

Initial Trauma Assessment

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Assessment of the traumatized child must proceed in a standardized and systemic fashion. Assessment and immediate treatment of life-threatening conditions occur simultaneously.

1. In general, the Advanced Trauma Life Support (ATLS) approach to the evaluation and prioritization of trauma patients is applicable for pediatric patients. A primary survey, followed by the secondary survey, should be completed promptly.
 - (a) As one proceeds through these components of trauma resuscitation, thought must be given to the age-specific anatomic and physiologic differences (infant vs. toddler vs. adolescent etc.)
 - (b) Ideally, the provider should review the normal vital signs by age prior to the patient's arrival in order to properly assess for the presence of shock upon the patient's arrival.
 - (c) Broselow Tape (Armstrong Medical, Lincolnshire, IL) should be laid out on the Emergency Department (ED) bed, preferably prior to the patient's arrival. If given pre-hospital information regarding age and/or weight, the provider should review weight-based dosing and equipment sizes in order to provide expeditious interventions.
2. Pre-hospital personnel and communication:
 - (a) Pediatric trauma patients may present via helicopter, ambulance, or "walk-ins" to the ED.
 - (b) As in the case of adult trauma, the emphasis in pre-hospital care is:
 - (i) Airway.
 - (ii) Control of bleeding.

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- (iii) Shock management.
 - (iv) Immobilization.
 - (v) Minimizing scene time.
- (c) Information gathering is crucial to providing appropriate care upon the patient's arrival to the trauma bay. Pre-hospital personnel should relay the mechanism of injury, as this can often suggest the degree of injury, as well as specific injuries for which the child should be evaluated. Other pertinent details should be reported such as time of injury, care received, and patient history.
3. Stabilization of the cervical spine:
- (a) As with adults, you should assume that the injured child has a cervical spine injury until proven otherwise.
 - (b) For infants, there is minimal offset between the occiput and thorax. In addition to airway-positioning considerations, this creates challenges in cervical spine immobilization techniques which vary based on the age, level of cooperation, and habitus of the child.
 - (i) Unconventional adjuncts are sometimes needed to assist with immobilization of an injured infant or toddler. These may include towel rolls, sheets, pillows, long spine boards, papoose devices, etc.
 - (ii) The best approach to cervical spine immobilization in the uncooperative pediatric patient is a combination of one or more of the above adjuncts AND a 2-piece rigid cervical collar, such as the Miami J (Ossur Americas, Foothill Ranch, CA) junior sizes for under 12-years-old.
4. "ABCDE" primary survey:
- (a) Airway:
 - (i) Establishing a patent airway is the first priority, always. Failure to maintain a patent airway and subsequent hypoxia is the most common cause of cardiac arrest in children.
 - (ii) Weight and aged based equipment size references (endotracheal tube, laryngoscope, bag-valve, etc.) are available in the trauma bay, and ideally should be in plain view prior to the patient's arrival.
 - (iii) A neutral position for the infant and toddler is NOT the "sniffing position". Flexion should be avoided in these patients, and thus the mid-face should be parallel to the spine board. Padding placed beneath the torso will help to compensate for the disproportionate head size and prominent occiput of young children.
 - (iv) There are distinct and vital differences in the pediatric airway. This includes:
 1. Large oropharyngeal soft tissue (tongue, tonsils).
 2. Funnel-shaped larynx - allowing secretions to accumulate in the retropharyngeal space.

3. Anterior/cephalad larynx.
4. Shorter trachea (5 cm in infants, 7 cm in 18-month-old) – allowing for easy main-stem bronchus intubation or tube dislodgement.

(b) Breathing:

- (i) Again, hypoxia is the most common cause of cardiac arrest in children.
- (ii) Normal respiratory rates vary widely based on age. For example, a 1-month-old should have a rate of 30–50 bpm, and a 2-year-old would be 18–30 bpm. Pulse oximetry, capnography, blood gas values, etc. will also assist in monitoring ventilation efforts.
- (iii) As with adults, needle decompression, tube thoracostomy, and surgical airways should be considered for the child with inadequate ventilation despite a seemingly patent upper airway.
- (iv) Normal spontaneous tidal volumes are 6–8 mL/kg for infants and children; however, the patient will likely require slightly larger volumes (7–10 mL/kg) during assisted ventilation.

