

Chapter 2

Respiratory System

Thomas J. Mancuso

T.J. Mancuso, MD, FAAP

Senior Associate in Perioperative Anesthesia, Critical Care Medicine and Pain Medicine,
Boston Children's Hospital, Boston, MA, USA

Associate Professor of Anaesthesia, Harvard Medical School, Boston, MA, USA

© Springer International Publishing AG 2017

R.S. Holzman et al. (eds.), *Pediatric Anesthesiology Review*,

DOI 10.1007/978-3-319-48448-8_2

Questions

1. Respiratory syncytial virus (RSV):
 1. Is the second most important lower respiratory tract pathogen in early childhood.
 2. Causes infected cells to form characteristic syncytia.
 3. Confers lifelong immunity after one infection.
 4. Infects well over one million children annually.
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

2. Which of the following is part of the clinical presentation of RSV bronchiolitis?
 1. It is commonly seen in children less than 2 years of age.
 2. Young infants with the illness may have lethargy and apnea.
 3. Respiratory distress (caused by small airway obstruction).
 4. Wheezes, rales, and rhonchi all may be heard on auscultation of the lungs.
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

3. Respiratory syncytial virus (RSV) can cause:
 1. An upper respiratory illness.
 2. Bronchiolitis.
 3. Otitis media
 4. Pneumonia.
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

Answers

1. C, 2, 4

RSV is the most important respiratory tract pathogen in childhood. It is the major cause of bronchiolitis and pneumonia in children less than 1 year of age, although placentally transmitted antibody may offer protection for the first 4–6 weeks of life. RSV is a medium-sized RNA virus that produces characteristic syncytial cytopathology. The occurrence of outbreaks each fall and winter and the very high incidence in the first year of life are characteristics not seen with other respiratory viruses.

2. E. All of the above

Infants and children infected with RSV first present with the rhinorrhea, then cough accompanied by audible and auscultatory wheezing. There is intermittent fever and the clear rhinorrhea persists throughout the illness. Hospitalized infants with RSV have normal CXRs only about 10 % of the time.

3. E. All of the above

RSV most typically causes coryza and pharyngitis, often with fever. In 10–40 % of infected children, there is lower respiratory tract involvement (pneumonia, bronchiolitis). RSV infection is usually an outpatient illness. Generally 1–3 % of infected infants are hospitalized.

4. Infection with RSV:
 1. Is very common among infants.
 2. Often leads to more serious respiratory distress in infants aged 2–6 months.
 3. Occurs in epidemics annually during the months of November through April.
 4. Confers lifelong immunity to the RSV virus.
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

5. The pathologic changes brought about by RSV infection include:
 1. Necrosis of the respiratory epithelium.
 2. Edema of the submucosa.
 3. Destruction of cilia.
 4. Small airway obstruction by edema and necrotic cells.
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

6. Infection with RSV leads to more severe respiratory distress in:
 1. Ex-preterm newborns
 2. Infants with seizure disorders
 3. Children with congenital heart disease
 4. Infants with sickle cell trait
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

7. Treatments for RSV bronchiolitis include:
 1. Amoxicillin
 2. Ribavirin
 3. Racemic epinephrine
 4. Oxygen
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

4. A. 1, 2, 3

Annual epidemics of RSV occur during the 4–5 months of the winter. It is estimated that up to 50 % of susceptible infants undergo infection during each epidemic. Infection is almost universal by the second birthday. Reinfection occurs at a rate of 10–20 % per epidemic throughout childhood with higher rates in day care settings.

5. E. All of the above

The pathology seen in the lung includes necrosis of the respiratory epithelium, mucus secretion, and edema of the submucosa. These changes lead to mucus plugging of the small airways with distal hyperinflation or atelectasis.

6. B. 1, 3

Infection of immunocompromised infants with RSV often results in more severe disease. RSV infection in the first few weeks following bone marrow or solid organ transplant can be as high as 50 %. Children for whom immunoprophylaxis is considered useful are ex-preterm newborns with BPD or CLD and ex-preterm newborns discharged from hospital during RSV season.

7. C. 2, 4

Most hospitalized infants are hypoxemic, requiring humidified oxygen therapy. A trial of inhaled bronchodilators is often undertaken and continued if the clinical status of the child improves.

