

Pediatric Trauma: A Small Cry for Help

April 2022 Continuing Education

Objectives

- Assessment considerations and challenges specific to pediatric trauma patients
- Assessment and management of burns in pediatric patients
- Signs of non-accidental trauma/child abuse and the mandated reporter
- Fluid management of the pediatric trauma patient
- Pain management of the pediatric trauma patient

Developmental groupings

Neonate: 0 – 28 days

Infant: 1 mo – 12 mo

Toddler: 1 y – 3 y

Pre-school: 3 y – 5 y

School-age: 6 y – 10/11 y

Puberty: 11 y+

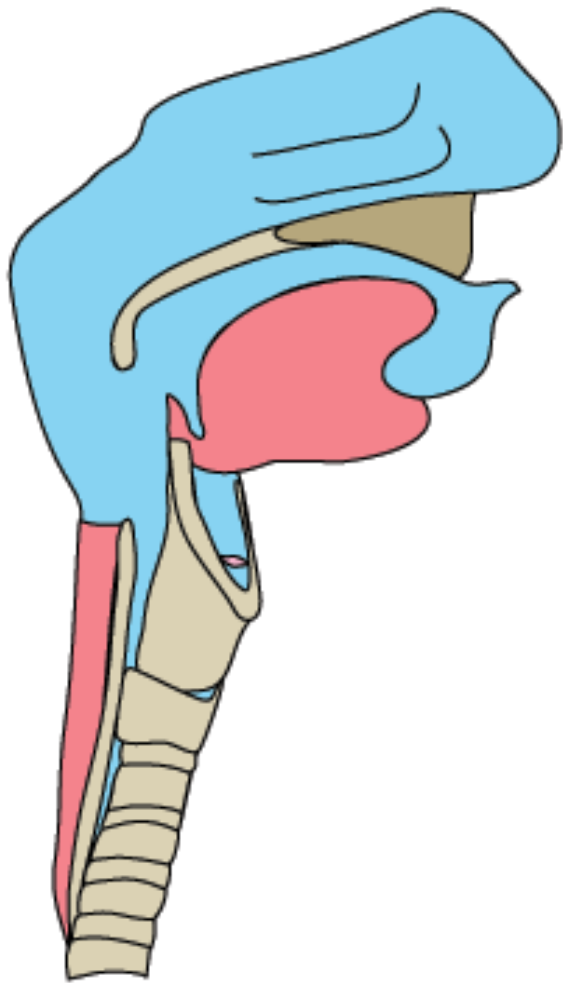
Brief Pediatric A/P Review

- Head is larger part of body surface area/weight, especially <2 yo
- Fontanelles open
- Increased body surface area compared to weight
- Heart & great vessels are same as adult
- Immature sympathetic system
- Excellent compensatory mechanisms - Hypotension is a LATE sign of shock!
- Circulatory blood volume: 70 - 80 ml/kg

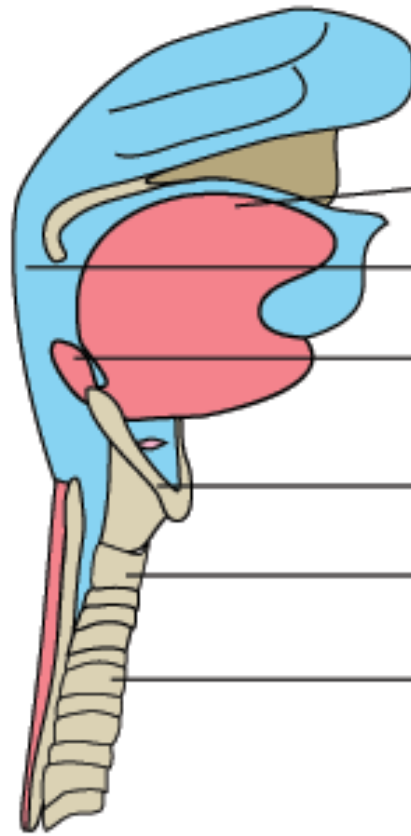
Brief Pediatric A/P Review

- Small pulmonary reserves
- Diaphragm is chief muscle of respiration
- Obligate nose breathers
- Ribcage more flexible, less protection

- Airways EASILY compressed with flexion or extension – aim for sniffing position
- Increased metabolic rate, increased O₂ consumption



