Pediatric Trauma I

EMC 420: Maternal & Child Emergency Care

D. Trigg, MD

Objectives

- Describe unique anatomic and physiologic characteristics of the pediatric age group that affect response to injury and management.
- Define concepts of the primary and secondary surveys.

Objectives (2 of 2)

- Discuss management priorities based on life-threatening injuries identified in the primary survey.
- Discuss the identification and initial treatment of life-threatening injuries to major organ systems.
- Review relevant issues of injury prevention.

Case Study 1: "Struck by Car"

- 5-year-old previous healthy boy is struck by a car while crossing street
- He is thrown 15 feet from the vehicle.
- Appearance is unresponsive, work of breathing is tachypneic without retractions, circulation to skin is pale

Trauma Assessment

- Proceeds in a logical sequence to evaluate and treat life and limb threatening injury
  - Initial assessment (primary survey)
    - Pediatric Assessment Triangle (PAT)
    - ABCDEs (F- family)

Initial Assessment

PAT:

- Abnormal appearance, normal breathing, abnormal circulation

Vital signs:

- HR 160, RR 36, BP 80/65, Wt 20 kg

Case Progression (1 of 2)

- Paramedics stabilize spine, administer 100% oxygen by face mask
- IV placed en route and 100 mL NS infused prior to arrival in ED

Case Progression (2 of 2)

- On arrival in ED, patient continues to be unconscious, tachypneic, diaphoretic, and pale.

What are anatomic and physiologic differences that impact your care of the pediatric trauma patient?

Background (1 of 4)

Anatomy/Physiology

- Overall smaller size, more compact organs
- Proportionately larger head
- Smaller, narrower, funnel-shaped upper airway
- Flatter facets joints, more elastic cervical ligaments

Injury Response

- Multiple injuries more common
- Higher frequency of head trauma
- Higher frequency of soft-tissue obstruction
- Greater propensity for spinal cord injury without radiologic abnormality (SCIWORA)

Background (3 of 4)

Anatomy/Physiology

- Thinner chest wall, more flexible ribs
- Horizontal ribs, weaker intercostals
- More mobile mediastinum
- Abdominal organs more anterior and less subcutaneous fat

Injury Response

- Higher frequency of pulmonary injury
- Young children are diaphragm breathers
- Tension pneumothorax poorly tolerated
- Higher risk of intra-abdominal injury and bleeding

Background (4 of 4)

Anatomy/Physiology

- Softer bones, thicker periosteum
- Active, unfused bony growth plates
- Compensatory vasoconstriction
- Larger body surface area/mass ratio

Injury Response

- Higher frequency of incomplete fractures
- Disturbed growth after growth plate fractures
- Normal blood pressure with early shock
- Greater heat loss from exposed body surfaces

Initial Assessment (1 of 2)

A: Open, increased secretions, trachea midline

B: Rapid, symmetric, poor tidal volume, no retractions, equal breath sounds

C: Pale diaphoretic skin, pulse thready, capillary refill time 5 sec

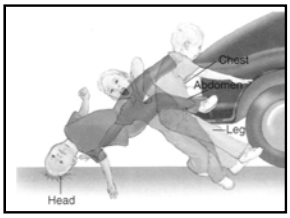
Initial Assessment (2 of 2)

D: GCS 5, pupils midposition and sluggishly reactive

E: Forehead abrasion, left elbow deformity, left flank abrasion, distended abdomen, left thigh deformity

Waddell Triad

- Closed head injury
- Intraabdominal injury
- Midshaft femur fracture



Question

What is your general impression of this patient?

General Impression

- Multiply and critically injured
  - Decompensated shock and traumatic coma

What are your management priorities?

Case Discussion: Management Priorities

- Contact surgeon early.
  - Do not delay management of patient but contact the surgeon prior to patient's arrival if possible.

Management Priorities

- Life-sustaining therapies are guided by findings on initial assessment.
  - Relieve airway obstruction.
  - Support ventilation, oxygenation.
  - Restore circulating volume.
  - Prevent neurologic deterioration.
- Injury-treating therapies are guided by the findings on detailed physical exam.

Case Progression: Management Priorities (1 of 5)

- Suction airway.
- Begin RSI and endotracheal intubation
  - Indications: Decompensated shock, need for neurologic resuscitation (GCS ≤9)

Case Progression: Management Priorities (2 of 5)

- Pharmacologic agents to facilitate ETI
  - Etomidate (reduces ICP and no change in BP)
  - Lidocaine (reduces ICP)
  - Atropine (prevents bradycardia)
  - Succinyl choline or rocuronium (paralytic)
- Followed by lorazepam or other agent for continued sedation

Case Progression: Management Priorities (3 of 5)

- Begin mild hyperventilation and observe for change in pupillary status; reassess with ABG (target PCO_2 30-35 mmHg).
- *More is not better!*

Case Progression: Management Priorities (5 of 5)

- Fluid resuscitation with saline 20 mL/kg rapidly x 2
- Begin O-blood transfusion 10 mL/kg
- Obtain blood for type and cross (priority), hemoglobin, electrolytes, renal and liver function tests, amylase, glucose, prothrombin time (PT) and partial thromboplastin time (PTT)