Antibiotics are not useful in uncomplicated RSV bronchiolitis. They may be indicated if a consolidated pneumonia develops, however. Ribavirin has been shown to have a modest effect on the course of RSV pneumonia, but hospital stay and mortality have not been reduced. Long-term effects are unknown. It is currently recommended only for high-risk infants with RSV such as those with CLD, congenital heart disease, or immunodeficiency.

8. True statements regarding the prognosis for infants with RSV bronchiolitis include:
1. Infants who develop the illness are more likely to have recurrent wheezing later in life.
 2. Approximately 1–2 % of infants hospitalized with this illness die.
 3. Two to 5 % of hospitalized infants with this illness develop respiratory failure.
 4. Anti-RSV antibody administration will dramatically decrease the severity of the illness.
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
9. The differential diagnosis of wheezing in children during the first year of life includes:
1. Bronchiolitis (RSV).
 2. Ataxia-telangiectasia with pulmonary involvement.
 3. Gastroesophageal reflux (GER).
 4. Cystic fibrosis.
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
10. Asthma, a chronic disease of reversible airway obstruction:
1. Is characterized by episodes of recurrent wheezing and coughing
 2. Only rarely has an allergic basis in children
 3. Often begins before the sixth birthday
 4. Is decreasing in prevalence and severity
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above

8. A. 1, 2, 3

Administration of Palivizumab (Synagis), a monoclonal antibody against RSV or RSV-IVIG, high-titer antibody against RSV, is recommended for protecting high-risk infants from serious complications of RSV. It has been shown to reduce total hospital days in this population.

9. E. All of the above

Wheezing is a manifestation of obstruction in the lower respiratory tract in children. There are many etiologies:

Acute wheezing: asthma (intrinsic, exercise, anxiety, or cold induced), infection, airway foreign body, and aspiration of GI, oral secretions

Chronic: asthma (as above), tracheo- or bronchomalacia, airway compression (various vascular compressions, enlarged lymph nodes, tumors), bronchitis, cystic fibrosis, sequelae of RDS (chronic lung disease or bronchopulmonary dysplasia)

10. A. 1, 2, 3

Asthma is the most frequent admitting diagnosis in children's hospitals. Before puberty, males are affected twice as often as females. Thereafter, the incidence is equal. Thirty percent of children who will later be diagnosed as asthmatics are symptomatic by 1 year of age, and 80 % present by the fourth birthday. Although up to 50 % of asthmatic children are nearly symptom-free by 20 years of age, resolution is rare in children with steroid-dependent disease.

11. Airway narrowing in asthma is due to:
1. Thickened basement membranes
 2. Edema of the small airways
 3. Mucus secretion
 4. Increased airway smooth muscle tone
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
12. Causes of wheezing in asthmatic children include:
1. Viral respiratory infections such as RSV infection
 2. Tobacco smoke
 3. Aspirin
 4. Animal dander
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
13. The changes in the small and large airways that occur in asthma lead to:
1. Increased airway resistance, especially noticeable during exhalation
 2. Hypercarbia resulting from decreased respiratory drive
 3. Ventilation-perfusion (V/Q) mismatch due to nonuniform airway involvement
 4. Increased specific compliance due to much lower resting lung volumes
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
14. Pathophysiologic alterations seen in asthmatic children include:
1. Nonuniform small airway obstruction
 2. V/Q mismatch
 3. Decreased lung compliance as a result of hyperinflation
 4. Atelectasis
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above

11. E. All of the above

The airway obstruction in asthma is due to bronchoconstriction, mucus hypersecretion, mucosal edema, cellular infiltration, and also desquamation of epithelial and inflammatory cells within the airways.

12. E. All of the above

Wheezing is a complex process involving autonomic, immunologic, infectious, endocrine, and psychological factors. In children with extrinsic or allergic asthma, wheezing results from exposure to environmental factors, and these patients have increased, IgE against the implicated allergens. Children with intrinsic asthma do not have such antibodies. Viral infections are the most important infectious triggers of asthma (see RSV). Emotional factors may trigger wheezing and children with this chronic disease may suffer emotional consequences from the illness.

13. B. 1, 3

PaCO₂ is generally low early in asthma attacks, rising as the obstruction worsens. PaO₂ is often low during an acute exacerbation and may remain so for several days after the worst of the attack is over. Reversible airway obstruction is a hallmark of asthma, with PEF and FEV₁ increasing at least 10 % following bronchodilator administration.