Adult's Upper Airway



Child's Upper Airway

Tongue is larger in proportion to mouth

Pharynx is smaller

Epiglottis is larger and floppier

Larynx is more anterior and superior

Narrowest at cricoid

Trachea narrow and less rigid

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Pediatric Vital Signs



AMERICAN ASSOCIATION
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NURSES

PALS

Vital Signs in Children

Heart Rate (per minute)

Age	Awake Rate	Sleeping Rate
Newborn to 3 months	85 to 205	80 to 160
3 months to 2 years	100 to 190	75 to 160
2 to 10 years	60 to 140	60 to 90
>10 years	60 to 100	50 to 90

Respiratory Rate (breaths/min)*

Age	Rate
Infant	30 to 60
Toddler	24 to 40
Preschooler	22 to 34
School-aged child	18 to 30
Adolescent	12 to 16

Definition of Hypotension by Systolic Blood Pressure and Age

Age	Systolic Blood Pressure (mm Hg)
Term neonates (0 to 28 days)	<60
Infants (1 to 12 months)	<70
Children 1 to 10 years (5th BP percentile)	<70 + (age in years × 2)
Children >10 years	<90

Resp:

- Infants 40's
- Toddlers 30's
- Adolescents 20's

HR:

- Newborn/infant > 100
- Young kids up to 140
- < 100 after age 10

Low BP:

- 70 + 2(yrs)
- 90 after age 10

Pediatric Trauma

- Leading cause of death in children greater than 1 year
 - > 90% are due to blunt trauma (MVC is #1)
- More than 25,000 lives lost per year
- 4x that number suffer permanent disability
- 16 million injury related hospital ED visits yearly

Introduction

- The treatment of seriously injured pediatric trauma patients requires rapid assessment and institution of life-preserving therapy
- Time is of the essence
- A systematic approach is preferred

Introduction

Initial Assessment

- 1. Preparation
- 2. Triage
- 3. Primary survey
- 4. Resuscitation
- 5. Adjuncts to the primary survey/resuscitation
- 6. Secondary survey
- 7. Adjuncts to the secondary survey
- 8. Post resuscitation monitoring and re-evaluation
- 9. Definitive care

Introduction

- The primary and secondary surveys should be repeated frequently to determine any deterioration in the patient's status
- Any necessary treatment is to be instituted at the time an adverse change is identified
- These activities occur in parallel or simultaneously

Primary Survey

- A. Airway maintenance with cervical spine protection
- B. Breathing and ventilation
- C. Circulation with hemorrhage control
- D. Disability: Neurologic status
- E. Exposure/Environmental control

Airway

- The airway should be assessed first to ascertain patency
- This rapid assessment for signs of airway obstruction should include inspection for foreign bodies and facial, mandibular, or tracheal/laryngeal fractures that can result in airway obstruction

Airway

- The cervical spine should always be protected during airway assessment
- Care should be taken to prevent excessive movement of the c-spine
- Presume cervical spine injury in any patient with multisystem trauma, especially with an altered LOC or blunt injury above the clavicle

Airway

- The chin lift or jaw thrust maneuvers are recommended
- If the patient is able to talk the airway is patent
- Frequent reevaluation is essential
- A patient with a Glasgow Coma Scale (GCS) of 8 or less usually requires advanced airway management

Breathing and Ventilation

- The patient's chest should be exposed to adequately assess chest wall excursion
- Auscultation should be performed to assure adequate airflow in the lungs
- Visual inspection and palpation may detect injuries to the chest wall that may compromise ventilation

Circulation

- Hemorrhage is the predominant cause of preventable post-injury deaths
- Hypotension following injury must be considered to be hypovolemic in origin until proven otherwise
- LOC, skin color, and pulse yield important information within seconds

Circulation

LOC

- When circulating blood volume is reduced, cerebral perfusion may be critically impaired, resulting in altered LOC

Skin color

- Pink skin, especially in the face and extremities, is reassuring that the patient is not hypovolemic
- Ashen, gray skin of the face and white skin of exsanguinated extremities are ominous signs

Circulation

Pulse

- Central pulses (femoral or carotid) should be assessed bilaterally for quality, rate, and regularity
- Full, slow, and regular peripheral pulses are usually good signs of relative normovolemia

Disability

A rapid neurologic evaluation is performed at the end of the primary survey to establish the patient's LOC and pupillary size/reaction