(c) Circulation:

- (i) Be wary of the pediatric patient's ability to show little sign of impending decompensated shock. Tachycardia and/or diminished skin perfusion may be the only signs of deterioration. Systolic blood pressure alone may not reveal hemorrhage even after a loss of 30 % of circulating blood volume.
- (ii) Weight-based fluid resuscitation should be utilized when needed. Blood volume is approximated as 80 mL/kg. Warm isotonic crystalloid should be given as a 20 mL/kg bolus for suspected shock, up to a total of three boluses. Non-responders should be considered for blood transfusion and/or operation.

(d) Disability:

- (i) Identify the child's level of consciousness. Almost as a rule in pediatrics, a child who is quiet or stoic in the presence of stress/pain instills a higher level of concern for life-threatening trauma.
- (ii) The Glasgow coma scale (GCS) is used in pediatrics just as in adult trauma patients. A pediatric version of the GCS is utilized for younger and/or non-verbal children. The score range is 3–15, same as with adults (Table 1).

(e) Exposure:

- (i) Children should be completely exposed and examined, including the removal of all clothing and diaper. Avoid thermal energy loss as the infant/toddler will have a high body surface area to body volume ratio. Warmed blankets should be readily available, and they should be applied as soon as the primary survey is completed.

Table 1 Pediatric and adult Glasgow coma scale

Criteria	Infant	Child	Adult	Score
Eye opening	Spontaneous	Spontaneous	Spontaneous	4
	Verbal stimulus	Verbal stimulus	Verbal stimulus	3
	To pain	To pain	To pain	2
	None	None	None	1
(Criterion total)				(1–4)
Verbal response	Coos, babbles	Oriented, appropriate	Oriented	5
	Irritable cries, consolable	Confused	Confused	4
	Inconsolable, moans	Inappropriate words	Inappropriate words	3
	Inconsolable, agitated	Incomprehensible	Incomprehensible	2
(Criterion total)				1
Motor response	None	None	None	(1–5)
	Spontaneous, purposeful	Obeys command	Obeys command	6
	Withdraw to touch	Localizes pain	Localizes pain	5
	Withdraw to pain	Withdraw to pain	Withdraws to pain	4
	Flexion to pain (decorticate posture)	Flexion to pain (decorticate posture)	Flexion to pain (decorticate posture)	3
	Extension to pain (decerebrate posture)	Extension to pain (decerebrate posture)	Extension to pain (decerebrate posture)	2
(Criterion total)	None	None	None	1
Total GCS				3–15

5. Vital signs and monitoring:

- (a) The Provider should utilize a multi-modal monitoring approach for a child just as they would for an adult. Urine output, vital signs, labs/ABG/i-STAT (Abbott Laboratories, Abbott Park, IL), nasogastric tube, electrocardiogram (ECG), ventilation monitoring, and frequent re-assessment are the mainstay for the monitoring of trauma patients.
- (b) Normal urine output:
 - (i) Infants – 2 mL/kg/h.
 - (ii) Younger children – 1.5 mL/kg/h.
 - (iii) Older children – 1 mL/kg/h.
- (c) Pediatric normal vital signs: (Table 2)

Table 2 Pediatric normal vital signs

Age	Weight (kg)	Heart rate	Systolic BP	Respiratory rate
Preterm	<2.5	120–180	40–60	55–65
Neonate	3	90–170	50–90	40–60
1 month	4	110–180	66–104	30–50
6 months	7	110–180	72–110	25–35
1 year	10	80–160	72–110	20–30
2–3 years	12	90–150	74–124	18–30
4–5 years	17 kg	65–135	79–119	18–30
6–8 years	24 kg	70–115	77–118	18–24
8–10 years	28 kg	65–110	80–118	18–22
10–12 years	35 kg	55–110	84–131	14–22
13–14 years	50 kg	55–110	92–140	12–20
15–18 years	70 kg	55–110	100–140	12–20

