 0.43
D. 1.0
E. 0.29

Correct Answer: A

Odds ratio (OR) is used in retrospective studies and is defined as ratio of odds of the event occurring in one group to the odds of the event occurring in another group. As opposed to relative risk (see critique to question 21), selection of subjects occurs *based on the outcomes* (rows) and NOT based on belonging to the group.

The *odds of being hospitalized* are 15 to 35, or 15/35 = 0.43. The *odds of being discharged,* similarly, are 40 to 10, or 4.0

The OR therefore is 0.43/4 = 0.11.

An alternative formula for OR calculation is mentioned below, yielding identical result

$$\mathrm{OR} = \frac{\mathrm{ad}}{bc}$$

ABP Content Specification

- Calculate and interpret an odds ratio

Question 23

The same group of residents, determined to completely ruin your day, presses on with their review of the same article described in question 21.

They would like to calculate absolute and relative risk reduction of being hospitalized for asthma after receiving steroids. Please refer to the table in question 21 for calculation.

Your reply to them that

A. relative risk reduction is 65%
B. relative risk reduction is zero
C. relative risk reduction is 50%
D. relative risk reduction cannot be calculated from the table presented
E. relative risk reduction is 100%

Correct Answer: A

First, we need to find the event rate (ER), which is the percent of hospitalized patients in each group.

In the group of patients receiving steroids (we will call it experimental group event rate, or EER), it's 15/55, or 27%. In the group of patients not receiving steroids (control group event rate, CER), it's 35/45, or a whopping 78%.

So the *absolute risk reduction (ARR)* of hospitalization if patients receive steroids is 78–27% = 51%.

This means that if, say, 100 patients were treated with steroids in the ED for asthma exacerbation, 51 of them would be "saved" from hospitalization (and "*number needed to treat*" is 1/ARR).

Now, *the relative risk reduction (RRR)* takes into account the number of events in the group that does not receive treatment with steroids.

$$\mathrm{RRR} = \frac{\mathrm{CER\text{-}EER}}{\mathrm{CER}} = \frac{78\% - 27\%}{78\%} = 65\%$$

ABP Content Specification

- Differentiate relative risk reduction from absolute risk reduction

Question 24

A resident approaches you with a question about using survival analysis as a statistical method. She asks you to give her an example of a suitable survival analysis.

You reply to her that survival analysis can be used

A. only for the analysis of mortality cases
B. only if there is demonstrated survival of the patients in the experimental group during treatment
C. to analyze the elapsed time until any event of interest occurs
D. only if the exact time of the event is known
E. for the analysis of intraoperative survival rates

Correct Answer: C

Survival analysis (SA) encompasses statistical procedures for the analysis where *time until an event of interest occurs* serves as an outcome variable. Although SA began as an analysis of true survival (i.e., survived/died type of data), it can also be used for any event of interest, such as time to relapse of a chronic disease after treatment.

Exact timing of that event does not need to be known and can actually occur after the study period ends (this kind of data is called "censored").

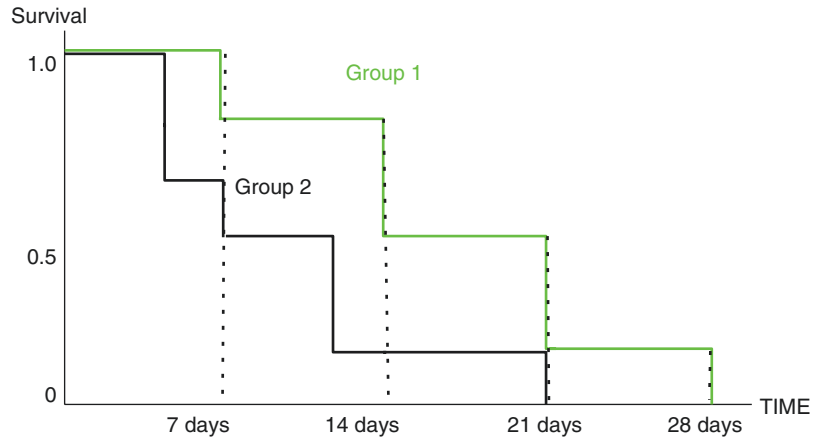
Intraoperative survival rate cannot be analyzed using survivor analysis as there is no time until the event of interest (mortality) occurs.

ABP Content Specification

- Identify when to apply survival analysis (e.g., Kaplan-Meier)

Question 25

You are presented a Kaplan-Meier survival curve of two groups of patients with asthma: group 1 is receiving experimental controller medication regimen, and group 2 is receiving the standard controller medication regimen. Each group had 100 patients. The outcome of interest is the first wheezing episode after initiation of controller medications.



After evaluating this curve, you conclude that

A. probability of survival to 6 days is 100% for group 1
B. probability of survival to 7 days is 100% for group 2
C. probability of survival to 14 days is 50% for group 2
D. probability of survival to 14 days is equal for groups 1 and 2
E. probability of survival to 28 days is lower for group 1

Correct Answer: A

The *"survival"* described in the vignette means *a time period until the event of interest* (first wheezing episode) *occurs*. Y axis represents a probability of survival, 1.0 being 100%. X axis represents days of survival. Survival probability (Y axis) to 6 days is 1.0, or 100%, for group 1 (the first "drop," or attrition, in survival is observed at day 7). In other words, the probability of not having a wheezing episode by day 6 is 100%.

Group 2 fared worse, and its probability of survival to 7 days is close to 0.6, or 60%, and to 14 days is about 0.1.

ABP Content Specification

- Interpret a survival analysis (e.g., Kaplan-Meier)

Question 26

You are reviewing a newly published study of length of time to an unscheduled visit for asthma to their pediatrician or ED in children discharged from the ED after acute exacerbation. This study had two groups of patients: control group (patients receiving a standard 5-day course of oral steroids) and experimental group (patients receiving a 3-day course of oral steroids).

The article reports the Hazard Ratio = 1 of having had an unscheduled visit for asthma by day 14 after ED visit.

Hazard Ratio = 1 means that

A. there was one unscheduled visit for asthma in each group by day 14
B. the risk of an unscheduled visit for asthma was 10% in both groups
C. there was no difference in unscheduled visits for asthma in experimental group compared to the control group by day 14
D. 100% of children in both groups had an unscheduled visit for asthma by day 14
E. at least one child in each group had an unscheduled visit for asthma by day 14.

Correct Answer: C

Hazard ratios are often used in survival analysis. *Hazard* is the probability of an event of interest at any given time *t* (sometimes it is called instantaneous event rate).

Hazard ratio then is

$$\text{Hazard ratio} = \frac{\text{hazard in group 1}\left(\text{experimental group}\right)}{\text{hazard in group 2}\left(\text{control group}\right)}$$

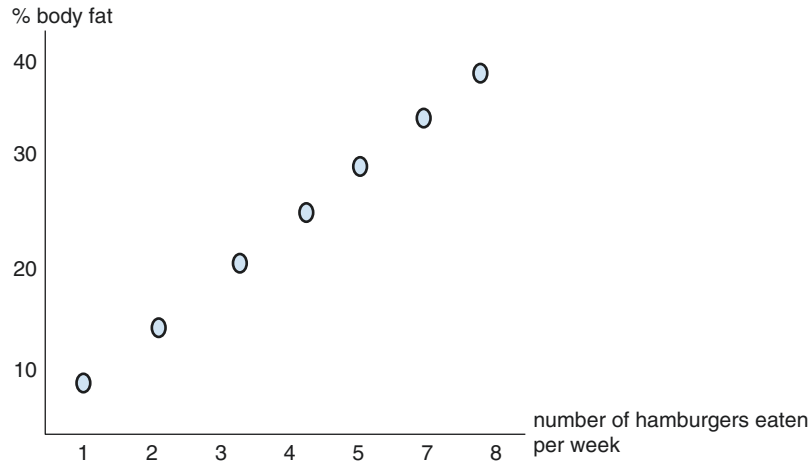
- Hazard ratio = 1 suggests that there is no difference in event rates between two groups at any point of time.
- Hazard ratio = 2 suggests that twice as many patients in group 1 are having events COMPARED to the patients in group 2 at any point of time.
- Hazard ratio = 0.5 suggests that half as many patients in group 1 are having events COMPARED to the patients in group 2 at any point of time.

ABP Content Specification

- Interpret a hazard ratio

Question 27

You are presented with the following graph of body fat measurements in individuals consuming hamburgers:



After studying this graph, you conclude that

A. consumption of a large number of hamburgers per week causes obesity
B. If correlation coefficient is less than 1.0, there is no correlation between number of hamburgers eaten and percentage of body fat
C. for this graph correlation coefficient can be positive or negative

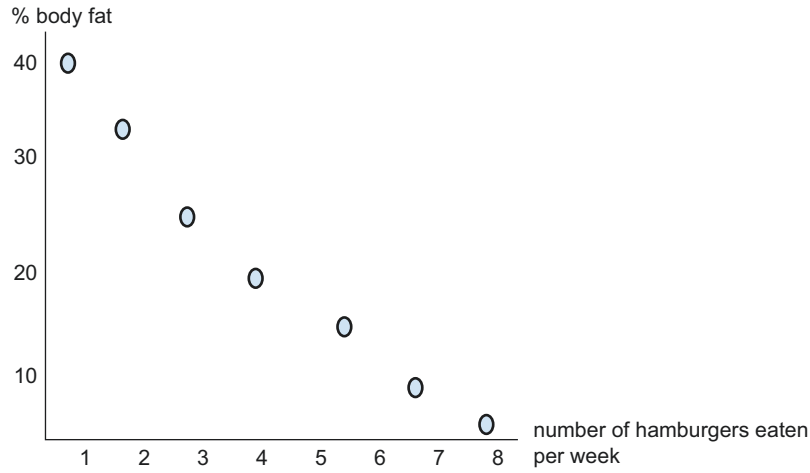
D. reduction in number of hamburgers consumed will lead to reduced body fat percentage
E. there is a strong positive correlation between number of hamburgers eaten per week and percentage of body fat

Correct Answer: E

This graph shows a strong positive correlation between two variables, that is, with each unit increase in one variable, there is a corresponding increase in another variable.

Correlation coefficient (r) can range from −1.0 (perfect negative correlation) to 1.0 (perfect positive correlation). Correlation coefficient of zero means that there was no correlation between two variables. For the graph presented in the vignette, it is clearly positive correlation.

A strong negative correlation graph would look something like this



Correlation is by no means causation, so (a) and (d) are wrong. Although it is quite possible that large number of hamburgers consumed per week might cause increased percentage of body fat, it cannot be ascertained from this graph.

ABP Content Specification

- Understand the uses and limitations of a correlation coefficient

Question 28

A group of fellows approaches you with the question about design and analysis for the study they are planning to do. They are planning to study influence of the amount of fluids administered within the first hour of presentation to the ED, time to the first antibiotic administration, age, gender, and other variables on a length of time spent in pediatric intensive care unit for patients presenting in septic shock.

You advised them that one of the multivariate analysis techniques they can choose is

A. t-test
B. chi-squared
C. ANOVA
D. correlation
E. linear regression

Correct Answer: E

Out of all statistical tests listed, only multiple linear regression represents *multivariate analysis*. Using multivariate analysis techniques, a researcher can evaluate the influence of multiple variables (such as amounts of fluids administered within the first hour presentation, timing to the first antibiotic administration, age, gender, etc.) on the outcome variable (such as length of time spent in pediatric intensive care unit). *Linear regression* is used when the outcome variable is a continuous variable, and *logistic regression* is

used for dichotomous outcome of interest variable.

The rest of the statistical tests mentioned are used for *bivariate analysis* (i.e., analysis of relationship between only two variables). These tests are often used in preparation for multivariate analysis.

