Module IV

Pediatric Trauma
Differences in anatomy, physiology and mechanics in children result in different injury patterns and response to trauma

- Falls
- Fires
- Penetrating trauma
- Explosions
PRE-HOSPITAL HIGH RISK CRITERIA

• Blunt injury
  – Significant injury; physiologic compromise

• Penetrating injuries
  – Thorax, abdomen, head and neck
PRE-HOSPITAL DESTINATION CRITERIA: BURNS

• High risk burns: > 10% second degree
  > 5% third degree

• Destination: specialized pediatric burn unit after stabilization on-site/initial facility
SCENE IMMOBILIZATION
TRAUMA PRIMARY SURVEY

A - Airway patency
B - Breathing and ventilation
C - Circulation with hemorrhage control
D - Disability: Mental status
E - Exposure: Completely undress patient
A - AIRWAY
(PRIMARY SURVEY)

• Midline positioning

• Do jaw thrust to open airway and protect c-spine

• Head tilt and chin lift are contraindicated

• Cervical spine immobilization
B - BREATHING

- Assess minute ventilation
- Assess chest expansion
- Breath sounds
- Heart sounds
- Chest percussion
BAG-VALVE-MASK VENTILATION

- Midline position
- “Open” airway
- Proper sized mask
- Proper sized bag
• Assess pulse, end organ perfusion (capillary refill, temperature/appearance of extremities, CNS) and blood pressure

• Begin aggressive fluid resuscitation immediately
  – (IV/IO)

• Control external hemorrhage using direct pressure to wounds . . . .
  – ? tourniquet
D - DISABILITY

- Determine mental status with rapid assessment
- Is the child responsive?
- Pupil and motor exam
- Glasgow coma scale
E - EXPOSURE

- Completely undress the patient
- Perform a complete examination
- Don’t let the patient get cold
- Glucose, lab tests
# Shock Related to Trauma

<table>
<thead>
<tr>
<th>Classify</th>
<th>Cause</th>
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<tbody>
<tr>
<td>Hypovolemic</td>
<td>• Hemorrhage</td>
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<tr>
<td></td>
<td>• Burns</td>
</tr>
<tr>
<td>Cardiogenic</td>
<td>• Miocardial contusion</td>
</tr>
<tr>
<td>Obstructive</td>
<td>• Massive hemothorax</td>
</tr>
<tr>
<td></td>
<td>• Tension pneumothorax</td>
</tr>
<tr>
<td></td>
<td>• Tamponade</td>
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<tr>
<td>Distributive</td>
<td>• Spinal cord injury</td>
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## Pediatric Trauma Score

<table>
<thead>
<tr>
<th>Category</th>
<th>+2</th>
<th>+1</th>
<th>-1</th>
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<tbody>
<tr>
<td>Size/weight</td>
<td>&gt;20 kg</td>
<td>10-20 kg</td>
<td>&lt;10 kg</td>
</tr>
<tr>
<td>Airway</td>
<td>Normal</td>
<td>Stable</td>
<td>Unstable</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>&gt;90 mm Hg</td>
<td>50-90 mm Hg</td>
<td>&lt;50 mm Hg</td>
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<tr>
<td>CNS</td>
<td>Awake</td>
<td>Obtunded</td>
<td>Comatose</td>
</tr>
<tr>
<td>Open Wound</td>
<td>None</td>
<td>Minor</td>
<td>Major</td>
</tr>
<tr>
<td>Fractures</td>
<td>None</td>
<td>Closed</td>
<td>Open or Multiple</td>
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# Pediatric Trauma Score

<table>
<thead>
<tr>
<th>Score</th>
<th>Mortality Prediction</th>
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<tbody>
<tr>
<td>&gt;8</td>
<td>&lt;1% mortality predicted</td>
</tr>
<tr>
<td>&lt;8</td>
<td>Suggests referral to trauma center</td>
</tr>
<tr>
<td>4</td>
<td>Predicts 50% mortality</td>
</tr>
<tr>
<td>&lt;1</td>
<td>Predicts &gt;98% mortality</td>
</tr>
</tbody>
</table>
TRAUMATIC BRAIN / HEAD INJURY