14. E. All of the above

CXR abnormalities often seen in children during acute exacerbations of asthma include hyperinflation, atelectasis, infiltrates, and pneumomediastinum. PEF and FEV₁ are decreased, often by more than 15 %. ABG abnormalities are described above.

15. Treatment of acute exacerbations of asthma includes:
1. CPAP
 2. Steroids
 3. Cromolyn
 4. Beta-agonists
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
16. Regarding the use of theophylline as a treatment for asthma:
1. The medication has a narrow therapeutic range.
 2. It inhibits phosphodiesterase and is an adenosine receptor antagonist.
 3. It is effective orally and intravenously.
 4. Side effects include sleep disturbances, nausea, vomiting, and headaches.
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
17. Which of the following are common side effects of nebulized albuterol?
1. Nausea and vomiting
 2. Jitteriness, sleep disturbances
 3. Suppression of adrenal secretion
 4. Tachycardia
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
18. Complications of asthma seen in children with asthma include:
1. Pneumothorax.
 2. Pneumonia.
 3. Pneumomediastinum.
 4. Sudden death.
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above

15. C. 2, 4

Therapy of acute asthma is aimed at lessening bronchoconstriction and reducing inflammation. Oxygen is administered by mask or nasal prongs. Bronchodilation is achieved with various inhaled medications such as beta-2 agonists (albuterol) and/or cholinergic antagonists (ipratropium bromide). Systemic corticosteroids are often given for a short course. CPAP will likely worsen air trapping and is avoided. Commonly is useful for prophylaxis, especially with exercise-induced asthma. Cromolyn is a maintenance medication with little use during acute exacerbations.

16. E. all of the above

Theophylline may be given orally as a sustained release preparation for children with moderately severe asthma as an alternative to inhaled steroids or cromolyn. It also may be used IV in the treatment of acute severe asthma. The therapeutic range is 10–20 mg%. Toxicity may be seen with serum levels of 25–30 mg%.

17. C. 2, 4

Other treatments for asthma include:

Ipratropium: a cholinergic antagonist that may cause tachycardia and abdominal pain. Cromolyn: an inhaled powder, which may cause coughing especially when first used. It is used as a preventive measure in asthma, not a treatment of acute exacerbations.

Albuterol: the jitteriness from albuterol usually occurs with excessive use of either the PO or inhaled forms.

18. E. All of the above

Death from childhood asthma is rare, but mortality rates have been increasing. Mortality rates are several times higher in African-American children than in white children.

19. Clinical manifestations of cystic fibrosis include:
1. Productive cough and recurrent respiratory infections
 2. Hemoptysis, pneumothorax, and atelectasis
 3. Maldigestion due to exocrine pancreatic insufficiency
 4. Diabetes insipidus
- A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above
20. Cystic fibrosis, the major cause of severe chronic lung disease in children:
1. Occurs in 1:3,000 white and 1:17,000 black live births
 2. Is characterized by thickened secretions
 3. Primarily involves the pulmonary and gastrointestinal systems
 4. Is inherited as an autosomal dominant trait
- A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above
21. Treatments that patients with cystic fibrosis (CF) might receive include:
1. Pancreatic enzyme replacement, high calorie diets, and fat-soluble vitamin supplements
 2. Antibiotics to control progression of pulmonary infections
 3. Bronchodilator and anti-inflammatory agents
 4. Oxygen
- A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

19. A. 1, 2, 3

CF is characterized by obstruction and infection of the airways and malabsorption of many important nutrients. After 10 years of age, 85 % of children with cystic fibrosis will develop diabetes mellitus. People with CF have varying degrees of the following respiratory tract problems: failure to clear mucus secretions, dehydrated mucus secretions, and chronic infection in the respiratory tract. The rate of progression of lung disease is the chief determinant of morbidity and mortality. The first lung pathology is bronchiolitis, followed later by bronchiectasis. Interstitial disease is not a regular feature although eventually fibrosis does develop. The paranasal sinuses are filled with secretions and the epithelial lining is hyperplastic and hypertrophic. The nasal mucosa is edematous and develops polyps.

20. A. 1, 2, 3

The CF gene is most common in Northern and Central Europeans. It codes for a protein called the transmembrane conductance regulator (CFTR) that is expressed largely in epithelial cells of the airways, GI tract, sweat glands, and GU system.