ABP Content Specification

- Identify when to apply regression analysis (e.g., linear, logistic)

Question 29

A group of fellows are planning to study the influence of the amount of fluids administered within the first hour of presentation to the ED, time to the first antibiotic administration, age, gender, and other variables on the length of time spent in pediatric intensive care unit for patients presenting with septic shock. They ask you to help interpret results of linear regression analysis they performed for their research study. In particular, they seek an explanation of *R* squared (r^2) of 0.75.

You explain to them that

A. their multivariate model explains 75% of variation of the outcome variable
B. area under the curve = 0.75
C. patients who did not get large amounts of fluids or prompt antibiotics administration will have 75% chance of longer stay in ICU
D. 75% of predicted variables are related to the outcome variable
E. 75% of predicted variables are statistically significant

Correct Answer is: A

During regression analysis, a regression fitted line is created, which reflects the general trend of data distribution. A *residual* is the distance between the actual observed value to this fitted line.

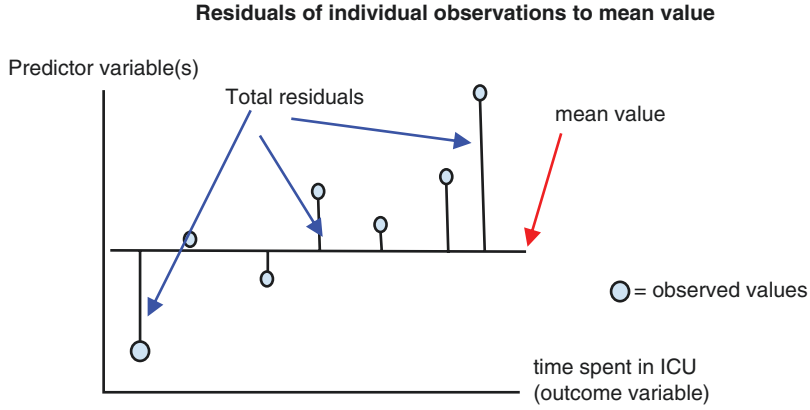
R squared (or a coefficient of determination) is a proportion of the variance of the outcome variable which can be explained by the predicted variable(s) included in a regression model.

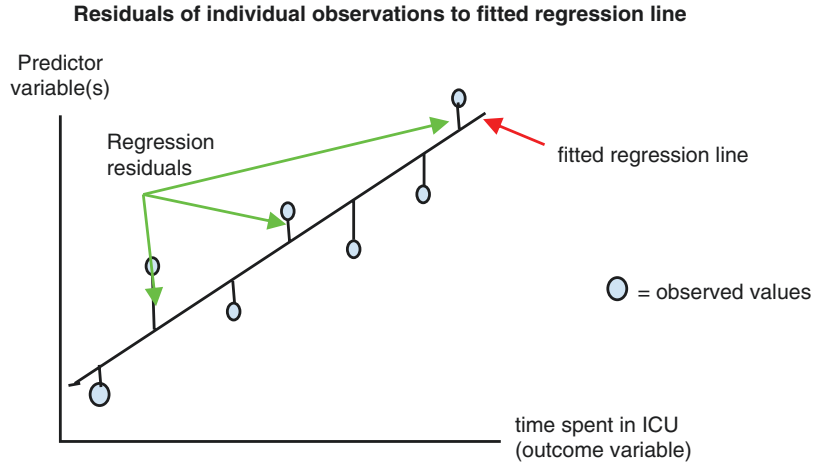
Regression residuals (more precisely, the sum of their squares), representing the differences between individual observations and the fitted regression line are compared to total residuals (again, to the sum of their squares), which represent differences of individual observations to the mean value of observations.

R squared of 1 means that the fitted model explains 100% of variance of the outcome variable, whereas *R* squared of zero means that the fitted model explains none of variance of the outcome variable.

R squared is considered to be one of the so-called *goodness-of-fit* measures, serving as a statistical estimate of how well the regression line approximates the real data points.

$$R\,\text{squared} = 1 - \frac{\text{sum of squares of regression residuals}}{\text{sum of squares of total residuals}}$$





ABP Content Specification

- Interpret a regression *analysis (e.g., linear, logistic)*

Question 30

You are reviewing study results describing performance of the new point-of-care rapid test for a Group A beta hemolytic Streptococcus (GAS).

	Throat culture positive for GAS	Throat culture negative for GAS	Total
Rapid test positive for GAS	90	5	95
Rapid test negative for GAS	15	80	95
Total	105	85	*n* = 190

After reviewing this table, you conclude that sensitivity of this new test is

A. 100%
B. 90.5%
C. 85.7%
D. 94.7%
E. 84.2%

Correct Answer: C

Let's look at this table again. In the vignette, a new test is compared to a "gold standard" (throat culture).

Compared to gold standard, the cells in the table will reflect:

	Throat culture positive for GAS	Throat culture negative for GAS	Total
Rapid test positive for GAS	True positives (a)	False positives(b)	a + b
Rapid test negative for GAS	False negatives(c)	True negatives(d)	c + d
Total	a + c	b + d	*n*

Sensitivity is the proportion of true positives correctly identified by the new test, or

$$a/(a+c)$$

From the table, it's 90/105 = 85.7%

When the test has 100% sensitivity, it identifies all patients *with* a disease. Highly sensitive tests help identify all patients with disease but also have a higher chance of being positive in patients without disease (false positives). Highly sensitive tests are often used for screening programs for identification of serious but treatable (at the early stages) conditions (such as cervical cancer or inborn errors of metabolism), with additional (and hopefully, highly specific) tests on all positives.

Specificity is the proportion of true negatives correctly identified by the new test, or

$$d/(b+d)$$

When the test has 100% specificity, it identifies all patients *without* a disease.

ABP Content Specification

- Calculate and interpret sensitivity and specificity

Question 31

Referring to the table below that describes the performance of a new point-of-care test for Group A beta hemolytic Streptococcus, a Nurse Practitioner approaches you and asks you what the positive predictive value (PPV) of the test is and requests your help in calculating it.

	Throat culture positive for GAS	Throat culture negative for GAS	Total
Rapid test positive for GAS	90	5	95
Rapid test negative for GAS	15	80	95
Total	105	85	$n = 190$

You reply to her that PPV of the test is a

A. proportion of the patients with a positive test who truly have a disease. PPV = 94.7%
B. proportion of the patients with a positive test who don't have a disease. PPV = 94.7%
C. proportion of the patients with a negative test who truly have a disease. PPV = 84.2%
D. proportion of the patients with a negative test who don't have a disease. PPV = 90.5%
E. proportion of the patients with a disease who have a positive test. PPV = 100%

Correct Answer: A

PPV measures the ability of the test to correctly identify patients with disease, reflecting the probability of the disease given the positive test.

From the table, PPV = a/(a + b) = 90/95 = 94.7%

Negative predictive value (NPV) of the tests measures the ability of the test to correctly identify patients without disease, reflecting the probability of no disease given the negative test.

$$NPV = \mathrm{d} / \left(\mathrm{c} + \mathrm{d}\right)$$

ABP Content Specification

- Calculate and interpret positive and negative predictive values

Question 32

A Nurse Practitioner states that the urgent care site she is working at, the prevalence of strep throat infections is very low. She asks you whether this will affect negative and positive predictive value of the new rapid test as well as its sensitivity and specificity.

You reply to her that

A. positive and negative predictive values *are* influenced by the prevalence of disease, and sensitivity and specificity are not.
B. positive and negative predictive values *as well as* sensitivity and specificity *are* influenced by prevalence of disease
C. positive and negative predictive values *are not* influenced by the prevalence of disease, and sensitivity and specificity *are*
D. positive and negative predictive values *as well as* sensitivity and specificity *are not* influenced by prevalence of disease

Correct Answer: A

Positive and negative predictive values *are* influenced by the prevalence of disease, and sensitivity and specificity *are not.*

Prevalence of the disease is calculated as

Prevalence = (a + c)/*n*, or all positives/total number of patients.

Using the following table describing the performance of the new point-of-care rapid test for a Group A beta hemolytic Streptococcus (GAS), the prevalence = 105/190 = 55.3%.

	Throat culture positive for GAS	Throat culture negative for GAS	Total
Rapid test positive for GAS	90	5	95
Rapid test negative for GAS	15	80	95
Total	105	85	*n* = 190

- PPV = a/(a + b) = 90/95 = 94.7%
- NPV = d/(c + d) = 80/95 = 84.2%

- Sensitivity = a/(a + c) = 90/105 = 85.7%
- Specificity = d/(b + d) = 80/85 = 94.1%

If the prevalence changes to 133/190 = 70%, then the table will look like this:

	Throat culture positive for GAS	Throat culture negative for GAS	Total
Rapid test positive for GAS	114	3	117
Rapid test negative for GAS	19	54	73
Total	133	57	*n* = 190

- PPV from the new table, PPV = a/(a + b) = 114/117 = 97.4%
- NPV from new table = d/(c + d) = 54/73 = 74.0%
- Sensitivity = 114/133 = 85.7%
- Specificity = 54/57 = 94.7% (decimal arithmetical discrepancy is due to the need to have whole numbers in the table)

With increased prevalence, PPV of the test increases as well, but NPV decreases. And we're talking about the same test!

ABP Content Specification

- Understand how disease prevalence affects the positive and negative predictive value of a test

Question 33

Referring to the following table describing performance of the new point-of-care rapid test for a Group A beta hemolytic Streptococcus (GAS), the nurse practitioner is attempting to calculate likelihood ratio for the rapid test.

	Throat culture positive for GAS	Throat culture negative for GAS	Total
Rapid test positive for GAS	90	5	95
Rapid test negative for GAS	15	80	95
Total	105	85	*n* = 190

You advise her that

A. positive likelihood ratio is the probability of getting a positive test result if the patient is truly having strep throat infection
B. positive likelihood ratio is a proportion of all patients with strep throat infection correctly identified by the new test
C. positive likelihood ratio measures of probability of disease given the positive test results
D. negative likelihood ratio is a proportion of people without strep throat infection correctly identified by the test
E. negative likelihood ratio is the probability of no disease given the negative test results

Correct Answer: A

Likelihood ratio (LR) is the probability of getting a test result if the patient is truly having condition of interest.

Positive and negative LRs (LR+ and LR−) then are

$$LR+ = \frac{\text{probability of individual with a condition having "+" test}}{\text{probability of individual without a condition having "+" test}}$$

$$LR- = \frac{\text{probability of individual with a condition having "–" test}}{\text{probability of individual without a condition having "–" test}}$$

If we define likelihood ratios in terms of sensitivity and specificity,

then

$$LR+ = \frac{\text{sensitivity}}{1-\text{specificity}}$$

$$LR- = \frac{1-\text{sensitivity}}{\text{specificity}}$$

So, for the rapid test presented in question 30, LR+ = 14.5

To interpret the likelihood ratio, we should bear in mind that

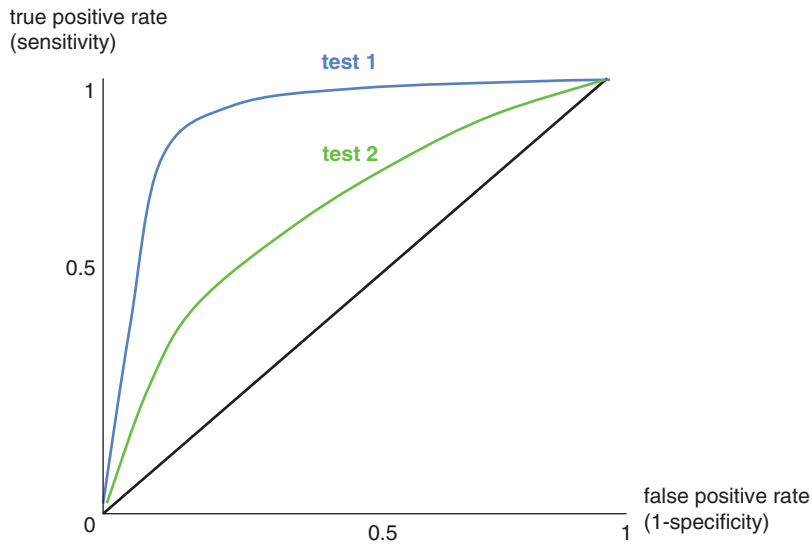
- LR = 1 signifies no change in likelihood of disease when the test is positive.
- LR = 2 to 5 indicates small increase in likelihood of disease with a positive test,
- LR = 5 to10—moderate increase and
- LR of 10 and more indicates large increase in likelihood of disease with a positive test.

