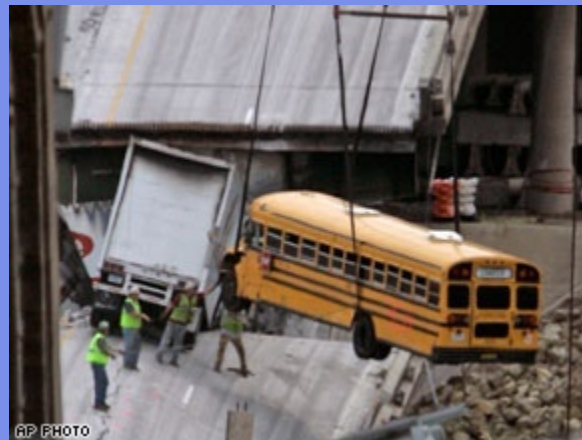


# MODULE IV

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## Pediatric Trauma



# PEDIATRIC TRAUMA

## HIGH RISK MECHANISMS



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

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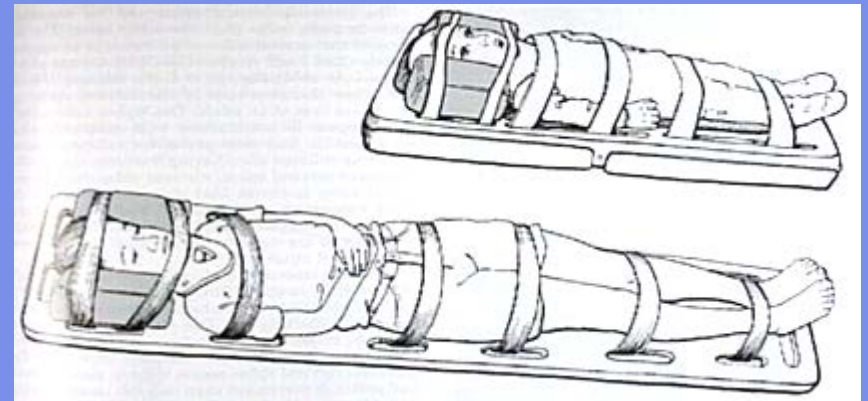
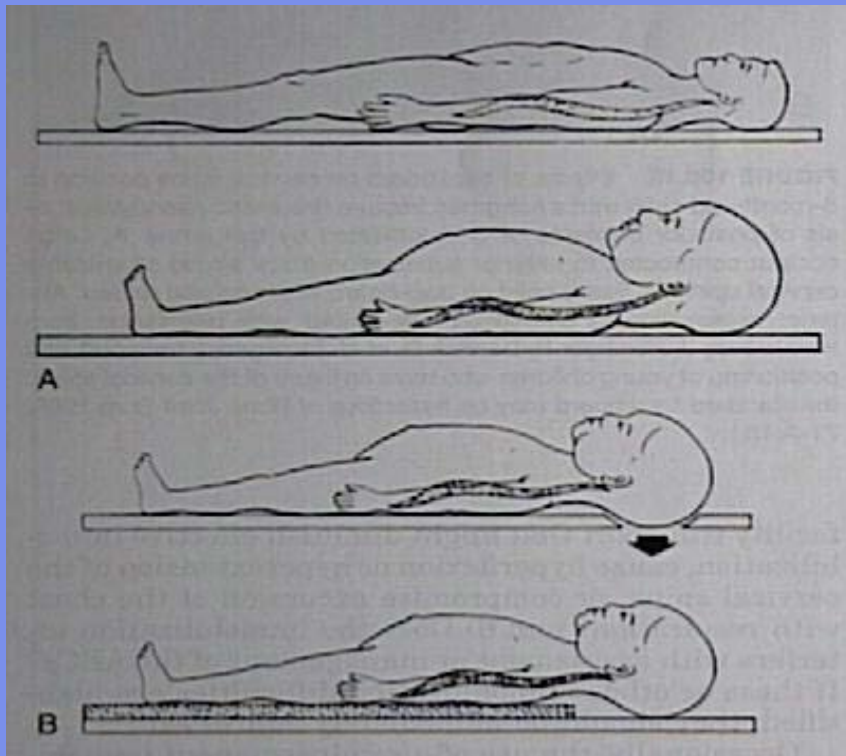
- **Blunt injury**
  - Significant injury; physiologic compromise
- **Penetrating injuries**
  - Thorax, abdomen, head and neck

# PRE-HOSPITAL DESTINATION CRITERIA: BURNS

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- 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

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**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)

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- Midline positioning
- Do jaw thrust to open airway and protect c-spine
- Head tilt and chin lift are contraindicated
- Cervical spine immobilization

# B - BREATHING

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- 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



# C - CIRCULATION

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- 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

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- 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

Classify	Cause
Hypovolemic	<ul style="list-style-type: none"><li>• Hemorrhage</li><li>• Burns</li></ul>
Cardiogenic	<ul style="list-style-type: none"><li>• Miocardial contusion</li></ul>
Obstructive	<ul style="list-style-type: none"><li>• Massive hemothorax</li><li>• Tension pneumothorax</li><li>• Tamponade</li></ul>
Distributive	<ul style="list-style-type: none"><li>• Spinal cord injury</li></ul>