21. E. All of the above

Antibiotics, given PO, IV and via inhalation, are used to control the progression of lung infection. Steroids are used to treat allergic pulmonary aspergillosis. Anti-inflammatory agents may slow the progression of lung disease.

22. Croup, a clinical syndrome of barking cough, hoarseness, and inspiratory stridor, has several causes, including respiratory viruses. Characteristics of croup include:
1. The illness lasts for 4–6 days.
 2. There is a characteristic CXR finding called the pencil (or steeple) sign indicative of subglottic tracheal narrowing.
 3. Treatment with inhaled racemic epinephrine (0.5 cc of a 2.25 % solution) temporarily improves the stridor.
 4. Dexamethasone, 0.3–0.5 mg/kg, is a treatment for the illness.
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
23. Clinical characteristics of croup (laryngotracheobronchitis) include:
1. Mild temperature elevation, rarely reaching 39 °C
 2. The presence of a URI (upper respiratory infection) for 1–3 days prior to the onset of stridor
 3. A peak incidence during the ages of 18 months to 3 years
 4. A typical barking cough
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
24. Acute epiglottitis presents differently than viral croup in the following way(s):
1. The course of epiglottitis is much more rapid and fulminating.
 2. The temperature elevation in epiglottitis is greater.
 3. The age range of children with epiglottitis is older.
 4. Very often other family members of children with epiglottitis have been ill with URI symptoms.
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above

22. E. All of the above

Croup is the most common form of acute upper airway obstruction and is most commonly caused by a virus. Symptoms are characteristically worse at night. Most children with croup progress to stridor and slight dyspnea and then begin to recover. Agitation and crying, with associated more rapid respiratory rate and turbulent air-flow, worsen the situation. Children with croup prefer to sit upright.

23. E. All of the above

Older children are generally not seriously ill. Other family members may have a mild respiratory illness. The nighttime worsening may recur for several consecutive days before the illness resolves.

24. A. 1, 2, 3

Epiglottitis is usually seen in children aged 2–7 years, while croup is more often seen in younger children. Epiglottitis is caused by bacteria, croup a virus. Other family members are not acutely ill with respiratory viruses as is the case with croup. Epiglottitis is a severe bacterial infection associated with high fever, rapidly progressing airway obstruction, and dyspnea.

25. Aspirated airway foreign bodies:
1. Can usually be seen on either a PA or lateral CXR
 2. Most often occur in 2–4-year-old children
 3. Are usually first noted during an acute URI when the child has more severe symptoms than usual
 4. May not be noted until some time after the aspiration episode
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above
26. Bacterial tracheitis, a cause of upper airway obstruction that occurs as a superinfection of viral laryngotracheitis:
1. Is often caused by coagulase+ Staph or Haemophilus influenzae
 2. Is diagnosed with airway endoscopy
 3. Is regularly treated with endotracheal intubation and IV antibiotics
 4. Is seen only in the teenage years
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above
27. Regarding acute otitis media (AOM) in children:
1. Both bacteria and viruses are known causative agents.
 2. Meningitis is a possible complication of untreated bacterial AOM.
 3. It is generally treated with PO antibiotics.
 4. Infants less than 1 month of age with AOM should be thoroughly evaluated for systemic infection.
 - A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

25. C. 2, 4

Most airway foreign bodies are not radio-opaque and many are actually food, often peanuts. Although up to 50 % of cases of airway foreign body aspiration come to medical attention soon after the aspiration event and the parents give a history of a specific choking episode, a substantial minority of cases are discovered in the evaluation of a child with recurrent wheezing for several months.

26. A. 1, 2, 3

Bacterial tracheitis is one of the laryngotracheal respiratory tract infections affecting children. The others are croup, viral laryngotracheobronchitis, and epiglottitis. Bacterial tracheitis is acute in onset, affects children 4–5 years of age, and is associated with a cough and harsh stridor. Treatment of affected children often involves IV antibiotics, hospitalization, and intubation.

27. E. All of the above

AOM is a very common childhood infection. Management strategies vary. The etiologic agent in a particular case is rarely identified. The tympanic membrane in AOM is red, often bulging, and immobile, and the normal landmarks are not seen. With repeated episodes of AOM or with chronic serous OM, pediatricians often refer their patients to an ORL specialist for myringotomy and tube placement. Untreated AOM can develop into acute mastoiditis, which can destroy the mastoid air cells.