ABP Content Specification

- Calculate and interpret likelihood ratios

Question 34

A resident approaches you with the receiver operator characteristic (ROC) curves for two different rapid strep tests. She asks you to help her determine which test is more accurate in detecting disease.



You reply to her that

A. tests are equal in accuracy
B. test 1 is more accurate
C. test 2 is more accurate
D. test 1 is better if the prevalence of the disease is high
E. test 2 is better if the prevalence of the disease is low

Correct Answer: B

ROC curves are used to evaluate the overall accuracy of the tests (i.e., their ability to separate people with a disease, i.e., true positives from those without disease). Test 1 in the vignette is more accurate. The farther to the upper left the test line is from the diagonal line, the more accurate it is.

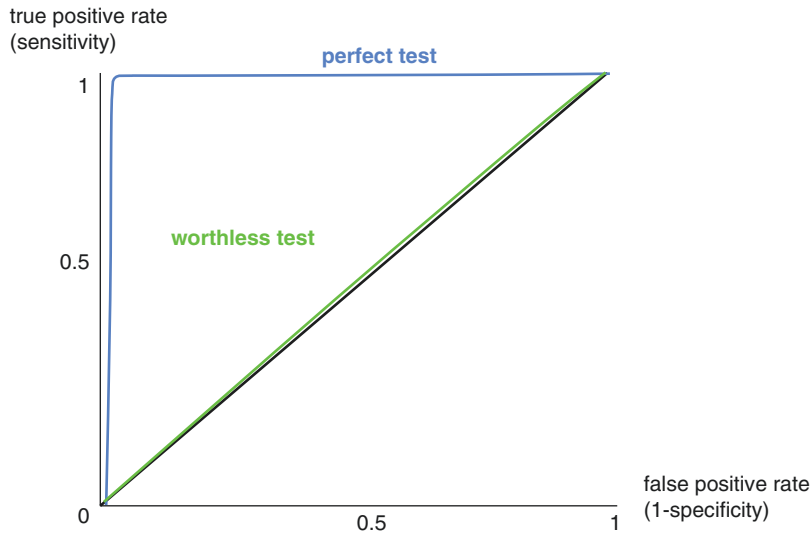
The diagonal line represents a completely worthless test, that is, at any cutoff point the true positive rate is the same as false positive rate.

The perfect test is the one that reaches a 100% of true positive rate with a 0% false positive rate

Often, the area under the ROC curve (0.5 for a worthless test, and 1.0 for a perfect test) is used to evaluate the accuracy of the test.

ROC curves are also used to find specific cutoff points on the curve for the best tradeoff point between sensitivity and specificity.

As it was explained in the critique to question 32, sensitivity and specificity of the test *are not* affected by the disease prevalence, and therefore choices d. and e. are incorrect.



(ROC curves were first described during World War II to evaluate the individual radar operator's characteristics in determining the source of the signal received by the radar).

ABP Content Specification

- Interpret a receiver operator characteristic curve

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Practice Chapter 35

James A. Meltzer

Question 1

A 40-day-old full-term male presents to your ED with swelling and erythema of his right breast. The mother notes it has been present since the day prior and has become increasingly red and swollen. The child has no concerning medical history, has been otherwise well, had no fever, and is feeding normally. His exam is notable for an awake interactive and comfortable baby with an erythematous, mildly indurated, and swollen right breast without any nipple discharge or fluctuance.

After an initial work-up, what would be your management for this child?

A. Discharge home with follow-up tomorrow with pediatrician and no antibiotics
B. Discharge home with follow-up tomorrow with pediatrician and oral clindamycin
C. Admit for intravenous clindamycin
D. Admit for intravenous vancomycin, incision, and drainage
E. Perform an evaluation for sepsis including lumbar puncture and admit for IV antibiotics

Correct Answer: C

The infant described in this vignette is a well neonate with signs of mastitis. The most likely pathogen causing this infection is *Staphylococcus aureus*. As a large percentage of *S. aureus* throughout the United States is considered methicillin-resistant *S. aureus* (MRSA), antibiotic therapy should be aimed toward this pathogen. Community-acquired MRSA can be treated relatively well with clindamycin, although resistance to this antibiotic is on the rise. As this child is well appearing and otherwise well, clindamycin appears to be an appropriate choice over vancomycin which requires close monitoring for nephrotoxicity. This patient should be admitted for IV clindamycin as there have been several reports demonstrating that patients discharged on oral antibiotics are at an increased risk of developing abscess. If the infant showed any signs of systemic involvement, a full sepsis evaluation including lumbar puncture and admission to the hospital for IV broad-spectrum antibiotic treatment would be indicated.

ABP Content Specification

- Know the etiology and understand the pathophysiology of mastitis.
- Recognize the signs and symptoms of mastitis.
- Plan the management of mastitis.

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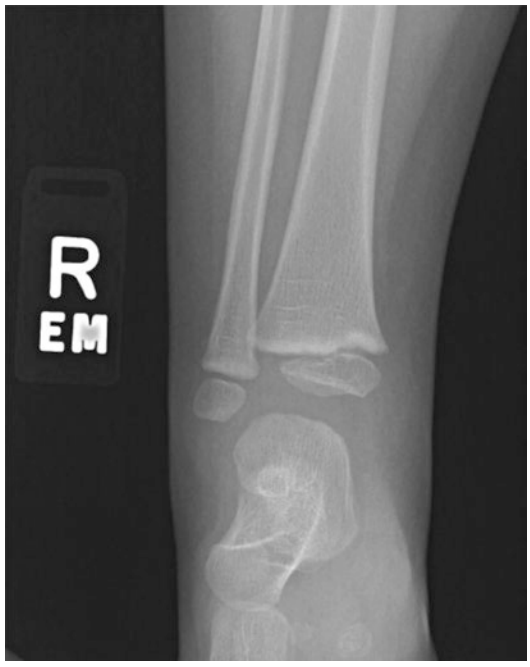
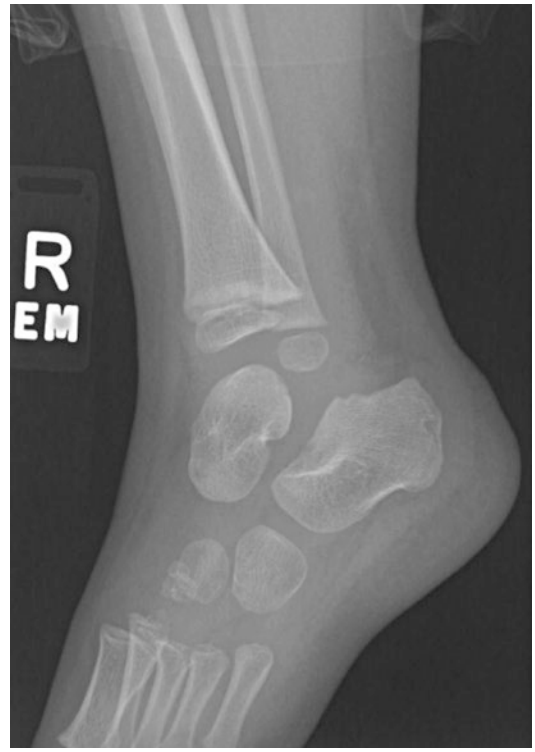
M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_35

Take-Home Message
In a well-appearing neonate with mastitis, an evaluation for sepsis including a lumbar puncture is not needed.

Question 2

A 3-year-old boy with no previous medical problems presents for right leg pain. The patient had tripped and fell while running last week but immediately returned to play. He awoke with right lower leg pain 6 days ago and the pain has persisted since. There is no history of other trauma. In addition, for the past 4 days, he has had mild cough, rhinorrhea, and fever. In your ED his vitals were as follows: temperature, 101.5 °F orally; heart rate, 115 bpm; respiratory rate, 22 bpm; and pulse oximetry, 99% in room air. The patient has a mild limp while walking into the exam room. On physical examination, he appears normal except for point tenderness over the right distal tibia without redness, swelling, or ecchymosis. Radiographs obtained are shown below:





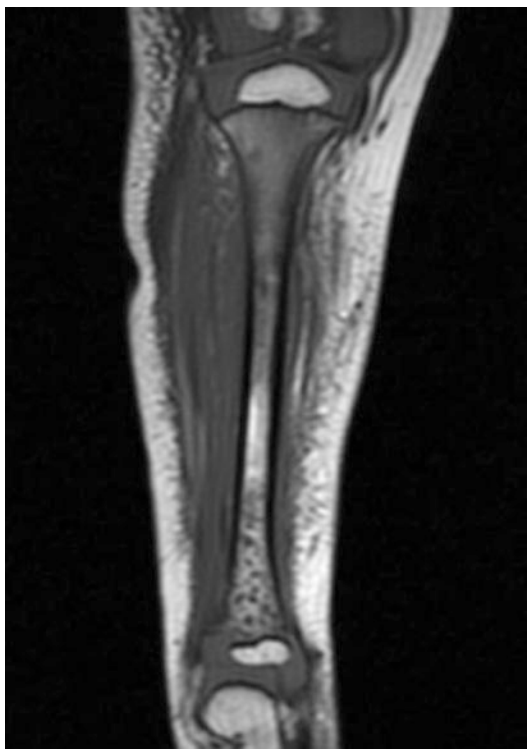
Which test is most appropriate in the evaluation of this patient to provide a diagnosis?

A. Repeat radiographs in 1 week
B. Fluoroscopy of the leg and foot
C. Blood culture
D. Magnetic resonance imaging (MRI) of the leg and foot
E. Computed tomography (CT) scan of the leg and foot

Correct Answer: D

The patient in this vignette with 6 days of leg pain and 4 days of fever was diagnosed with osteomyelitis. The initial radiographs are often negative (as was in this case) and should not dissuade the physician from performing further work-up. Delaying further evaluation (A) for 1 more week would be inappropriate as osteomyelitis will continue to destroy this child's bone during that time. Fluoroscopy (B) is not the exam

of choice and would not add much more detail over plain radiographs. Blood cultures are important in the evaluation of children with osteomyelitis and can be the only source from which the organism is identified (e.g., negative bone cultures at operation). Blood cultures are not the MOST appropriate choice, however, as the organism will take time to grow (C). MRI (D) has become the test of choice in the evaluation of osteomyelitis as it provides excellent detail of the bone early in the course, specifically the development of sub-periosteal abscesses. The MRI obtained on the same day as the above radiographs demonstrates obvious osteomyelitis of the distal tibia (see Figure below). Computed tomography (CT) also can also be used to aid in the evaluation, particularly in young children who may not tolerate, or may require sedation for, a lengthy MRI evaluation. CT, however, imparts a substantial amount of radiation to the child and should be avoided if possible.



ABP Content Specification

- Know the etiology and understand the pathophysiology of osteomyelitis.
- Recognize signs and symptoms of osteomyelitis.
- Recognize and interpret relevant laboratory and imaging studies for osteomyelitis.

Take-Home Message

MRI has become the test of choice in the evaluation of osteomyelitis as it provides excellent detail of the bone early in the course, specifically the development of sub-periosteal abscesses.

Question 3

A 12-year-old boy presents to your ED with complaints of fever and sore throat for the past 2 days. Of note, he returned from visiting his family in Ghana 5 days prior. The child is well-appearing on exam with normal vital signs and has a mildly erythematous throat without exudate and mild abdominal pain. He denies cough, vomiting, diarrhea, and rash. His physical exam and vital signs are within normal limits for his age. You perform a rapid strep test and it is negative.

What is the next appropriate course of action?