AVPU Method

- A. Alert
- V. Responds to Vocal stimuli
- P. Responds to Painful stimuli
- U. Unresponsive to All stimuli

Disability

- An altered LOC indicates the need for immediate re-evaluation of the patient's oxygenation, ventilation, and perfusion status
- If these are excluded, then traumatic central nervous system injury should be considered until proven otherwise

Exposure/Environmental Control

- The patient should be completely undressed to facilitate thorough examination and assessment
- The patient should then be covered with warm blankets or an external warming device to prevent hypothermia

Resuscitation

Airway

- Airway should be protected in all patients and secured when the potential for airway compromise exists

Resuscitation

Breathing/Ventilation/Oxygenation

- Every injured patient should receive supplemental oxygen by mask if not intubated
- A tension pneumothorax should be immediately treated with needle decompression if suspected according to current guidelines

Resuscitation

Circulation

- A minimum of two large bore IVs should be established
- Establishment of upper extremity peripheral IV access is preferred
- Ringer's lactate (LR) is preferred as the initial crystalloid solution for shock and should be administered rapidly as a 20 cc/kg bolus.
 - Repeat the bolus if the patient is still exhibiting signs of shock after completion of the first bolus

Vascular access

- IV access is often difficult in volume-depleted children
- Consider IO placement according to current guidelines if peripheral IV access cannot be quickly initiated and the patient requires resuscitation

TXA

Consider TXA administration according to current guidelines if there is evidence of hemorrhagic shock

Secondary Survey

- The secondary survey does not begin until the primary survey is completed, resuscitative efforts are well-established, and the patient is demonstrating normalization of vital signs
- A head-to-toe evaluation of the patient is completed, including reassessment of all vital signs

Glasgow Coma Scale Score

Modified Glasgow Coma Scale for Infants and Children

	Child	Infant	Score
Eye opening	Spontaneous	Spontaneous	4
	To speech	To speech	3
	To pain only	To pain only	2
	No response	No response	1
Best verbal response	Oriented, appropriate	Coos and babbles	5
	Confused	Irritable cries	4
	Inappropriate words	Cries to pain	3
	Incomprehensible sounds	Moans to pain	2
	No response	No response	1
Best motor response*	Obeys commands	Moves spontaneously and purposefully	6
	Localizes painful stimulus	Withdraws to touch	5
	Withdraws in response to pain	Withdraws to response in pain	4
	Flexion in response to pain	Abnormal flexion posture to pain	3
	Extension in response to pain	Abnormal extension posture to pain	2
	No response	No response	1

*If patient is intubated, unconscious, or preverbal, the most important part of this scale is motor response. Motor response should be carefully evaluated.

Secondary Survey

History

- AMPLE Method:
 - A. Allergies
 - M. Medications
 - P. Past illnesses/Pregnancy
 - L. Last meal
 - E. Events/Environment related to the injury

Pain Management

EMERGENCY MEDICAL RESPONDER/EMT

- Display a calm and compassionate attitude
- Acknowledge and assess the patient's pain by obtaining a thorough history and rating
- Identify and treat the cause
 - Musculoskeletal injuries:
 - Realign angulated fractures, if possible, being cautious not to aggravate the injury or pain
 - Reposition (not reduce) dislocated joints to improve comfort, circulation, sensation, and motion
 - Apply a well-padded splint that immobilizes the long bone above and below the injury or the joint above and below the injury
 - Immobilize joints in mid-range position
 - Do not compromise distal circulation
 - Elevate the injured extremity if no fracture or dislocation is found
 - Apply ice or cold packs to the injured area
 - Apply a compression bandage or ace wrap if a splint is not needed
 - If backboard is needed to help immobilize long bone fractures, move patients, or unique extrication scenario:
 - Pad the backboard with a blanket(s)
 - Pad voids between the patient and backboard—behind knees, and small of back
 - Pad the straps
 - Keep the patient warm and protected from rain/snow, ambulance exhaust, etc.
- Check distal neurologic function, pulses, and capillary refill before and after splinting

Mercyhealth System Pre-Hospital Medical Guidelines

Approved: 04/07/2020

2.36.2

- Reassure and comfort the patient; Use a calm and soothing voice
- Distract them or encourage them not to focus on their injury, but to think about something more pleasant
- Eliminate stress inducing distractions—i.e. family, police and bystanders
- Coach the patient's breathing—calm, deep full inhalations, and relaxed slow exhalations
- Explain to the patient what is happening and what will happen next
- Adjust the ambient temperature of the treatment area to a comfortable level for the patient
- Reassess pain after all interventions