28. Children with acute sinusitis:
1. Have URI symptoms (nasal discharge and cough) that persist for more than 10 days
 2. May have persistent daytime cough
 3. May have facial pain and swelling in association with their URI
 4. May complain of headache
- A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above
29. Regarding URI's in children:
1. Mucociliary dysfunction can persist for weeks after recovery from the URI.
 2. Viral URI's predispose children to bacterial infections such as pneumonia, sinusitis, or otitis media.
 3. Nasal discharge, initially watery, becomes mucopurulent after 5–7 days.
 4. Young infants may develop fever to 38 °C or 39 °C with uncomplicated URI's.
- A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above
30. Children with allergic rhinitis:
1. Often also have conjunctivitis
 2. Have pale edematous nasal membranes
 3. May have nasal polyps
 4. Will have fewer and lessened symptoms during exercise
- A. 1, 2, 3
 - B. 1, 3
 - C. 2, 4
 - D. 4 only
 - E. All of the above

28. E. All of the above

Sinusitis often accompanies the common cold or even allergic rhinitis. The maxillary, ethmoid, and sphenoid sinuses are present at birth, and the frontal sinuses develop at around the first birthday. These sinuses gradually become air filled over the first several years of life. Affected children have persistent purulent nasal drainage, nighttime cough, and facial tenderness and pain. Treatment is with PO antibiotics unless extension from the sinuses is considered a possibility.

29. E. All of the above

The common cold or viral URI is a frequent problem in children. These occur most often in the winter months, from early fall through late springs. Toddlers and young school-aged children can have up to six to nine colds/year. The number/year decreases, with most adults reporting 1–3/URI's year.

30. A. 1, 2, 3

The differential diagnosis of rhinitis in children includes sinusitis, viral URI, nasal foreign body, and allergic rhinitis. Children with allergic rhinitis do not have fever but often have allergic “shiners,” nasal polyps, and pale edematous nasal mucosa.

31. Regarding URI's in children:
1. The incidence is highest between the ages of 6–8 years.
 2. School-aged children normally experience one to two colds/year.
 3. Boys have more URI's than girls.
 4. Among children aged 1–4 years, those in day care have fewer URI's than those cared for only at home.
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
32. Which of the following causes pharyngitis most often?
- A. *Mycoplasma pneumoniae*
B. Rhinovirus
C. Adenovirus
D. *Haemophilus influenzae*, untypeable
E. Beta-hemolytic strep
33. Which of the following are considered etiologic agents for the common cold in children?
1. Parainfluenza viruses
 2. Group B beta-hemolytic streptococci
 3. Respiratory syncytial virus
 4. *Haemophilus influenzae* type B
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above
34. Influenza viruses:
1. Can cause primary pneumonia
 2. Cause epidemic respiratory infections
 3. Are spread from person to person via the respiratory route
 4. Confer lifelong immunity to all strains after one symptomatic infection
- A. 1, 2, 3
B. 1, 3
C. 2, 4
D. 4 only
E. All of the above

31. B. 1, 3

A viral URI typically lasts only 7 days with a minority lasting up to 2 weeks. As the URI resolves, the nasal secretions change from clear and thin to a thicker and yellow-green consistency.

32. C. Adenovirus

In children less than 2 years of age, the cause for pharyngitis is usually viral, whereas in children over 5 years of age group, a strep is the most common causative agent. Making the diagnosis of Strep pharyngitis is important because appropriate antibiotic treatment will prevent rheumatic fever as well as minimize the chance of local suppurative complications such as abscess formation. Diagnosis is with rapid antigen detection or throat culture. Antibiotic treatment does not, however, prevent the development of poststreptococcal glomerulonephritis.

33. B. 1, 3

The common cold in children is caused by a variety of viruses. It is not a bacterial infection and thus not treatable with antibiotics. Bacterial complications of viral URIs include sinusitis, otitis media, and pneumonia. There is no therapy for the common cold save symptomatic measures, and most over-the-counter medications sold for URI treatment have not been shown to be effective in reducing the symptoms.

34. A. 1, 2, 3

Influenza A viruses are responsible for epidemics. These epidemics follow a shift in one of the major antigens, neuraminidase, or hemagglutinin. The clinical picture in young children is milder than that seen in adults. Young children may exhibit bronchitis, laryngotracheitis, and/or mild upper respiratory tract symptoms. Older children and adults have high fever of abrupt onset, myalgias, chills, and cough. The cough and congestion may last for 2 weeks.