A. Send a malaria smear, CBC, chemistry with liver enzymes, and blood culture
B. Treat with IM benzathine penicillin
C. Chest radiograph
D. Discharge home and have patient follow-up with the primary care doctor in 3 days
E. Discharge on ciprofloxacin for presumed typhoid fever

Correct Answer: A

Patients who return after travel from tropical or underdeveloped countries are at significant risk for developing serious infections (bacterial/viral/parasitic). A report published in 2007 from the GeoSentinel Surveillance Network found that

malaria was found in 21% of returned travelers (31% of whom were younger than 20 years old). For patients who return from Sub-Saharan Africa, malaria accounted for 42% of febrile illnesses. Other common causes of fever among travelers include dengue fever (CBC may show leukopenia and thrombocytopenia), hepatitis (the patient would have elevated liver enzymes), and typhoid fever (test with blood culture). Of the 12 deaths found in this study of almost 25,000 patients, approximately 33% were from malaria. IM penicillin is unnecessary given that the rapid strep test is negative and a chest radiograph is not indicated as there are no respiratory symptoms. Given the frequency with which malaria occurs among travelers returning from Sub-Saharan Africa and how quickly Malaria can progress to severe disease, it would be prudent to evaluate these patients with a CBC and peripheral smear along with liver tests and initiate appropriate antimalaria therapy if indicated.

ABP Content Specification

- Recognize the signs and symptoms of malaria.
- Be familiar with the ancillary studies relevant to malaria.
- Recognize the life-threatening complications of malaria.

Take-Home Message
Malaria should be a strong concern for any child with fever and history of recent travel to tropical or underdeveloped countries, even when the presentation is clinically compatible with an alternate diagnosis.

Question 4

A 5-year-old girl presents to your ED 2 weeks after being scratched on her left hand by her new kitten. She is complaining of swollen tender lymph nodes in her left axilla. She has also developed mild erythema around the site where she was scratched. Her parents also note that she has been febrile for the past 2 days and has developed generalized malaise. The patient also states that she is having difficulty seeing from her left eye, but denies ocular pain. An eye examination shows no conjunctival injection or discharge, but fundoscopy reveals granulomatous optic disc swelling, macular edema, and lipid exudates in the left eye.

What is the next appropriate course of action for this patient?

A. Discharge home with no antibiotics but follow up with ophthalmology
B. Discharge home with topical erythromycin and follow up with ophthalmology
C. Discharge home with oral azithromycin and follow up with ophthalmology
D. Admit to hospital for intravenous gentamicin with ophthalmology consult
E. CT scan of the orbits

Correct Answer: D

The child in this vignette is suffering from infection with *Bartonella henselae* (i.e., cat scratch disease). Most children who develop regional lymphadenopathy after inoculation with *Bartonella henselae* do so after 1–2 weeks. Most cases of *Bartonella* occur in children after contact with a young cat. Fever and malaise are common symptoms. Treatment is supportive as *Bartonella* infection is often self-limited although some experts recommend outpatient antibiotics for acutely ill children. This child has developed ocular manifestations of *Bartonella* infection, namely *neuroretinitis*, as demonstrated by painless vision loss, a normal external exam, and the specific ophthalmologic exam findings described in the vignette. Patients with neuroretinitis should be admitted to the hospital and treated with intravenous antibiotics. Gentamicin is an acceptable choice. Most children with *Bartonella* neuroretinitis will have few, if any, lifelong sequelae. Computed tomography of the orbits is not needed in the evaluation of neuroretinitis.

ABP Content Specification

- Know the etiology of cat scratch disease.
- Recognize the signs and symptoms of cat scratch disease.

- Recognize the life-threatening complications of cat scratch disease
- Plan the management of cat scratch disease

Take-Home Message
Patients with a history of a cat scratch and ocular symptoms must be evaluated by ophthalmology.

Question 5

A 6-year-old boy presents with bloody diarrhea for the past day after returning from Mexico. Today, he has had three episodes of very soft stools with drops of blood on the toilet paper. He has not had fever, vomiting, or rash. His vital signs and physical examination are within normal limits. You send a stool culture.

For which of the following organisms would antibiotics be recommended?

A. Shigella
B. Salmonella
C. E. coli 0157:H7
D. Campylobacter
E. None of the above

Correct Answer: E

Antibiotics are not recommended for all children with bacterial enteritis as most cases will resolve spontaneously. Most experts will recommend antibiotics for those with severe disease or those who are immunocompromised. The patient described in the vignette has mild symptoms and can be treated at home with supportive care. Although a recent meta-analysis of randomized trials of antibiotics for *Shigella* dysentery demonstrated that antibiotic therapy shortened the course of diarrhea, the American Academy of Pediatrics Red Book continues to recommend antibiotic avoidance except for those with severe disease or who are immunocompromised. The same recommendation is given for children with *Salmonella* and *E. coli* enteritis. Whether patients with *E. coli* 0157:H7 enteritis who are treated with antibiotics are at higher risk of developing hemolytic uremic syndrome than those who are not treated remains controversial. Most recommend against antibiotic treatment for immunocompetent patients with noninvasive disease.

ABP Content Specification

- Know the etiology and understand the pathophysiology of the common causes of bacterial gastroenteritis.
- Recognize signs and symptoms of bacterial gastroenteritis.
- Recognize and interpret relevant laboratory and imaging studies for bacterial gastroenteritis.
- Plan management of acute bacterial gastroenteritis.

Take-Home Message
Despite a higher incidence of bacterial enteritis in travelers, unless a patient has severe disease or is immunocompromised, antibiotic treatment is not indicated.

Question 6

A 3-year-old boy with no pertinent past medical history presents to your ED with diarrhea for the past 3 days. His mother states that he has had profuse non-bloody diarrhea (>10×/day) without vomiting or fever. In the ED, his heart rate is 160 bpm, he is afebrile, and his blood pressure is 80/50 mmHg. He appears listless, his distal pulses are present, and his capillary refill is 2 seconds. His physical examination is otherwise unremarkable. His present weight is 12% less than his weight in clinic one month prior. An IV access is established immediately, blood is drawn for laboratory tests and a normal saline bolus at 20 ml/kg is initiated. The laboratory reports a sodium level of 119 mEq/L.

You plan to correct his hyponatremia over 48 hours so as to avoid:

A. Osmotic demyelination syndrome
B. Cerebral edema
C. Acute heart failure
D. Refeeding syndrome
E. Hyperchloremia

Correct Answer: A

Osmotic demyelination syndrome (ODS), formerly known as central pontine myelinolysis, occurs when patients with severe hyponatremia, most often with a sodium <120 meq/L, experience a rapid correction of their hyponatremia. When a child has developed hyponatremia over several days, his brain adapts to this change in order to prevent the development of cerebral edema. To do this, cerebral astrocytes shed intracellular solute in order to lower intracerebral tonicity and match the tonicity of plasma. This process thus avoids any substantial shift of fluid across the blood-brain barrier.

Rapid fluid correction, however, can raise the tonicity of plasma faster than the brain cells can adapt to, and thus cause water to shift across the blood-brain barrier from the brain toward the plasma. Although not completely delineated, some experts believe that this relatively rapid egress of fluid results in the development of ODS through (1) astrocyte apoptosis followed by (2) loss of communication between astrocytes and oligodendrocytes (myelin producing cells).

ODS symptoms often occur several days after aggressive hydration. Neurologic symptoms in children with ODS include ataxia, dysarthria, seizures, locked-in syndrome, and coma. In the 1960s, ODS was almost always a fatal disease. However, with improvements in medical care, the mortality rate in children in the United States has dropped substantially, with many patients making a partial or full recovery.

ABP Content Specification

- Know the etiology and understand the pathophysiology of hyponatremia, including hyponatremic dehydration.
- Recognize signs and symptoms of hyponatremia, including hyponatremic dehydration.
- Recognize and interpret relevant laboratory studies for hyponatremia, including hyponatremic dehydration.
- Recognize life-threatening complications of hyponatremia, including hyponatremic dehydration
- Plan management of acute hyponatremia, including hyponatremic dehydration

Take-Home Message

Correction of hyponatremia should be done over 48 hours to prevent osmotic demyelination syndrome.

Question 7

To be effective, oral rehydration solution (ORS) ideally should have:

A. No glucose
B. A sodium concentration that is half the number of moles of glucose
C. An equimolar concentration of sodium and glucose
D. An osmolality >300 mOsm/L
E. Twice as much glucose as sodium

Correct Answer: C

Several studies have demonstrated that ORS that is *equimolar* in sodium and glucose is as effective as intravenous fluids for correcting mild to moderate dehydration in children with acute gastroenteritis. The rationale for an equimolar solution is based on the properties of the sodium-glucose transporter in the small intestine which absorbs sodium and glucose in a 1:1 ratio. Excess glucose in the small intestine increases the luminal osmolality, resulting in decreased absorption of water into plasma, and increased diarrhea. The current recommendation is for ORS to have 75 mmol per liter of sodium and 75 mmol per liter of glucose. In addition, the World Health Organization (WHO) now endorses that ORS have an osmolality that is 245 mOsm/L. They determined that solutions with higher osmolality resulted in a longer duration of diarrhea than those with lower osmolality.

ABP Content Specification

- Know the anatomy and pathophysiology relevant to oral rehydration.

Take-Home Message
Lower osmolality solutions with a 1:1 sodium to glucose ratio are ideal for ORS. This improves water absorption and minimizes diarrhea.

Question 8

In the Unites States, the most common cause of acute liver failure (ALF) in children is:

A. Viral hepatitis
B. Acetaminophen toxicity
C. Autoimmune liver disease
D. Indeterminate
E. Metabolic disease

Correct Answer: D

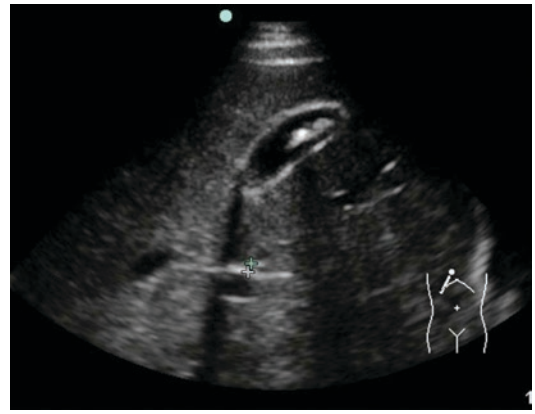
The Pediatric Acute Liver Failure Study Group in 2006 demonstrated that, for the majority (49%) of children in developed countries who develop ALF, a cause is never determined. Overall, acetaminophen toxicity (14%) and metabolic disease (10%) are the commonly known causes for ALF. As expected, acetaminophen toxicity (21%) is more often a cause of ALF in children older than 3 whereas metabolic disease (18%) is more often a cause in those younger than 3. Wilson disease and respiratory chain defect were among the most common metabolic diseases resulting in ALF. Other causes of ALF in children include autoimmune hepatitis, viral hepatitis (e.g., hepatitis virus, CMV, EBV, HSV, enterovirus), drugs (e.g., mushrooms, anesthetics, Bactrim, Dilantin, INH, iron), leukemia, and shock.

ABP Content Specification
- Know the causes of fulminant hepatic failure, including drugs, storage diseases, and autoimmune disorders.

Take-Home Message
Most causes of pediatric liver failure are not specifically identified.

Question 9

A 14-year-old boy with sickle cell disease presents to the ED with increasing jaundice and abdominal pain for the past week. He has been afebrile but has become increasingly nauseous. His vitals are within normal limits and his physical exam is unremarkable except for right upper quadrant (RUQ) tenderness. You perform a point-of-care RUQ bedside ultrasound (Figure).



What is being measured anterior to the portal vein in this image?