Pain Management

PARAMEDIC

- IV 0.9% Normal Saline @ KVO
- Consider a bolus of 500 ml if signs of hypovolemia are present
- Reduce pain medication dose by 50% in elderly or smaller framed patients
- Consider **Ondansetron (Zofran)** 4 mg IV/IM or ODT. May repeat x1 in 15 min. Pediatric 0.1 mg/kg max dose 4mg.
- **Fentanyl Citrate** 100 mcg IV/IM/IO/IN repeat if needed in 5 minutes-max dose of 300 mcg. Pediatric dose 1mcg/kg IV/IO and 2mcg/kg IN
Or
- **Dilaudid** 1 mg IV/IO/IM, may repeat in 10 minutes-max dose 4 mg (Adults Only)
Or
- Consider low dose **Ketamine** for severe pain unresponsive to narcotics 0.25mg/kg IV (max dose 25mg) or 0.5mg/kg IM (max dose 50mg) may repeat every 10 min
Or
- Consider high dose **Ketamine** for extreme pain dissociation 1-2mg/kg slow IV (max dose 200mg) or 5mg/kg IM (max dose 500mg) may repeat every 10 min
- For pediatric patients follow Broselow Tape or approved medical director product or app, if larger use half adult dose up to puberty.
- Reassess patient's pain before each additional dose.
- Recheck blood pressure before each additional dose; Dilaudid can cause hypotension. Fentanyl or Ketamine are preferred in hypotensive patient, hold Fentanyl, if SBP < 90 mmHg and preferentially use low dose Ketamine.
- For severe burn patients see Burn and RSA guidelines
- Do not withhold pain meds from someone in pain. Assessment at hospital can be done even after pain meds are given.

Selected Pediatric Trauma Topics

Pediatric Head Trauma

Primary Injury

Mechanical Injury
Sheer Forces
Bleeding

Secondary Injury

Hypoxia
Acidosis
Inflammation
Hypoperfusion
Cerebral Edema
Infection

Pediatric Head Trauma

Primary Injury

Mechanical Injury
Sheer Forces
Bleeding

Prevention
Seat Belts
Helmets
Legislation

Secondary Injury

Hypoxia
Acidosis
Inflammation
Hypoperfusion
Cerebral Edema
Infection

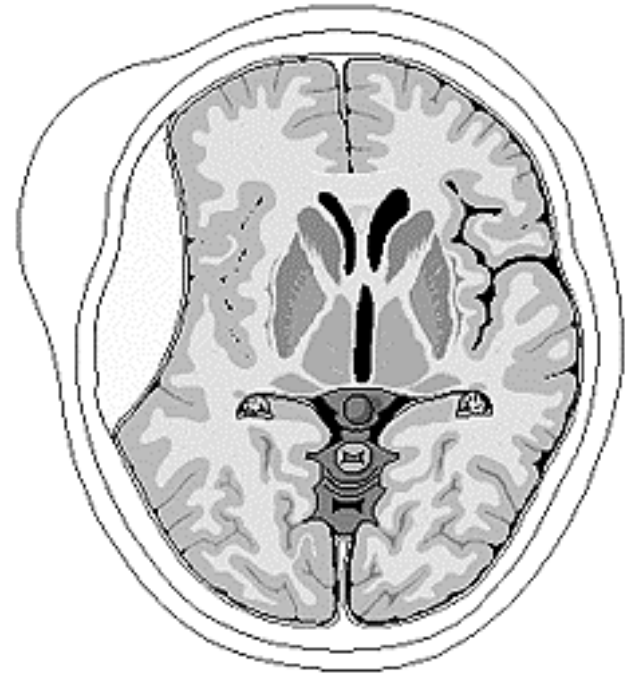
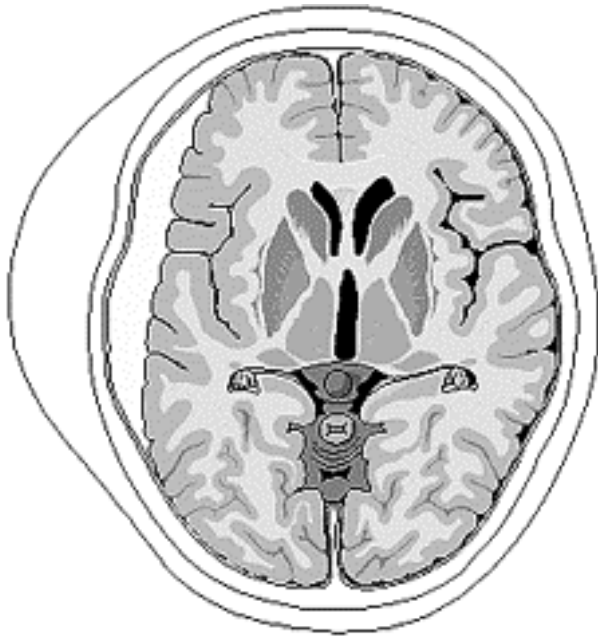
Aggressive Resuscitation
Optimize Oxygen Delivery
Appropriate Triage &
Transport

