

Trauma

Background:

- Trauma is the leading cause of mortality in children.
- Blunt injury accounts for approximate 90% of all pediatric trauma and may result in multisystem injury.
- Challenges in pediatric trauma management include:
 - Inability of small children to communicate effectively.
 - Small airways at risk for compromise with even minimal airway edema.
 - Disproportionately large heads and thinner cranium increases risk for parenchymal brain injury.
 - Cervical spine flexibility increases risk of spinal cord injury without radiographic abnormality (SCIWORA).
 - Compliant chest wall increases risk for pulmonary injury without bony disruption.
 - Spleen and liver are less protected by the rib cage.
- Identifying the injury mechanism, extent (single or multiple areas), type (blunt, penetrating), and severity are necessary to guide management and disposition.
- Younger and more seriously injured children have improved outcomes at pediatric trauma centers.
- For suspected or known non-accidental trauma:
 - Notify the Center for Child Protection (616-391-1242), local law enforcement, and Child Protective Services.

Signs and Symptoms:

- Given the challenges noted above, a thorough multisystem evaluation is imperative.

Evaluation:

- Utilize Advanced Trauma Life Support (ATLS) guidelines.
- Primary survey: Identify and address life-threatening conditions.
 - A: Airway maintenance and cervical spine protection.
 - B: Breathing and ventilation.
 - C: Circulation and hemorrhage control.
 - D: Disability (evaluation of neurologic status)
 - E: Exposure (complete visualization)/environmental control (prevention of hypothermia).

Glasgow coma scale and pediatric Glasgow coma scale

Sign	Glasgow Coma Scale ^[1]	Pediatric Glasgow Coma Scale ^[2]	Score
Eye opening	Spontaneous	Spontaneous	4
	To command	To sound	3
	To pain	To pain	2
	None	None	1
Verbal response	Oriented	Age-appropriate vocalization, smile, or orientation to sound, interacts (coos, babbles), follows objects	5
	Confused, disoriented	Cries, irritable	4
	Inappropriate words	Cries to pain	3
	Incomprehensible sounds	Moans to pain	2
	None	None	1
Motor response	Obeys commands	Spontaneous movements (obeys verbal command)	6
	Localizes pain	Withdraws to touch (localizes pain)	5
	Withdraws	Withdraws to pain	4
	Abnormal flexion to pain	Abnormal flexion to pain (decorticate posture)	3
	Abnormal extension to pain	Abnormal extension to pain (decerebrate posture)	2
	None	None	1
Best total score			15

The Glasgow coma scale (GCS) is scored between 3 and 15, 3 being the worst, and 15 the best. It is composed of three parameters: best eye response (E), best verbal response (V), and best motor response (M). The components of the GCS should be recorded individually; for example, E2V3M4 results in a GCS of 9. A score of 13 or higher correlates with mild brain injury; a score of 9 to 12 correlates with moderate injury; and a score of 8 or less represents severe brain injury. The pediatric Glasgow coma scale (PGCS) was validated in children 2 years of age or younger.

Data from:

1. Teasdale G and Jennett B. Assessment of coma and impaired consciousness. A practical scale. *Lancet* 1974; 2:81.
2. Holmes JF, Palchak MJ, MacFarlane T, Kuppermann N. Performance of the pediatric Glasgow coma scale in children with blunt head trauma. *Acad Emerg Med* 2005; 12:814.

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- Secondary survey: Systematic head-to-toe evaluation, past medical history, allergies, medications, time of last meal, events leading up to the injury.
- Labs: CBC, electrolytes, type and cross, LFTs, coags, amylase and lipase.
- Focused Assessment with Sonography for Trauma (FAST) exam: Rapid ultrasound exam of four abdominal locations (right and left upper quadrant, subxiphoid region, pelvis).
- Imaging: CXR, lateral C-spine XR, head CT.