A. Common bile duct
B. Cystic duct
C. Peri-cholecystic fluid
D. Biliary stone in the neck of the gallbladder
E. Edge artifact

Correct Answer: A

Patients with sickle cell disease are at increased risk for biliary disease due to their propensity for increased hemolysis and high bilirubin turnover. A point-of-care bedside ultrasound of the RUQ is performed most often with a low-frequency curved or phased array probe. The probe is placed in the midline with the probe-marker pointing superiorly, and the abdomen is scanned as the probe is moved laterally toward the patient's right (or vice-versa). The ideal image is one that forms an "exclamation mark"

with the important structures of the right upper quadrant. The "dot" of the exclamation mark is the portal vein; this can be confirmed by placing Color Doppler over it to demonstrate blood flow. The gallbladder is represented by the remaining portion of the exclamation mark. Biliary stones, as demonstrated in the image, appear as hyperechoic (white) structures which have a sharp shadow deep to them. The shadow is produced because the stone absorbs the sound waves and does not let them pass deep to it. Also, note in this image the presence of edge artifact. This artifact is encountered when the sound waves are refracted after hitting a round structure (e.g., gallbladder) on its edge and produce a shadow deep to the edge.

The sonographer should slowly scan through the gallbladder in the longitudinal plane and then again in the transverse plane to thoroughly evaluate the gallbladder. In addition, the sonographer should attempt to identify the common bile duct which is the structure being measured in the image. On the exclamation point view, the common bile duct is best located just anteriorly to the portal vein and will lack flow on Color Doppler. The diameter of the common bile duct in adults should be less than 4 mm. In children, the size of the common bile duct, however, will vary directly with their age. When the common bile duct is enlarged, one should suspect that the common bile duct is obstructed. Sonographic features of cholecystitis which are not present in this image include pericholecystic fluid, which appears as anechoic (black) fluid surrounding the gallbladder, and thickening of the gallbladder wall.

ABP Content Specification

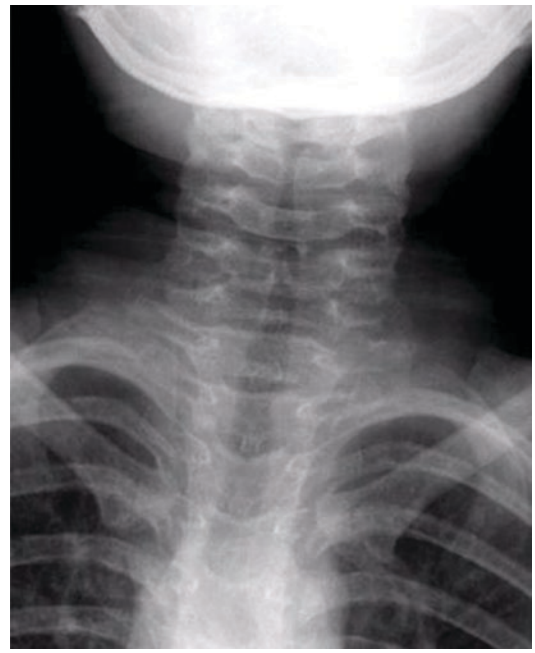
- Recognize and interpret relevant laboratory and imaging studies for biliary tract disease.

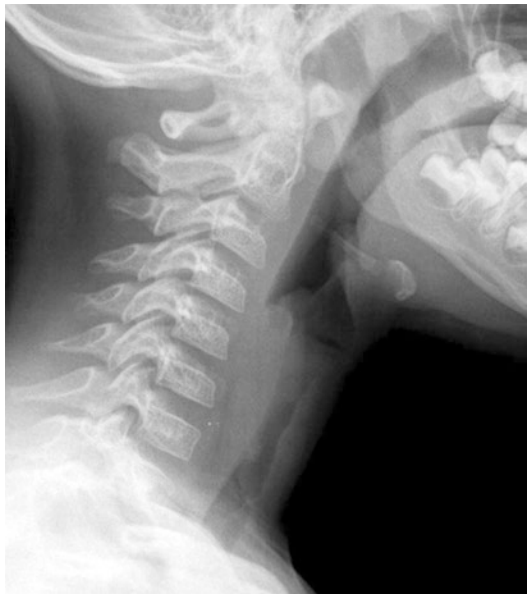
Take-Home Message

The common bile duct is a bright walled structure that runs anterior to the portal vein.

Question 10

A 4-year-old boy presents to the Emergency Department (ED) for the second time this week with worsening stridor. He was seen 2 days prior, diagnosed with croup, given oral dexamethasone and 1 dose of nebulized racemic epinephrine. He was noted to have improved in the ED on that day and was discharged home. He developed a fever yesterday and worsening stridor overnight. ED vital signs were as follows: temperature, 103.3 °F; HR, 160 bpm; respiratory rate, 30; and an oxygen saturation, 92% in room air. He is noted to be in respiratory distress with subcostal and intercostal retractions, and inspiratory stridor. Except for transmitted upper airway sounds, his lungs are clear to auscultation bilaterally. He improves initially after a dose of nebulized racemic epinephrine, and soft tissue neck radiographs are obtained and shown below. Over the next hour, he begins to deteriorate despite another dose of racemic epinephrine and IV steroids. Now he is becoming increasingly somnolent, with an oxygen saturation of 89% in room air, a respiratory rate of 48 with subcostal and intercostal retractions.





What is the cause of his respiratory failure?

A. Viral croup
B. Bacterial epiglottitis
C. Bacterial retropharyngeal abscess
D. Esophageal foreign body
E. Bacterial tracheitis

Correct Answer: E

Respiratory failure is the most common cause of cardiac arrest in children and has many causes. When evaluating a patient with respiratory failure, it is helpful to organize the differential diagnoses into system groups such as respiratory, cardiovascular, neurological, gastrointestinal, metabolic, and hematologic.

This child's cause of respiratory failure is primarily related to his respiratory system. Respiratory problems are commonly divided into upper and lower respiratory tract causes, although they can overlap. Viral croup (A) is a common cause of upper airway obstruction and can be treated with oral or intramuscular steroids. For patients with stridor at rest, nebulized racemic epinephrine should be given. The majority of these children are discharged home after a period of observation in the ED. Occasionally, viral croup can be complicated by bacterial superinfection causing bacterial tracheitis. Bacterial tracheitis carries a substantial risk of airway obstruction due to the formation of pseudo-membranes, particularly seen with staphylococcal infections. Bacterial tracheitis can lead to respiratory failure, especially among younger children whose airways are exponentially smaller (and more easily occluded) when compared to older children and adults (i.e., Poiseuille's law).

Radiographs should only be obtained in stable patients and can help differentiate the etiology of the patient's stridor, especially for those that are not improving with standard therapy. Patients with viral croup (A) will often demonstrate the classic "steeple sign" on the anteroposterior radiograph. On the lateral radiograph, a swollen epiglottis appears as a "thumb print sign" and is suggestive of epiglottitis (B). Enlargement of the retropharyngeal soft tissue anterior to the vertebral bodies indicates a retropharyngeal abscess (C). A radio-opaque foreign body (D) can be seen on X-ray, while a radio-lucent foreign body may only produce subtle soft tissue shadowing. This patient's anteroposterior and lateral radiographs demonstrate bacterial tracheitis (E) with a "ragged" trachea with irregularities representative of bacterial pseudo-membranes.

ABP Content Specification

- Know the etiology of respiratory failure.
- Differentiate by age the etiology and understand the pathophysiology of tracheitis.
- Recognize signs and symptoms of tracheitis.
- Recognize and interpret relevant laboratory and imaging studies for tracheitis.
- Recognize life-threatening complications of tracheitis.

Take-Home Message

Tracheitis is an uncommon but serious cause of upper airway obstruction and can present with stridor and ill appearance. Radiographs of the neck may be helpful to differentiate it from other causes of upper airway obstruction.

Question 11

Which of the following is a reason why infants are more prone to respiratory failure than older children?

A. Less airway resistance
B. Small intrathoracic airway caliber with an over-abundance of cartilaginous support, and excessive collateral ventilation
C. More type 1 muscle fibers
D. Immature brainstem respiratory center
E. Lower basal metabolic rate

Correct Answer: D

Most respiratory failure in children occurs in young infants, especially those who are premature. These infants are predisposed to respiratory failure for several reasons. (1) Infants have smaller airways which creates an exponential *increase* in airway resistance. Infections and other causes of inflammation can create small changes in the diameter of the airway, resulting in a substantial degree of obstruction. (2) Infants are predisposed to atelectasis due to small intrathoracic airway caliber with a *lack* of cartilaginous support and collateral ventilation. (3) Infants have a relative *lack* of type 1 muscle fibers compared to older children, resulting in them more easily "tiring out." (4) Apnea is more common in infants due to an immature respiratory center located in the brainstem. (5) Infants have a higher basal metabolic rate than older children.

ABP Content Specification

- Differentiate etiologies of respiratory failure by age.
- Understand the pathophysiology of respiratory failure.

Take-Home Message

Respiratory failure resulting in cardiac arrest occurs more rapidly and more often in young infants due to their smaller airway size, immature cartilage and muscles. Infants have a higher metabolic rate, and this makes hypoxia less tolerable.

Question 12

What is the recommended treatment for a child with tachycardia with a wide complex (>0.09 second) without chest pain, respiratory distress, or changes in mental status or perfusion? This patient has no relevant past medical problems. On EKG, the rhythm is regular and QRS is monomorphic.

A. Adenosine
B. Epinephrine
C. Cardioversion
D. Defibrillation
E. Synchronized cardioversion

Correct Answer: A

Supraventricular tachycardia (SVT) (narrow complex <0.09 seconds) is much more common in children than ventricular tachycardia. In addition, wide-complex tachycardia can sometimes be supraventricular in origin (i.e., SVT with aberrancy). For these reasons, the American Heart Association (AHA) guidelines state that adenosine should be considered for stable children with wide-complex tachycardia if (1) the patient does not have a known history of ventricular tachycardia, (2) the rhythm is regular, and (3) the QRS is monomorphic. If adenosine fails, amiodarone or procainamide should be administered.

For stable patients with arrhythmias, it is strongly recommended to seek cardiology consultation prior to initiating anti-arrhythmic medication. If there are any signs of cardiopulmonary compromise, then electric synchronized cardioversion (E) should be attempted. If cardiopulmonary compromise progresses and the child becomes pulseless, cardiopulmonary resuscitation (CPR) should be initiated with chest compressions, defibrillation (D), and epinephrine (B) according to the AHA Pediatric Advance Life Support algorithm for pulseless arrest.

ABP Content Specification

- Know the treatment of stable dysrhythmias.

Take-Home Message
SVT with aberrancy presents with a wide complex. If the patient is stable, adenosine is the treatment of choice.

Question 13

What drug cannot be given down the endotracheal tube during pediatric resuscitation?

A. Lidocaine
B. Adenosine
C. Naloxone
D. Epinephrine
E. Atropine

Correct Answer: B

The endotracheal tube can serve as an option to deliver medications during cardiopulmonary resuscitation when the patient lacks intravenous access. According to the American Heart Association (AHA), the following lipid-soluble medications can be given down the endotracheal tube: lidocaine, epinephrine, atropine, and naloxone. To memorize these, the "LEAN" or "LANE" mnemonic is often used. The AHA recommends briefly stopping CPR and then administering the medication followed by 5 ml of saline and five positive-pressure breaths. The absorption of medications in the trachea is variable, and the exact dose of medications has yet to be elucidated. Many experts recommend doubling or tripling the dose of lidocaine, atropine, and naloxone if the endotracheal route is to be used. Pediatric Advanced Life Support (PALS) guidelines recommend an endotracheal dose of epinephrine 10 times that of the intravenous dose used for resuscitation: endotracheal, 0.1 mg/kg or 0.1 ml/kg of the 1:1000 concentration; intravenous, 0.01 mg/kg or 0.1 ml/kg of the 1:10,000 concentration. Adenosine should not be given down the endotracheal tube.

ABP Content Specification
- Know the routes of administration of drugs used in resuscitation.

Take-Home Message
Although not an ideal route, the endotracheal tube may be used for lidocaine, epinephrine, atropine, or naloxone.