6. Life threatening injuries should be promptly identified during the primary survey. Rapid correction of these injuries requires immediate intervention. Some of the injuries which may require immediate intervention while completing the primary survey include:

- (a) Airway obstruction.
- (b) Respiratory arrest.
- (c) Tension pneumothorax.
- (d) Sucking chest wound.
- (e) Flail chest.
- (f) Arrhythmia.
- (g) Ongoing hemorrhage.
- (h) Pericardial tamponade.
- (i) Shock.

7. Secondary survey:

- (a) Obtain further information regarding mechanism of injury.
- (b) AMPLE history.
 - (i) Allergies.
 - (ii) Medications.
 - (iii) Past medical history.
 - (iv) Last meal.
 - (v) Environment of injury.
- (c) Head to toe evaluation searching for all injuries.
- (d) Includes log-rolling patient to check back.
- (e) Rectal examination to check for blood, tone, and high-riding prostate.
- (f) Examination of all extremities for bony stability, motor, and sensory function.

8. Adjuncts to care:

(a) IV access:

- (i) Common peripheral sites for IVs in children are the antecubital fossa and saphenous veins, though many other options exist in the extremities, jugular veins (requires: long neck, stable airway, stable c-spine), and scalp (infants). Two large-bore IVs is needed in the case of major trauma.
- (ii) If unsuccessful at gaining peripheral vein access within 90 s or three attempts, then intraosseous (IO) access should be considered, particularly in the unstable patient. This is typically performed using the anterior tibial access.
- (iii) If an IO approach is not an option or is unsuccessful, a femoral venous line may be utilized. The final option, and the least time-efficient, is a venous cut-down (typically the saphenous vein at the ankle).

(b) Foley catheter:

- (i) Sizes by age are available on the Broselow Tape. Ranges from 5 French to 12 French (Table 3).
- (ii) A relative contraindication exists if blood is present at the urethral meatus, or if there are other reasons to suspect genitourinary injury.

(c) Laboratory tests:

- (i) Due to lower total blood volumes in children, a minimalist approach should be used when ordering lab work for the pediatric trauma patient.
- (ii) Labs should be requested individually based on suspicion of injury due to signs, symptoms, or mechanism. One should NOT routinely order a full “trauma panel”.
- (iii) Trauma panel: CBC, electrolytes, LFT’s, amylase/lipase, PT/INR/APTT, ethanol, drugs of abuse, lactic acid, urinalysis, type and hold specimen for blood bank.

9. Radiographic evaluation:

(a) FAST (Focused Assessment with Sonography for Trauma).

- (i) Rapid ultrasound exam of the RUQ, LUQ, subxiphoid region, and pelvis.
- (ii) This is used routinely for children just as with adults.

Table 3 Foley catheter size estimation

Age group	Foley size (Fr.)
Infant	5–6
Toddler	8
5–11-years-old	10
11–18-years-old	12

- (b) Chest and pelvis x-ray.
 - (i) May be omitted if the child is stable and without apparent injury to these regions, such as in the case of isolated head trauma.
 - (ii) May be simplified by combining the chest and pelvis with a single “baby-gram” for small children and infants.
- (c) CT:
 - (i) Due to the harmful risks from radiation, a minimalist approach should be employed when ordering CT scans in children.
 1. For patients without signs, symptoms, or mechanism for multi-system trauma, order studies by body location rather than panels.
Examples:
 - (a) Chest versus chest/abdomen/pelvis.
 - (b) Head versus head/c-spine.
 2. Plan ahead of time for sedation when needed, as younger children and infants may require some degree of sedation for studies to be completed.
 3. Obtain CT scans when needed, while balancing the immediate risk of missing an injury against the future risk of a cancer caused by ionizing radiation.