Management:

Initial trauma management in children with severe multiple trauma

Timeline	Assessment	Management*
0 minutes		
	Mobilize trauma resources	Immobilize C-spine Assess vital signs
	Airway	
	Identify:	
	Obstruction	Open airway: suction secretions Administer 100 percent O2
	Midface fracture/difficult airway OR Direct airway injury	Surgical airway
	Breathing	
	Identify:	
	Tension pneumothorax	Needle decompression; place chest tube
	Massive hemothorax	Place chest tube
	Open pneumothorax	Apply 3-sided occlusive dressing
	Flail chest	Perform bag-valve-mask ventilation
	Impaired oxygenation/ventilation	Rapid sequence endotracheal intubation
	Circulation	
	Identify:	
	Absent circulation	Cardiac compressions, thoracotomy IF witnessed arrest
	External hemorrhage	Control external hemorrhage
	Signs of shock	Secure IV access; obtain laboratory studies Fluid resuscitation*
	Cardiac tamponade	Pericardiocentesis followed by thoracotomy
Pelvic fracture	Wrap or bind pelvis	
Disability		
Identify:		
Level of consciousness (GCS)	Endotracheal intubation for rapidly declining GCS, GCS ≤8 or herniation ^Δ	
Pupillary response	Elevate head of bed to 30° if no signs of shock	
Signs of spinal cord injury	Moderate hyperventilation (pCO2 30-35) Neurosurgical consultation Administer osmotic agents if normotensive	
Exposure		
Identify:		
Hypothermia	Remove clothing Initiate rewarming	
5 minutes		
	Repeat vital signs every 5 minutes	Continue care of airway, breathing, circulation, and disability
	Reassess response to interventions	Proceed to intraosseous or central venous access if peripheral IV access unsuccessful
	Intubated patients:	
	Monitor end-tidal CO2	Gastric tube placement
Obtain blood gas	Perform thoracotomy in patients who lose vital signs during resuscitation	
15 minutes		
	Reassess response to interventions	Continue care of airway, breathing, circulation, and disability
	Reassess level of consciousness	Logroll patient and remove spine board
	Examine head, neck, chest, abdomen, pelvis, and extremities	Provide analgesia
	Obtain screening radiographs (lateral c-spine, AP chest, AP pelvis)	Place urinary catheter IF no signs of urethral disruption
	Operative management for patients who remain hemodynamically unstable despite rapid blood infusion per trauma surgeon	
	Persistently hypotensive patients: FAST examination, if available	
20 minutes		
	Reassess response to interventions	Provide analgesia Splint fractures
	Reassess level of consciousness	Update tetanus immunization, as needed
	Perform complete PE (secondary survey)	Antibiotics for open fracture, contaminated wounds, or suspected bowel perforation
	Repeat selected laboratory studies (eg, hematocrit, blood gas, glucose)	Determine need for emergent life or limb-saving operative procedures
	Computed tomography of head, neck, chest, abdomen, or pelvis, as indicated by clinical findings	Transition to definitive care at a regional pediatric trauma center

pCO2: partial pressure of carbon dioxide; O2: oxygen; GCS: Glasgow coma scale; FAST: focused abdominal sonography for trauma.

* Clinicians should always perform actions in RED.

• Administer 20 mL/kg of warmed normal saline or Ringer's lactate over 10 to 20 minutes.

Δ Signs of herniation include coma, unilateral pupillary dilation with outward eye deviation followed by hemiplegia, hyperventilation, Cheyne-Stokes respirations, and/or decerebrate or decorticate posturing.

- Consult Pediatric Trauma and Pediatric Critical Care.
- For impending respiratory failure: See Supplemental Oxygen & Airway Management section in Preparing to Transport.
- For shock: See Sepsis and Septic Shock section in Infectious Emergencies.
- For seizure activity: See Seizure and Status Epilepticus section in Neurologic Emergencies.
- For suspected cerebral edema or elevated ICP (abnormal respiratory pattern, hypertension, bradycardia): Mannitol (1 g/kg/dose) IV once over 20 minutes [in-line filter set (≤ 5 micron) should always be used for mannitol concentrations $\geq 20\%$].