Question 14

A 3-week-old full-term baby with no history of medical problems presents to your ED with vomiting and diarrhea. The parents have attempted multiple times to give oral rehydration solution but the patient continues to vomit. On arrival, the heart rate is 150 bpm, and the systolic blood pressure is 75 mmHg. The patient is not tachypneic or febrile. The patient has persistent vomiting in the ED so a blood chemistry is drawn and intravenous fluids are started. The chemistry returns with a sodium 140 mEq/L, potassium of 5.8 mEq/L, and a HCO_3 of 19 mEq/L.

How should you alter your management of this patient in response to these laboratory values?

A. IV calcium gluconate
B. IV insulin and Glucose
C. IV $NaHCO_3$
D. Immediately repeat chemistry
E. No change in management

Correct Answer: E

The neonate in this vignette appears to have gastroenteritis that has failed oral rehydration. The clinician is presented with a chemistry that is within normal limits for a newborn. The normal limits of these particular chemistries for a neonate are as follows: Sodium, 130–145 mEq/L; Potassium, 3.7–5.9 mEq/L; Bicarbonate, 17–24 mEq/L. A potassium of 5.8 mEq/L would be abnormal for older children and can be quite alarming to the clinician unaware of the normal values of neonates. As this child has a normal chemistry, no change in management is necessary. There is no direct need to send a repeat chemistry.

Children with hyperkalemia are always a challenge to manage in the Emergency Department. Most children with true hyperkalemia will be

asymptomatic until their potassium level is greater than 7 mEq/L. Clinical manifestations of hyperkalemia include (1) ascending muscle weakness progressing to paralysis and (2) chest pain, palpitations, syncope, and cardiovascular collapse due to derangements in cardiac conduction. Patients with hyperkalemia should have an electrocardiogram performed which may demonstrate the classic "peaked" t-waves along with a shortened QT interval, prolonged PR interval, and a wide QRS. These conduction abnormalities can progress to ventricular fibrillation and asystole if not treated.

ABP Content Specification

- Recognize signs and symptoms of hyperkalemia.
- Recognize and interpret relevant laboratory and monitoring studies for hyperkalemia.
- Recognize life-threatening complications of hyperkalemia and its treatment.

Take-Home Message

The normal serum potassium for a newborn is higher than in older children.

Question 15

You would like to study the effect of albuterol on infants with bronchiolitis in the emergency department. You decide to do a prospective cohort study comparing infants <2 years old with their first episode of wheezing who receive albuterol, to similar infants who receive no albuterol. The outcome you are examining is rate of admission. You plan to collect information on the following potential confounding variables: age, race, gender, days of symptoms, personal and family history of atopy, oxygen saturation, retractions, respiratory rate, temperature, number of albuterol treatments given, and if any other medications were given. Using regression analyses, you believe you can reliably control for these variables.

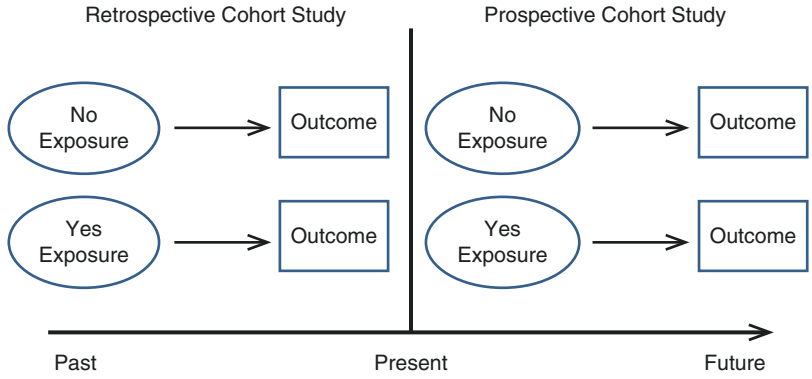
Why could a randomized-controlled trial (RCT) potentially offer more valid results?

A. It never would
B. Because it would ensure that the confounding variables collected are evenly distributed among treatment groups
C. Because it would better control for latent confounding
D. Because it would better control for recall bias
E. It would assure true evenness

Correct Answer: C

When preparing to study a particular intervention, study design is of the utmost importance. In general, most studies will use a cross-sectional, case-control, cohort, or randomized-controlled study design (RCT). All of these study designs can offer valid results, but there will always be some bias that must be considered.

Cohort studies examine patients with a particular exposure and look forward from that time point to see if the patient develops the outcome. Cohort studies can be divided into two types: retrospective/historical and prospective. Retrospective cohort studies begin in the past and (most often) examine an outcome that has occurred in the past. Prospective cohort studies begin in the present and examine an outcome that has yet to occur (see Figure).



Cohort studies are potentially easier to execute than RCTs, particularly if the exposure is uncommon. First, there usually are not any ethical concerns because there is often not a new intervention that is being tested but you are rather just examining the natural progression of disease. In other words, patients receive the intervention they would have received regardless of your study. Second, for retrospective cohort studies, you can examine a large amount of data relatively quickly and you do not have to wait for the outcome to occur.

One of the most difficult biases to overcome for cohort studies is selection bias. Patients who receive the exposure are often more ill (i.e., confounding by indication) or different in some way than those who do not receive the exposure. Several statistical methods are available to attempt to "adjust" for these differences, although all are imperfect. These include regression analyses, stratification, weighting, and matching. These methods attempt to make the exposure groups more alike with regard to the potential confounding variables you collected. They cannot adjust, however, for any of the potentially important variables you did not collect (i.e., latent confounders). This is one of the most important differences between cohort studies and RCTs. Through the randomization process, patients in each exposure group in an RCT will, most likely, be similar in both the characteristics you can measure and even in the characteristics you cannot. It is for this reason that the results of an RCT are often more valid than those of other study designs.

True evenness is a large sample property. RCTs cannot ensure that all characteristics are evenly distributed, particularly if the sample is small. Recall bias is a problem for case-control studies, not cohort studies.

ABP Content Specification

- Identify the study design most likely to yield valid information about the benefits and/or harms.

Take-Home Message

Randomized-controlled studies are the design that will most likely control for latent confounders.

Question 16

What is the "hidden curriculum"?

A. A learned yet unintended consequence of education
B. A strategy that motivates learners
C. An internet-based module to supplement active learning of a particular procedure
D. "Reflective practice" in teaching and learning
E. A method of teaching for behavior change

Correct Answer: A

The "hidden curriculum" is an unintended consequence of education. These are ideas and notions that are learned in school, or some other educational environment, that are not the intended subject of the formal curriculum. The hidden curriculum can come in the form of assumptions or expectations that are not formally introduced or communicated to the learner. The hidden curriculum can have beneficial or harmful effects. If the hidden curriculum is one of compassion and empathy for your fellow human beings, then most would consider it beneficial. However, if the hidden curriculum is one where emergency department patient throughput is emphasized over patient safety, then most would consider it detrimental.

The hidden curriculum is not a planned strategy. Therefore, educators cannot use it to motivate learners. Nor is it any type of module or specific educational approach. Moreover, it is not "reflective practice." Reflective practice is a process by which teachers and learners analytically inspect or "reflect" on their views and actions in a way that allows them to transform/inform the way they teach or practice in the future. Teaching reflective practice to trainees can promote self-development by allowing them to identify their shortcomings and then develop ways to improve upon them. The Accreditation Council for Graduate Medical Education emphasizes the importance of pediatric emergency medicine specialists demonstrating "self-awareness and reflection."

ABP Content Specification

- Understand the importance of "reflective practice" in teaching and learning.
- Recognize the impact of the "hidden curriculum" on learning.

Take-Home Message

There are potentially unintended consequences with education ("hidden curriculum").

Question 17

A 1st-year pediatric EM fellow is intubating a child and having some difficulty. Eventually, the intubation is successful after two attempts. Immediately afterward, the pediatric EM attending who was present for the case offers some feedback on possible maneuvers that could have made the intubation go more smoothly. The attending physician explains how positioning and apneic oxygenation may aid the fellow in intubating the patient.

How would education theory describe the feedback provided by the attending physician?

A. Summative
B. Formative
C. Innovative
D. Suggestive
E. Critical

Correct Answer: B

In educational theory, feedback is divided into two types: formative and summative. Formative is often described as "on-the-job" feedback. Formative assessments "help students identify their strengths and weaknesses and target areas that need work" and "help faculty recognize where students are struggling and address problems immediately." In contrast, summative feedback is often the summation of past performance. Specifically, summative assessments "evaluate student learning at the end of an instructional unit by comparing it against some standard or benchmark."

While the attending's comments may be "innovative" and "suggestive," educational theory does not use these as descriptors for a specific type of feedback. Components of effective feedback include: ensuring a friendly accessible setting, concentrating on specific behaviors, using a set standard for comparison, giving the feedback in a timely fashion, avoiding too much feedback, and promoting independent learning.

ABP Content Specification

- Identify components of effective feedback.
- Distinguish between formative and summative feedback.

Take-Home Message

Summative feedback is a summary, whereas formative feedback helps inform change and addresses deficiencies promptly.

Question 18

You are preparing to conduct a double-blind randomized-controlled clinical trial examining the effect of a new antibiotic for the treatment of bacterial conjunctivitis. Ocular ofloxacin will serve as the control. You believe the new antibiotic will be superior to ofloxacin because your preliminary data (n = 20) demonstrated that patients improved much more quickly on it than ofloxacin. Both medications have similar side-effect profiles.

Is it possible to have "clinical" equipoise in this study?

A. Yes. Because other similar researchers would still believe that ofloxacin could be equally effective as the new medication due to the lack of prior convincing data
B. Yes. Because you believe that the new medication is superior
C. No. Because other similar researchers would still believe that ofloxacin could be equally

effective as the new medication due to the lack of prior convincing data

D. No. Because you believe that the new medication is superior

E. No. Because the study has not been conducted yet

Correct Answer: A

Equipoise means "being in a state of balance." As ethical researchers, we are required to provide the best treatment for our patients. In order to conduct an ethical clinical trial, there must be an equal amount of risk and benefit in each arm of the study. For example, if the researchers believe, prior to the start of the study, that one arm is likely to gain more benefit while maintaining the same risk, then the study is ethically unbalanced. Equipoise is lost. If most researchers have a belief that one arm will be better than the other prior to initiating the study, how can there ever be equipoise in a clinical trial?

According to the concept of "clinical equipoise," "the (ethical) requirement is satisfied if there is genuine uncertainty within the expert medical community--not necessarily on the part of the individual investigator--about the preferred treatment." In other words, as long as there is doubt among similar experts, despite all available evidence, with regard to which is the best arm in your study, there is "clinical equipoise" and your study satisfies this ethical requirement. This is true, even if you believe one arm is superior to the other.

ABP Content Specification

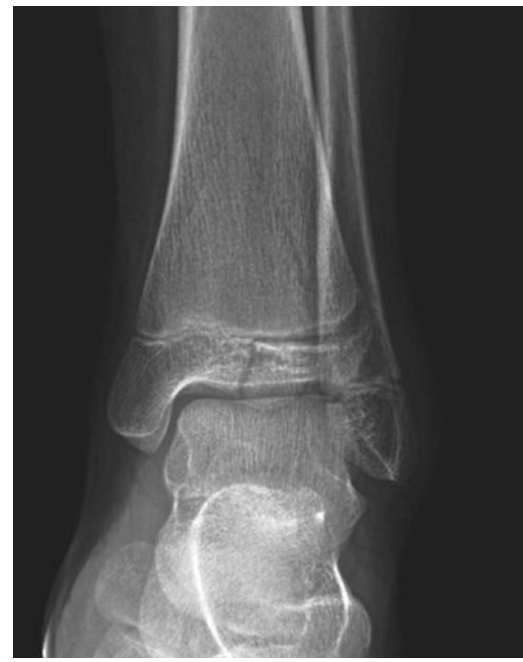
- Understand the importance of clinical equipoise in research with human subjects.