Head Trauma Primary Injuries

- Skull fractures
- Vascular injuries
 - Subdural
 - Epidural
 - Intracerebral hemorrhage



Subdural vs. Epidural



LifeArt: Williams & Wilkins
<http://www.lifeart.com>

Subdural Hematoma

- venous in origin
- associated with a reasonable outcome if removed early
- 5-10x more common than epidural in children



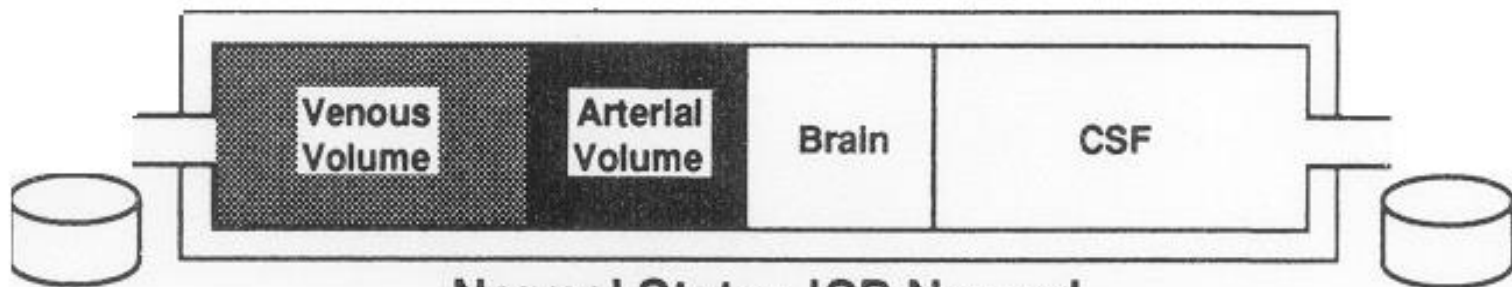
Epidural Hematoma

- arterial in origin
- true neurosurgical emergency
- similar presentation and course as adults