# PEDIATRIC TRAUMA SCORE

Pediatric Trauma Score			
Category	+2	+1	-1
Size/weight	>20 kg	10-20 kg	<10 kg
Airway	Normal	Stable	Unstable
Systolic BP	>90mm Hg	50-90 mm Hg	<50 mm Hg
CNS	Awake	Obtunded	Comatose
Open Wound	None	Minor	Major
Fractures	None	Closed	Open or Multiple

# PEDIATRIC TRAUMA SCORE

Pediatric Trauma Score	
>8	<1% mortality predicted
<8	Suggests referral to trauma center
4	Predicts 50% mortality
<1	Predicts >98% mortality

# TRAUMATIC BRAIN / HEAD INJURY

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- **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

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- **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 PCO<sub>2</sub> of 25-30) until clinical signs improve
  - Consider elevating the head of the bed 30 degrees
- **Consider a foley and nasogastric tube**

# THORACIC INJURIES

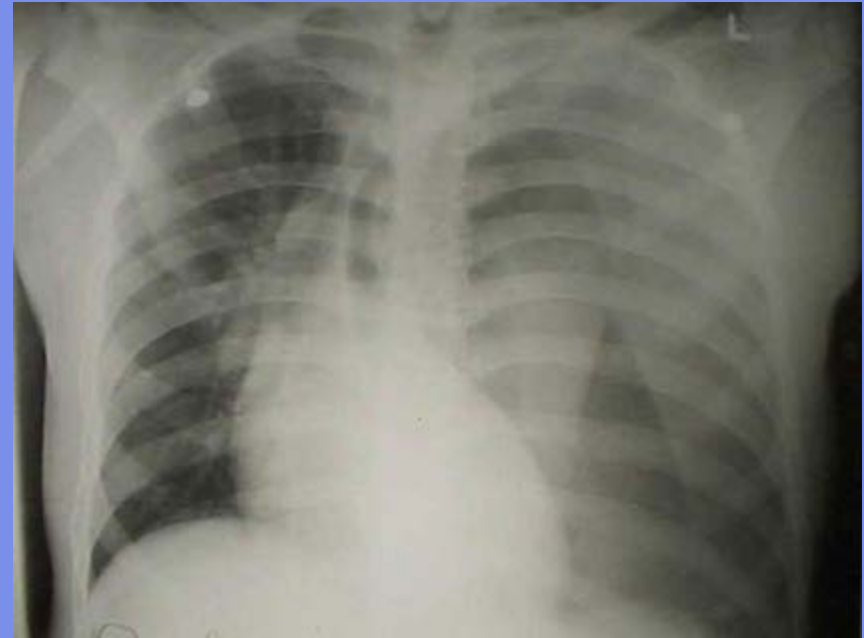
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- Pulmonary contusion/laceration (53%)
- Pneumothorax/hemothorax (38%)
- Rib/sternal fractures (36%)
- Other injuries
  - Cardiac (5%)
  - Diaphragm (2%)
  - Major blood vessels (1%)

# PNEUMOTHORAX

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- **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

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- 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

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- **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

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- **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?

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- **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

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- **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

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- 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

	Child %BSA	Adult %BSA
Head/Neck	18	9
Arm	9	9
Anterior Trunk	18	18
Posterior Trunk	18	18
Leg	14	18

# INHALATION INJURY

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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

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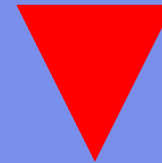
- **Upper airway edema is commonly seen during the first 6 to 24 hours after injury**
- **Management:**
  - Remove the patient from the gas and allow him to breathe air or oxygen
  - Early obstruction of the upper airway is managed with intubation

# EXPLOSIONS AND BLAST INJURIES

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- 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

Initial patients: Less injured



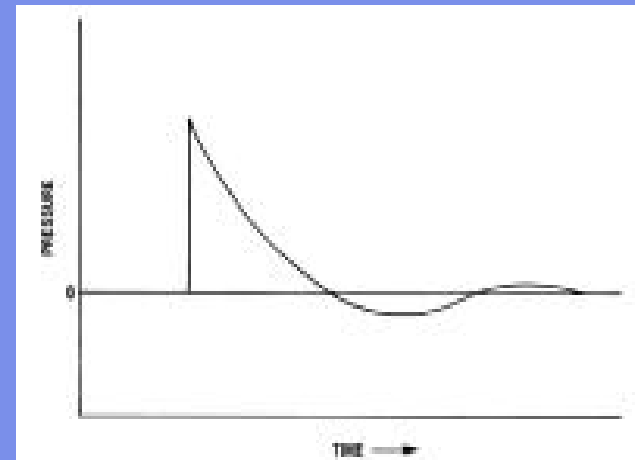
Later patients: More injured

- Upside down triage triangle

# 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



Friedlander Curve

# BLAST INJURIES

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- **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

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- **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

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- **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

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- **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**

# 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

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- **↑ 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!