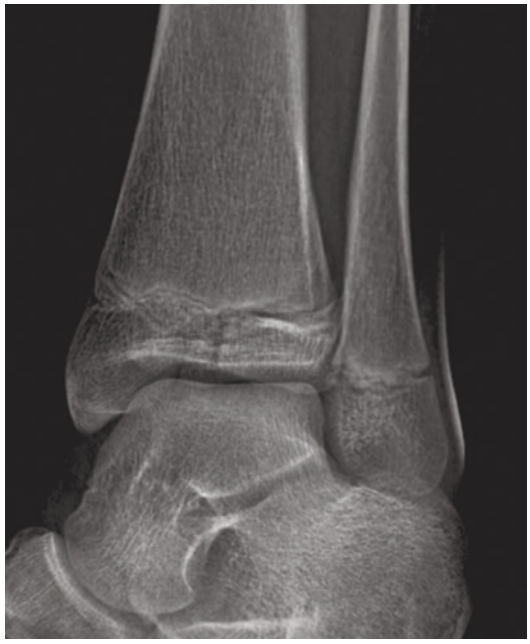
Take-Home Message

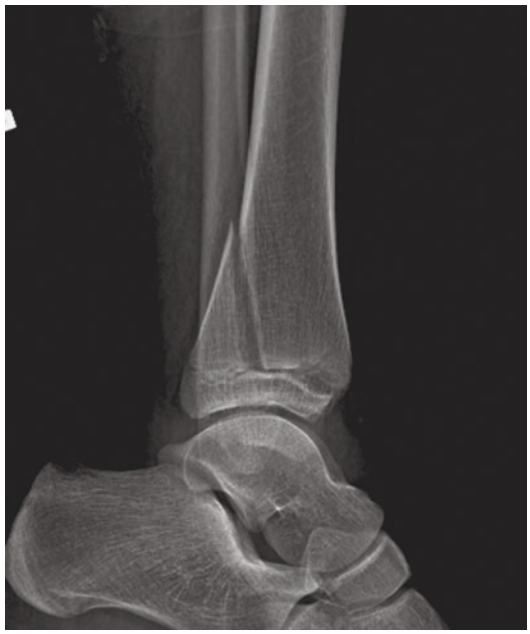
Clinical equipoise exists when similar researchers would believe that the treatment options in the study are potentially equivalent.

Question 19

A 13-year-old boy was playing basketball when he inverted his left ankle. He immediately felt pain and fell to the floor. His ankle began to swell and his coach called the ambulance, which brought him to your emergency department. In the emergency department, his vitals are normal and you note a swollen and diffusely tender left ankle. You obtain the three X-ray views (anterior-posterior, lateral, and oblique) below.







The patient is seen by orthopedics, a reduction is attempted, and the patient is casted. What would be the most appropriate next step for this patient?

A. Computed tomography (CT) of the ankle
B. MRI or the ankle
C. Admission to the hospital
D. Open reduction internal fixation
E. Make the child non-weight-bearing and follow-up in a month

Correct Answer: A

This child in the vignette has suffered a triplane fracture. This fracture extends through the coronal plane in the distal metaphysis, through the cross-sectional plane of the physis, and through the sagittal plane in the epiphysis. This fracture typically occurs during puberty after the distal tibial physis has begun to close. Because this fracture extends into the ankle joint, proper alignment is essential. Current recommendations advise surgical repair if there is greater than 2 mm of displacement in any one of the three planes. These measurements are best made on CT after closed reduction and casting. CT imaging should be obtained urgently.

ABP Content Specification

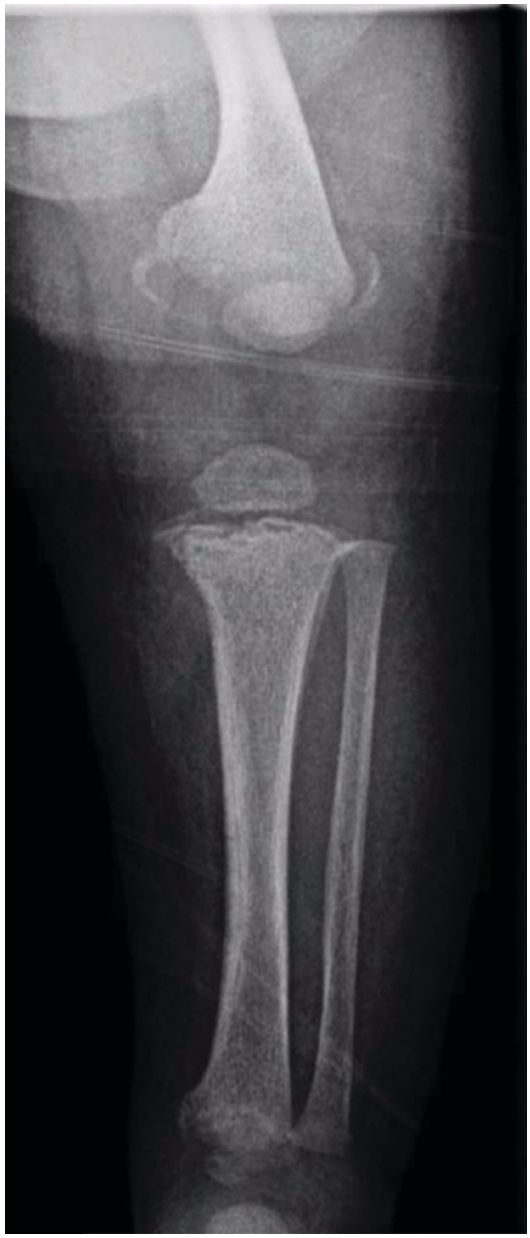
- Recognize a child with a tibial fracture.
- Know and understand the mechanisms of injury in tibial fractures.
- Plan the management of a child with a tibial fracture.

Take-Home Message
For children with triplane fractures, CT scan of the ankle should be obtained to determine the need for operative management.

Question 20

A 9-month-old previously healthy boy presents to your emergency department with a 1-day history of a swollen left knee and decreased range of motion. The mother states the child awoke this morning with these complaints and has become progressively worse throughout the day.

The child has been afebrile but is particularly cranky today. There is mild erythema about the left knee but the remainder of the skin exam is unremarkable without ecchymosis or petechiae. In addition, you do not note swelling to any other joint. You obtain the following knee radiograph:



What is the most likely diagnosis and what should be your next step in the management of this child?

A. Osteomyelitis, obtain an MRI
B. Septic joint, aspirate the joint, and start antibiotics
C. Legg-Calve-Perthes disease, follow up with orthopedics as an outpatient
D. Non-accidental trauma, consult child protective services
E. Transient synovitis, follow-up with orthopedics as an outpatient

Correct Answer: D

The radiograph depicts bucket-handle fractures of the distal femur and distal tibia. There is also a corner fracture of the proximal tibia as well as the appearance of callous along the lateral proximal tibia. Callous is indicative of fracture healing and typically is not seen on radiographs until 1 or 2 weeks after the fracture has occurred. Bucket-handle fractures are indicative of non-accidental trauma and child protective services need to begin an investigation. Other risk factors for non-accidental trauma include the patient's young age and multiple fractures at different stages of healing. Moreover, when the physical exam and radiographical findings do not align with the history, non-accidental trauma must be considered.

Osteomyelitis most often has a more indolent history, and fever is often a component of the presentation. Septic joint and transient synovitis are best diagnosed with ultrasound and will often have normal radiographs. Legg-Calve-Perthes disease is a hip disorder most often occurring in school-aged children.

ABP Content Specification

- Recognize common fractures associated with bony injuries characteristic of physical abuse.

Take-Home Message

Recognize that bucket-handle fractures are indicative of non-accidental trauma.

Question 21

A 2-year-old developmentally delayed girl with a history of gastrostomy tube placement shortly after birth presents to your community emergency department because her tube has fallen out. The father does not have a replacement tube. You should:

A. Refer the patient to the closest children's hospital, which is 2 hours away
B. Place a Foley catheter in the gastrostomy tract
C. Attempt an oral challenge
D. Place a nasogastric tube and begin feeding the child
E. Admit the child to the hospital for intravenous hydration

Correct Answer: B

Gastrostomy tube replacement is a key skill for the pediatric emergency physician. It is important to realize that the gastrostomy site can begin to close within hours of tube dislodgement, and it is therefore imperative to replace the tube as soon as possible. Ideally, the clinician would prefer to use an exact replica of the tube the patient previously had; however, a perfect replacement is not always readily available. Foley catheters are ubiquitous to all emergency departments and can serve as a temporizing tube until a better replacement becomes available. If the gastrostomy tract has begun to close, insertion with a smaller size tube is often successful.

Referring the patient to a hospital 2 hours away is not appropriate as the tract may become smaller by the time the patient arrives at the next facility, increasing the difficulty of tube insertion. Attempting an oral challenge also would be inappropriate as we do not have any information that that would be a safe alternative and can cause aspiration. If food is placed down a nasogastric tube, it may leak through the open gastrostomy tract. Moreover, the patient can be fed through a Foley catheter placed in the gastrostomy tract, so inpatient admission for intravenous hydration would be unnecessary.

ABP Content Specification

- Plan the key steps and know the potential pitfalls in performing gastrostomy tube replacement.

Take-Home Message

Gastrostomy tube tracts will begin to close within hours after tube removal. A Foley catheter is an acceptable temporizing alternative for a gastrostomy tube.

Question 22

A 4-year-old with no significant medical history presents with a bulls-eye-type rash on his leg. He had a tick exposure 1 week ago and removed the tick. The rash is about 10 cm in diameter and has an erythematous border with central clearing. You diagnose the patient with erythema migrans. What is your treatment plan?

A. Observe at home for progression
B. Doxycycline
C. Amoxicillin
D. Admit for IV azithromycin
E. B or C

Correct Answer: E

Current recommendation for the treatment of early Lyme disease, as manifested in this patient with erythema migrans, is to treat the patient with either doxycycline or amoxicillin. This has changed from previous recommendations that warned against treating young patients with doxycycline because of the risk of yellow tooth discoloration and dental enamel hypoplasia in patients with developing dentition. Recent studies have found this risk to be minimal. The 2018 AAP Red book states "Doxycycline, amoxicillin, or cefuroxime can be used to treat children of any age who present with erythema migrans. Azithromycin generally is regarded as a second-line antimicrobial agent for erythema migrans in the United

States, but further research on the efficacy of this agent is warranted."

Doxycycline may be preferred as it is more effective in the treatment of Lyme sequelae, is dosed less frequently (doxycycline twice a day for 10 days vs amoxicillin 3 times a day for 14 days), and has better MRSA coverage if there is the possibility of cellulitis.

ABP Content Specification

- Plan the management of bites/stings by type, including scorpions, spiders, ticks, and insects.
- Know the bites/stings that produce significant illness or injury in children.

Take-Home Message

Doxycycline is now considered safe and can be used to treat early Lyme disease even among very young children.

Question 23

A 1-month-old baby presents with a distended abdomen and multiple episodes of vomiting today. The mother describes the vomitus as "lime green." You witness one such episode in the emergency department. The child has been afebrile and has not had any diarrhea or recent travel. On examination, the patient's vitals are: Temp: 99 °F, HR 190 bpm, RR 55, oxygen saturation 99%, and BP 85/35. The child appears lethargic. You place an IV, draw labs, and administer IV fluids.

What is the next most appropriate step in the management of this patient?

A. CT of abdomen/pelvis
B. Surgical consult
C. Ultrasound of abdomen
D. Upper GI series
E. Pediatric gastroenterology consult

Correct Answer: B

The patient in this vignette has signs and symptoms concerning for midgut volvulus. Midgut volvulus causes bowel ischemia and can lead to bowel loss if not treated immediately. While a radiographic study will be needed emergently to demonstrate the volvulus, the surgery team needs to be contacted emergently and the operating room notified in anticipation of operative reduction. Following resuscitation, this is the most appropriate next step so as to minimize any delay and to provide the patient with the best chance for bowel reperfusion.