Case Progression

- Initial hemoglobin 10 gm/dL drops to 7 gm/dL after fluid resuscitation and up to 9 gm/dL after 400 mL of PRBCs
- LFTs elevated
  - ALT 100 IU/L
  - AST 80 IU/L

Further Management Priorities

- Perform complete trauma exam.
- Place urinary catheter.
- Place naso- or orogastric tube.
- Family informed of patient's condition

Case Progression (1 of 2)

- Urine 2+ blood, microscopic evaluation with 50 RBCs per hpf
- Nasogastric tube drains gastric contents and air, no blood noted
- Reassessment shows HR decreased to 120 and patient more responsive

Case Progression (2 of 2)

- After 2 units of PRBCs and 600 mL of saline, HR=120; patient somewhat agitated

Does this patient meet an indication for surgery?

Does this patient meet an indication for surgery?

- No.
  - Although patient presented in decompensated shock, initial resuscitation stabilized the patient.

Epidemiology

- Trauma is leading cause of death and disability in children worldwide.
- Most common injuries:
  - Infants: Physical abuse
  - Preschoolers: Falls
  - School aged: Motor vehicle collision – pedestrian or bicyclist
- Differences in anatomy, physiology, mechanism drive differences in injury pattern, response.

Pathophysiology

- Pediatric trauma can cause respiratory, circulatory, and neurologic failure.
- Three major presentations:
  - Most common: Bony injury
  - Less common: Head injury
  - Least common: Multiple injury
- Pediatric trauma can harm airway and breathing because most pediatric trauma involves the head.

Clinical Features: Respiratory Failure

- Tachypnea or bradypnea, ↑↑ or ↓ work of breathing, grunting, head bobbing, cyanosis, marked hypoxemia
  - Administer 100% O_2 via bag-mask or tracheal tube.

Clinical Features: Tension Pneumothorax

- Tachypnea, hypoxemia, ↓ BP, ± JVD, ± absent breath sounds, tracheal shift
  - Perform needle decompression.
  - Place chest tube.
  - Do *not* wait for CXR!

Clinical Features: Hemorrhagic Shock (Compensated)

- ↓ peripheral pulses, tachycardia, cool extremities, normal or ↑ BP
  - Apply direct pressure over bleeding site.
  - Do not blindly clamp vessels.
  - Infuse crystalloid fluid.

Clinical Features: Decompensated Shock

- Absent peripheral pulses, tachycardia or bradycardia, delayed capillary refill, ↓ BP
  - Infuse crystalloid fluid followed by packed red blood cells.

Clinical Features: Neurogenic Shock

- ↓ BP with warm flushed skin, spinal shock (↓ DTRs, ↓ sensory level, flaccid sphincters, hypotonia)
  - Infuse crystalloid fluid.
  - Consider adding vasopressor agents.

Clinical Features: Cardiac Tamponade

- Tachypnea, tachycardia, ↓ BP, ± JVD, ± muffled heart sounds
  - Perform pericardiocentesis.

Clinical Features: Traumatic Asphyxia

- Petechiae of head and neck, subconjunctival hemorrhages, occasionally ↓ LOC

Case Progression

- Continue secondary survey and complete detailed physical examination.
- Obtain radiographs of cervical spine, left elbow, and left femur.

Controversies in Management

- Use of hypertonic saline to decrease impact of increase in ICP has recently been shown to have promising results.
  - Reduced complications and ICU stays for children with GCS <8
- Consult with neurosurgery before initiating hypertonic saline resuscitation.

Case 1: Conclusion

- Understanding the differences in anatomy and physiology between adults and children is imperative to appropriate trauma management.
- Pediatric patients subjected to whole body force, such as a pedestrian struck by a car, are more likely to suffer multiple traumatic injury than adults.

Case Study 2: "Dazed"

- 8-year-old boy brought to primary care physician with complaint of being dazed and confused 30 min after tackle in football practice
- Has vomited three times since
- Patient is sleepy but appropriate, breathing without retractions, color is normal

Initial Assessment

PAT:
- Abnormal appearance, normal breathing, normal circulation

ABCDEs:
- Normal

Vital signs:
- HR 100, RR 20, BP 120/70, T 37.6ºC, Wt 26 kg

Questions

What is your general impression of this patient?

What are your management priorities?

General Impression

- Primary CNS/closed minor head trauma
- Management priorities are to assess for cervical spine injury and transfer to ED via EMS.

Case Progression

- After arrival in ED, patient continues to have nausea and vomits again.

What value are CT scan of the head in patients with minor head trauma?