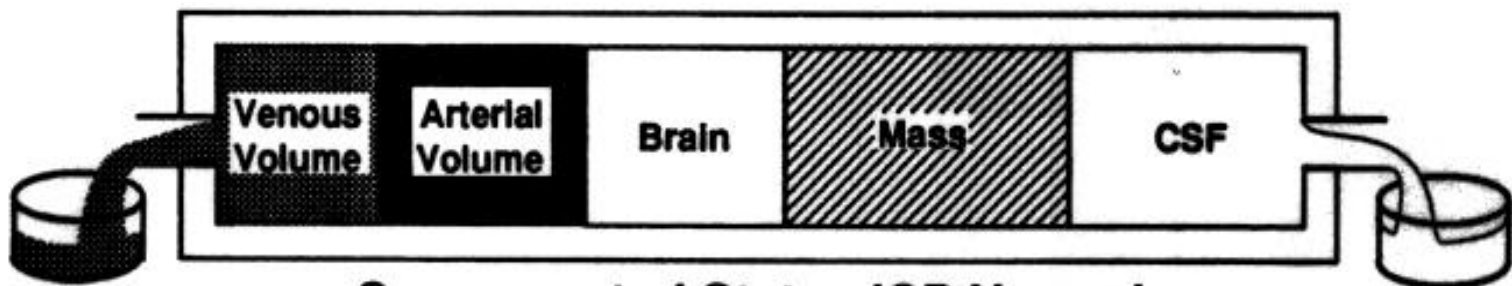


MONRO-KELLIE DOCTRINE

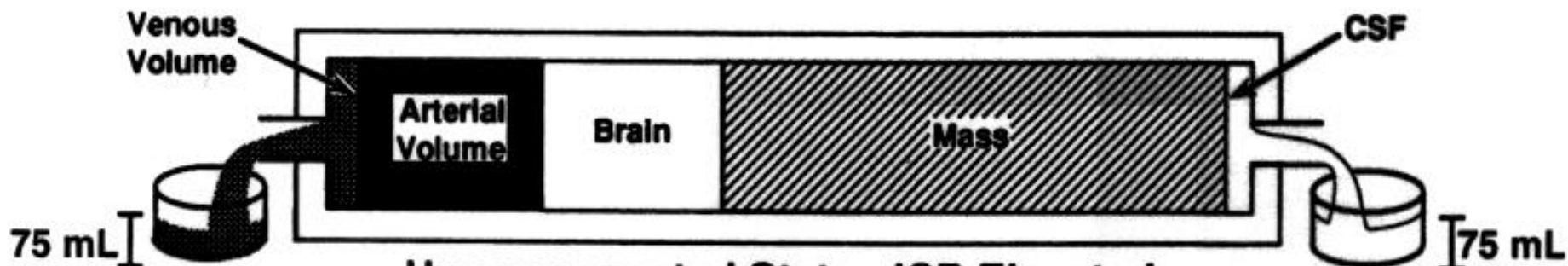
INTRACRANIAL COMPENSATION FOR EXPANDING MASS



Normal State - ICP Normal



Compensated State - ICP Normal



Uncompensated State - ICP Elevated

Spinal Cord Injury

- General
 - less common in pediatrics
 - accounts for < 10% of spinal cord injuries
 - still requires a high index of suspicion
- Pediatric Differences
 - more mobile spine
 - cervical muscles less supportive
 - immature ligaments-more flexible

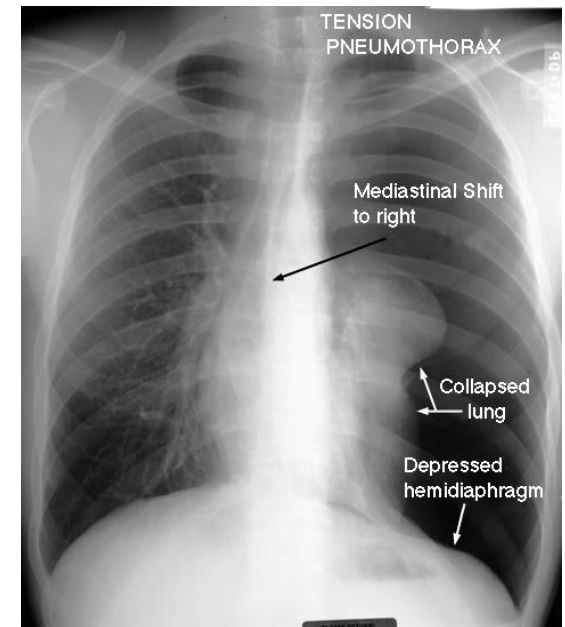
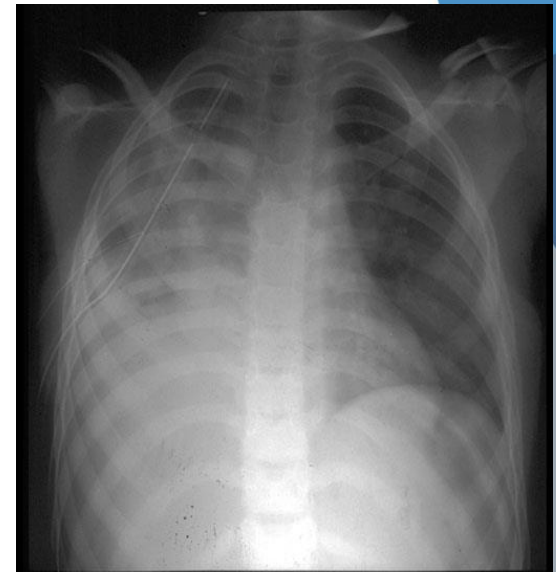
Thoracic Trauma

- Pediatric Differences
 - smaller size
 - undeveloped musculature & less ossification
 - greater elasticity and mediastinal mobility