ABP Content Specification

- Know the etiology and understand the pathophysiology of malrotation of the gut and acute midgut volvulus.
- Recognize signs and symptoms and complications of acute midgut volvulus.
- Plan the management of acute midgut volvulus and potential complications associated with this condition.

Take-Home Message

Midgut volvulus is a surgical emergency that must be suspected in any child presenting with bilious vomiting and shock, and surgical intervention should be expedited.

Question 24

A 16-year-old boy, with a past history of transposition of the great arteries repair in infancy, presents with chest pain and diaphoresis over the past few hours. His vitals upon presentation to the emergency department are as follows: HR, 185 bpm; BP, 95/40; RR, 20; and pulse ox, 99%. He is lethargic and appears confused. He has palpable femoral pulses with a regular rhythm, but his EKG demonstrates a wide QRS with tachycardia. You secure an IV and provide oxygen.

What is the next most appropriate step in the management of this patient?

A. Synchronized cardioversion
B. Defibrillation
C. External cardiac pacing

D. Intravenous adenosine
E. Intravenous lidocaine

Correct Answer: A

The patient in this vignette is experiencing ventricular tachycardia (V-tach). According to the 2015 Pediatric Advanced Life Support guidelines, the management of V-tach is determined by the patient's symptoms and whether a pulse is present. The first important decision in the management is to determine whether a pulse is present. Pulseless V-tach should be treated with defibrillation.

If a pulse is present, the next decision relies on whether the patient is considered stable or unstable. Patients are considered unstable if they are hypotensive, have signs of altered mental status, or have signs of shock. Unstable patients such as the patient in this vignette (e.g., altered mental status) should receive synchronized cardioversion after a dose of intravenous pain medication. Stable patients can be treated with pharmacologic cardioversion after consultation with cardiology.

ABP Content Specification

- Know the indications for cardioversion in resuscitation.

Take-Home Message

Children with unstable V-tach with a pulse should receive synchronized cardioversion.

Question 25

What is the difference between online medical direction and offline medical direction with regards to EMS?

A. Online medical direction allows EMS providers access to the internet and web-based training manuals, whereas offline does not
B. Online medical direction means EMS providers can access a physician to provide orders, whereas in offline they do not have access to a physician
C. Online medical direction means EMS providers can use live video feedback to receive orders from the physician, whereas in offline they have to rely on the telephone or radio to communicate
D. Online medical direction means EMS providers must follow their protocols line-by-line, whereas in offline they can deviate from the protocol based on their best judgment
E. Online medical direction applies only to a mass casualty event, whereas offline applies to all other times

Correct Answer: B

Online medical direction, also known as direct medical direction, allows the EMS provider to communicate directly via radio or telephone with a physician. The physician can then provide real-time direction of the medical care including use of medications. Online medical direction is more dynamic and optimal. Offline medical direction, or indirect medical direction, refers only to the availability of written or electronic protocols for the care of the patient. An EMS system may have online medical direction, offline medical direction, neither or both.

ABP Content Specification

- Differentiate between online (direct) and offline (indirect) medical direction.

Take-Home Message

Online medical direction allows EMS providers to directly communicate with the physician in real time, while offline medical direction involves the use of previously established protocols and guidelines.

Question 26

For which patient would an emergency department thoracotomy be indicated?

A. 10-year-old girl stabbed in the chest who has no pulse in the field and arrives pulseless in the emergency department
B. 17-year-old male who jumped from the 3rd floor of a building. He was unresponsive without a pulse in the field and upon arrival to

the emergency department. He is noted to have ecchymosis over his entire chest

C. 4-year-old girl who suffered a gunshot wound to the head by a stray bullet from a gang fight. The patient is unresponsive and has weak central pulses
D. 6-year-old male stabbed in the chest who initially was talking and had a pulse upon arrival to the emergency department but, during your evaluation, becomes unresponsive and pulseless
E. 14-year-old male who was in a car accident with a seat belt sign, who becomes pulseless 15 minutes prior to arrival in the ED

Correct Answer: D

An emergency department thoracotomy is indicated for patients who have experienced thoracic trauma and lose their vital signs acutely—either while on transport to the emergency department or while in the emergency department. The procedure is not without risks to the physician performing the procedure. There are multiple sharp instruments, sharp broken bones, and a large amount of blood, all of which increase the risk of transmission of blood-borne pathogens. Patient survival after emergency department thoracotomy is generally poor. It is highest for those with a single stab wound to the chest and lowest for those suffering blunt trauma, those pulseless in the field, and when performed by an inexperienced physician.

A risk-benefit decision needs to be made with every patient when considering thoracotomy. In general, patients with penetrating trauma who lose their vital signs in the ED or within minutes of arrival should receive an emergency department thoracotomy. Conversely, patients with blunt trauma who have been pulseless for a long time should not undergo emergency department thoracotomy.

ABP Content Specification

- Know the indications and contraindications for emergency thoracotomy.
- Plan the key steps and know the potential pitfalls in performing emergency thoracotomy.
- Recognize the complications associated with emergency thoracotomy.

Take-Home Message

Survival after emergency department thoracotomy is very low but it can be considered for patients with a single penetrating wound to the chest that become pulseless during transport or in the ED.

Question 27

A 6-year-old boy fell from a tree and injured his head. There was no loss of consciousness. On presentation to your emergency department, he is sleepy but talking and complaining of headache. You note mild ecchymosis over his right mastoid and right-sided hemotympanum. He has normal vital signs with a GCS of 15. He has no CSF rhinorrhea or otorrhea. A head CT demonstrates a basilar skull fracture without pneumocephalus or other intracranial injury. The remainder of the evaluation for trauma is normal. His headache improves and he becomes fully alert during your evaluation. What is the next step in management?

A. Admit to inpatient unit for monitoring
B. Antibiotic prophylaxis
C. Discharge home if no change after observation in ED
D. Admission for operative repair
E. Intravenous mannitol

Correct Answer: C

Basilar skull fractures involve the base of the skull and temporal bone. The classic physical examination signs of a basilar skull fracture include: hemotympanum, ecchymosis over the mastoid process of the temporal bone (i.e., Battle's sign), periorbital ecchymosis (i.e., raccoon eyes), CSF rhinorrhea, and CSF otorrhea. Approximately 50% of the time, children with a basilar skull fracture will have other intracranial injuries.

Children with an isolated basilar skull fracture on CT, however, are at very low risk for any clinically important adverse outcome or surgical intervention. If they have a normal GCS and their symptoms do not progress after a brief observa-

tion period in the ED, they can be safely discharged to follow up closely with a neurosurgeon. Antibiotic prophylaxis is not indicated for basilar skull fractures unless they have CSF rhinorrhea or otorrhea that does not resolve after one week. There is no role for mannitol as there is no increased intracranial pressure.

ABP Content Specification

- Plan the evaluation and management of basilar skull fractures.

Take-Home Message

Children with an isolated basilar skull fracture can be safely discharged home from the ED, provided they have a normal mental status and do not worsen after observation in the ED.

Question 28

A 10-year-old boy with no history of medical problems presents with chest palpitations and dizziness. In the emergency department, his vitals are as follows: HR 200 bpm, RR 20, BP 110/80, Pox 99%, Temp 97 °F. You obtain an EKG which demonstrates a narrow complex tachycardia with no demonstratable P-waves. You administer vagal maneuvers and, when that fails, you give a dose of intravenous adenosine at 0.1 mg/kg. The patient continues to have a HR of 200 bpm, chest palpitations, and dizziness. What is the next step in management?

A. IV Verapamil 0.3 mg/kg
B. Synchronized cardioversion 0.5 to 1 J/kg
C. IV Adenosine 0.2 mg/kg
D. IV Amiodarone 5 mg/kg
E. IV Procainamide 15 mg/kg

Correct Answer: C

The patient in the vignette is experiencing supraventricular tachycardia as demonstrated by a narrow complex tachycardia without P-waves. Pediatric Advanced Life support guidelines recommend to "attempt vagal stimulation first, unless the patient is hemodynamically unstable or the procedure will unduly delay chemical or electric cardioversion." When pharmacologic treatment is needed, adenosine is the drug of choice. Adenosine should be given through an IV as close to the heart as possible. The drug should be pushed through the IV and flushed rapidly. If the first dose of adenosine is ineffective, a second dose should be given at double the dose.

If the second dose of adenosine is ineffective or if the patient becomes unstable, synchronized cardioversion should be used. Pediatric Advanced Life support guidelines also state to "consider amiodarone or procainamide for a patient with SVT unresponsive to vagal maneuvers and adenosine and/or electric cardioversion."

ABP Content Specification

- Know the indications for and pharmacologic action of adenosine.

Take-Home Message

Children with SVT who receive adenosine that is ineffective at the 0.1 mg/kg (maximum 6 mg) dose should receive a second dose of adenosine at 0.2 mg/kg (maximum 12 mg), provided they remain stable.

Question 29

A 17-year-old female presents with diffuse watery diarrhea 2 weeks after returning from Africa. She is 6-weeks pregnant. She appears otherwise well with normal vital signs and a normal physical examination. Her urine pregnancy test is positive. The Giardia antigen test you sent is positive as well.

What should be your treatment for this patient?

A. Oral Azithromycin
B. Oral Metronidazole
C. IV Azithromycin
D. IV Clindamycin
E. No antibiotic therapy

Correct Answer: B

Giardia is a common infection in patients returning from travel to a foreign country, and patients with Giardia often present with a delayed onset of symptoms (>1 week). Antibiotic treatment for most individuals is oral metronidazole. Azithromycin and clindamycin are not effective against Giardia infection. In the past, pregnant teenagers with Giardia infection would present a management dilemma for the pediatric emergency provider. Metronidazole was once thought to be associated with adverse effects on the fetus. More recent evidence suggests that it is safe to use at any stage of pregnancy.

ABP Content Specification

- Plan the management of acute parasitic and fungal gastrointestinal infections.

Take-Home Message

Metronidazole is safe at any stage of pregnancy and is the treatment of choice for Giardia.

Question 30

Which of the following is true regarding varicella vaccination?

A. Less than 5% of patients who receive the varicella vaccine may develop a rash at the site of injection.
B. Pregnancy is not a contraindication to the varicella vaccine.
C. Patients on chronic aspirin therapy may receive varicella vaccination.
D. Vaccination provides complete protection from developing the chickenpox rash.
E. Patients that have been vaccinated with varicella are not susceptible to shingles.

Correct Answer: A

Rash at the site of the varicella vaccine injection may occur, although infrequently (3–5%). Developing a generalized rash after vaccination is similarly uncommon. Varicella vaccination is contraindicated in pregnant women as it is a live virus. Although cases of Reye syndrome have not been reported, varicella vaccination is also contraindicated in patients taking aspirin. In addition, while varicella vaccination is effective at preventing full-blown varicella infection, there is still a small and lower risk of developing herpes zoster (shingles) compared to natural infection. Mild varicella infection from the vaccine strain may also occur in a small number of patients.

ABP Content Specification

- Know the current guidelines for the immunization of children and recognize the most common side effects.

Take-Home Message

Varicella vaccine is a live virus and thus may cause a mild case of varicella after vaccination.

Suggested Reading

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Correction to: Prepare for the Pediatric Emergency Medicine Board Examination

Muhammad Waseem, Isabel A. Barata, Jennifer H. Chao, David Foster, and Noah Kondamudi

Correction to:
M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*
https://doi.org/10.1007/978-3-030-28372-8

This book was inadvertently published with the incorrect city and country on the affiliation of Dr. Noah Kondamudi. This has now been corrected in the book.

The updated online version of this book can be found at
https://doi.org/10.1007/978-3-030-28372-8

M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8_36

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M. Waseem et al. (eds.), *Prepare for the Pediatric Emergency Medicine Board Examination*,
https://doi.org/10.1007/978-3-030-28372-8

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