• **Primary injury**
  - Blunt or penetrating
  - Concussion, cerebral contusion, diffuse axonal injury, intracranial hemorrhage

• **Glasgow coma scale**
  - 3-8 = severe injury
  - 9-12 = moderate injury
  - 13-15 = mild injury

• **Secondary injury**
  - Result of metabolic events
    - Cerebral ischemia, brain edema
CLINICAL ASSESSMENT OF SEVERITY
TRAUMATIC BRAIN INJURY (TBI)

• Vital signs
• Glasgow Coma Scale
  – Level of consciousness
• Muscular strength/ tone
• Cranial nerve exam
• Diagnostic assessment of TBI
  – Head CT
  – Lateral C-spine
MANAGEMENT
HEAD INJURY

• Maintain head in neutral position, use rigid cervical collar

• Administer short-term sedation and analgesia
  – Midazolam (0.1 mg/kg) and Fentanyl (1-2 mcg/kg)

• If there are clinical signs of ICP
  – Sedation, Mannitol (0.5-1 gm/kg), and hyperventilation (to PCO₂ of 25-30) until clinical signs improve
  – Consider elevating the head of the bed 30 degrees

• Consider a foley and nasogastric tube
THORACIC INJURIES

- Pulmonary contusion/laceration (53%)
- Pneumothorax/hemothorax (38%)
- Rib/sternal fractures (36%)
- Other injuries
  - Cardiac (5%)
  - Diaphragm (2%)
  - Major blood vessels (1%)
PNEUMOTHORAX

- Simple vs Tension
  - Tracheal shift

- Air into pleural space
  - Loss of negative pressure
  - Collapse of lung

- Open pneumothorax
  - Occlusive dressing
HEMOTHORAX

- Blood accumulates in the pleural space
  - Lung compression

- Type of injury
  - Large pulmonary injury
  - Large vessels injury

- Hypovolemia
PERICARDIAL TAMPONADE

- Beck’s triad: narrow pulse pressure, neck vein distention, muffled heart tones
- Fluid in the pericardial sac
- Compresses heart and ↓ cardiac output
- Impairs venous return
- Arrhythmias
- Pericardiocentesis
ABDOMINAL INJURIES

- Third leading cause of death in children, after head and thoracic injuries
- Silent hypovolemia
- Solid organ vs hollow viscous
  - Spleen most common
- Unique features of children’s abdomen
BONE AND EXTREMITY INJURIES
INITIAL MANAGEMENT

• Splint, splint, splint…
  — Clean and cover wound
  — Different types of splints
  — Splint distally and proximally to joint

• Pain management
OPEN FRACTURES

• Implies significant force
  - Look for other injuries

• Increased complications
  - Infections, nerve impingement

• Management
  - Clean, cover, do not suture
  - IV antibiotics, keep NPO, and immobilize

• Will need OR surgical debridement
PELVIC FRACTURES

• Associated with high energy accidents
  – Blood loss can be significant

• Pelvic ring fracture: single fracture usually stable

• Multiple fractures: unstable
  – Genitourinary injuries
  – Abdominal injuries
  – Vascular abnormalities (pelvic vein section)
WHAT IS A BURN?

• Coagulative destruction of the skin or mucous membranes

• Microvascular reactions in the surrounding skin that increase the extension of the injury

• Causes
  – Heat
  – Chemical
  – Radiation
BURN CLASSIFICATION

• Minor
  – < 10% body surface area (BSA) second-degree, < 1% third-degree

• Moderate
  – 10-30% BSA second-degree, 1-10% third-degree
  – No hands, feet or genitalia

• Critical
  – Inhalational injury
  – > 30% BSA second-degree, > 10-20% third-degree
  – Complicating fracture
  – Extensive electric or chemical burns
BURNS MANAGEMENT

- Dilute and wash away offending chemicals
- Remove clothing
- Cover burns with clean dressing or sheet
  - Prevents contamination, decreases pain
- Keep warm
- Give pain medications
- Replace fluids – Rule of Nines...
  - >10% BSA in children
  - IV vs. oral (may attempt up to 25% BSA)
# RULE OF NINES

<table>
<thead>
<tr>
<th></th>
<th>Child %BSA</th>
<th>Adult %BSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/Neck</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Arm</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Anterior Trunk</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Posterior Trunk</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Leg</td>
<td>14</td>
<td>18</td>
</tr>
</tbody>
</table>
INHALATION INJURY

The patient faints...