AAP Practice Guidelines (1 of 2)

- Children with Minor Head Trauma (>2 years of age), 1999
  - Includes children with GCS=15, normal neurological exam, no evidence of skull fracture
- Children with minor head injury and no LOC – without other symptoms: No need for CT

AAP Practice Guidelines (2 of 2)

- Children with minor head injury and brief LOC (< 1 minute) with associated symptoms: Consider CT or observation
- Children with minor head injury and LOC with or without associated symptoms: CT

Epidemiology (1 of 3)

- Head trauma is one of the most common childhood injuries.
  - 500,000 emergency department visits per year
  - 95,000 hospital admissions
  - 7,000 deaths
  - 29,000 permanent disabilities

Epidemiology (2 of 3)

- Hospital care costs >$1 billion annually
- Falls are the most common mechanism (37%) for head trauma.
- Severe head trauma caused by motor vehicle collisions in children.
- In younger children and infants, most common cause is child maltreatment.

Epidemiology (3 of 3)

- Minor head trauma > 50% of all head injuries.
  - Risk of intracranial injury in infants and children with normal level of consciousness and minor head trauma is less than 1%

Background (1 of 2)

- There is no standard definition for minor head trauma.
- The term “minor head trauma” may refer to cases in which children have GCS scores of 13 to 15.

Background (2 of 2)

- The AAP defines children with minor head injury as:
  - “Those who have normal mental status at the initial examination, who have no abnormal or focal findings on neurologic examination, and who have no physical evidence of skull fracture.”

Anatomical Considerations

- Head-to-body ratio is greater.
  - Can result in more falls to head and also changes location of cervical injuries to higher in cervical spine
- Head comprises up to 10% of body mass.
- Brain less myelinated, results in greater sensitivity to shearing forces
  - May explain impact seizures

Anatomical Considerations

- Cranial bones thinner, resulting in greater transmission of a single force to brain
- Non-fused sutures makes skull easily deformable

Head Trauma History

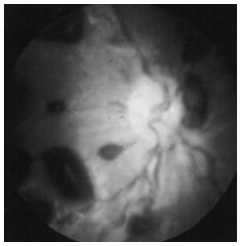
- Age of patient
  - Infants **< 3 months** of age at high risk
- Mechanism of injury
  - Falls **> 3 feet** at higher risk
- Associated signs and symptoms
  - Did infant or child cry right away?
  - Loss of consciousness
  - Vomiting
  - Further alteration in normal behavior
- Underlying medical problems

Neurological Assessment

- Level of consciousness
- Pupillary findings
- EOMs
- Gross motor and sensory exam
- Deep tendon reflexes
- Brainstem reflexes
- Funduscopic examination

Retinal Hemorrhages

- Retinal hemorrhages are seen in <1% of serious unintentional head injury but commonly seen in intentional injury.



Neurological Assessment

- Posturing indicates severe brain injury.

Clinical Features

- Infants and children < 2 years of age represent a group with special challenges.
  - High risk of skull fracture and intracranial injury

TABLE 9-6 Indications for Obtaining a CT Scan of the Head

Absolute indications:
- Penetrating injury
- GCS score of <15
- Focal neurologic deficit
- Posttraumatic seizures
- Persistent vomiting
- Extensive facial injury
- Signs of basilar skull fracture
- Calvarial skull fracture

Relative indications:
- History of change in level of consciousness
- Alcohol or drug intoxication
- Suspected child maltreatment
- Unreliable or inadequate history of injury
- Age <2, unless injury is trivial and witnessed by reliable adult
- Postconcussive amnesia
- Severe headache

Other suspicious findings (e.g., cranial bruit, violent mechanism of injury with other deaths), at discretion of any of the services involved in the care of the child

Adapted from: Kosair Children's Hospital Pediatric Trauma Manual, Louisville, Ky.

Special Considerations: Infants < 2 Years of Age

- Consider imaging if any evidence of scalp hematoma which may indicate skull fracture.
- Consider imaging children < 3 months with nontrivial mechanism.
- Presence of skull fracture increases risk of injury 20 X.

Risk of Deterioration

- For patients with normal head CT and normal neurological exam, deterioration is rare.
- Infants or young children who have shown deterioration have had an abnormal initial CT or abnormal neurological exam.

TABLE 9-8 Criteria for Discharge From Emergency Department in Neurologically Intact Children

- Brief or no loss of consciousness*
- Loss of consciousness more than 24 hours prior to admission
- History compatible with only minor injury
- Asymptomatic, with a GCS score of 15
- Normal radiographic findings
- Reliable caregivers, informed about warning signs of neurologic deterioration
- Easy access to hospital should there be any deterioration

*The period "brief" is controversial and not well defined in the literature. Judgment should be used in individual cases.

Adapted from: American Academy of Pediatrics. The management of minor closed head injury in children. *Pediatrics*. 1999;104:1407–1415; and Mitchell KA, Fallat ME, Raque GH, Hardwick VG, Groff DB, Nagaraj HS. Evaluation of minor head injury in children. *J Pediatr Surg*. 1994;29:851–854.

Case Outcome

- CT scan of the head was normal
- After 2 hours child stopped vomiting and was discharged home
- Instructions given to family about participation in sports
- Instructions given to parents about when to seek medical care

Case 2: Conclusion

- Head trauma is a significant cause of morbidity and mortality.
- Infants are at high risk of injury.
- Diagnostic evaluation must balance the risks of intracranial injury and possibly sedation with the benefit of imaging.