• Fire or smoke present in a closed area
• Evidence of respiratory distress or upper airway obstruction
• Soot around the mouth or nose
• Singed eyebrows, eyelashes
• Burns around the face or neck
INHALATION INJURY

• Upper airway edema is commonly seen during the first 6 to 24 hours after injury

• Management:
  – Remove the patient from the gas and allow him to breathe air or oxygen
  – Early obstruction of the upper airway is managed with intubation
EXPLOSIONS AND BLAST INJURIES

• Bombs and explosives cause unique injuries

• Among survivors:
  — Injuries include penetrating and blunt trauma
  — Blast lung is the most common lethal injury

• Half of all initial casualties will seek medical care over a one-hour period

• Upside down triage triangle

  Initial patients: Less injured

  Later patients: More injured
BLAST INJURIES

EXPLOSIVES

• High-order explosive
  – TNT, C-4, Nitroglycerin, ammonium
  – Supersonic over-pressurization shock wave

• Low-order explosive
  – Pipe bombs, gunpowder, pure petroleum based bombs (Molotov cocktail)
  – Subsonic explosion
BLAST INJURIES

• Primary mechanism:
  – Over-pressurization blast wave
  – Affects air filled cavities (lungs, ears)
  – Air embolism (stroke, acute abdomen, spinal cord injury)

• Secondary mechanism:
  – Flying debris
  – Penetrating or blunt injuries i.e. (eye injuries 10%)
BLAST INJURIES

• Tertiary mechanism:
  – Blast wind throwing the individual
  – Fractures, brain injuries, traumatic amputations…

• Miscellaneous:
  – Burns, crush injuries, respiratory (dust/ toxins)
“BLAST LUNG”

- Over-pressurization wave
- Most common fatal injury
- Can be found 48 hours later
- Triad: apnea, bradycardia, hypotension
- Suspect if: dyspnea, cough, hemoptysis, CP, hypoxia
- CXR: butterfly pattern
BLAST INJURIES
BRAIN

• Severe head injury is a leading cause of death
  – Subarachnoid, subdural hemorrhage most common (fatalities)

• Mild TBI’s are common, but may be occult

• Signs and symptoms may be subtle
  – Memory problems, headaches, dizziness, uneven gait, blurred vision, irritability, confusion…
BLAST ABDOMINAL INJURY

- GI gas-containing structures
- Petechiae, hemorrhages, large intramural hematomas
  - Severe overpressure leads to intestinal laceration, bowel perforation
- Colon: most common site of injury
- Ruptures may occur acutely several days after stretching, ischemia, and subsequent weakening of the bowel wall
- Tension pneumoperitoneum

*Ann Emerg Med 2001*
CRUSH SYNDROME

- Severe hypovolemic shock
- Detection of metabolic abnormalities
  - Hyperkalemia
  - Hypocalcemia
  - Metabolic acidosis
- Acute myoglobinuric renal failure
- Compartment syndrome

Treatment:
- massive volume replacement and alkaline solute (mannitol) diuresis
COMPARTMENT SYNDROME

• ↑ Intracompartment pressure → ischemia → muscle necrosis and nerve palsies
• Anterior compartment of lower leg
• Trauma does not have to be severe
  — Severe trauma interrupts the compartment
• ↑ pain, especially with passive extension
• Absent pulse, paresthesia, pallor, paralysis/paresis
• Direct measurement of compartment pressure
Thank you!