Thoracic Trauma Specific Injuries

- Pulmonary contusions
- Rib Fractures
- Pneumothorax
 - Tension
- Hemothorax
- Tracheobronchial Injury



Abdominal Trauma

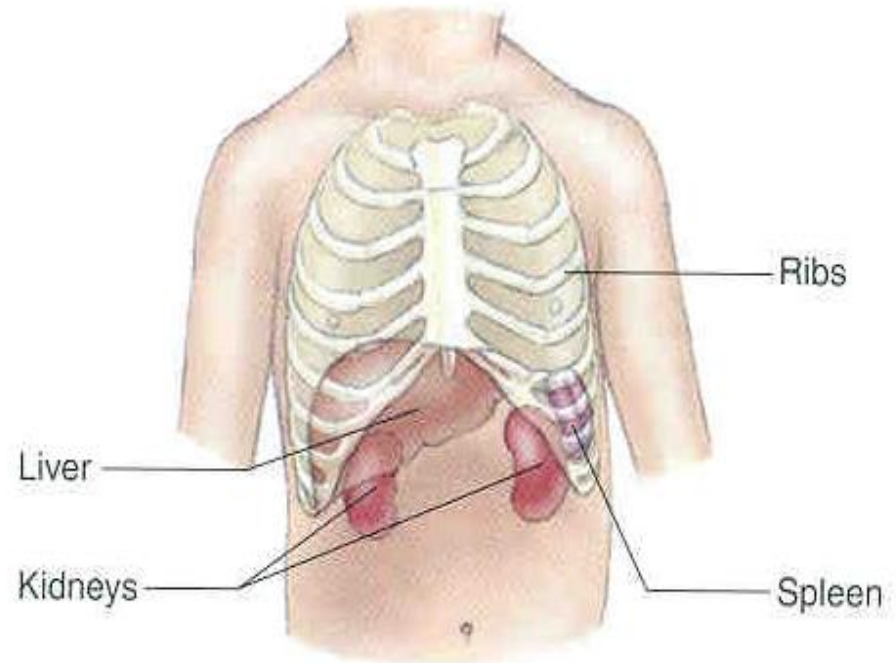
- General

- most abdominal trauma secondary to MVC and pedestrian/bicycle accidents
- penetrating trauma is less common in pediatrics
- abdominal trauma more likely found in:
 - lap belt injury
 - abuse/assault

Abdominal Trauma

Organs Specific Injuries

- Spleen
- Liver
- Kidney
- Bowel



Pelvic Trauma

- General

- uncommon pediatric injury
- contains critical neuro-vascular structures
- anatomy more prone to multiple injuries (i.e. fracture/dislocation)

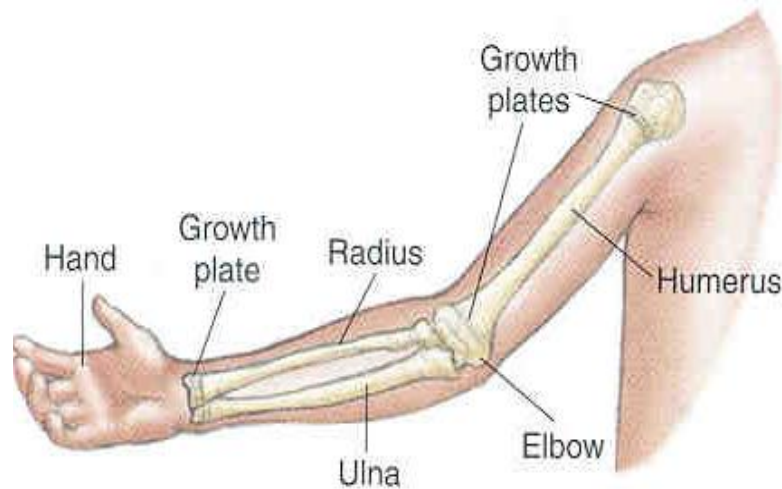
Musculoskeletal Injuries

- General

- Skeletal injuries occur in approximately 20% of all childhood trauma
- Fractures rare in first year of life
 - ABUSE until proven otherwise
- Adolescent fractures of upper extremity outnumber lower extremity 7:1
- High energy vs. Low energy

Musculoskeletal Injuries

- Pediatric Differences
 - radiolucent growth plate
 - immature skeleton, bone more porous
 - rapid healing and remodeling



Musculoskeletal Injuries

- General Assessment
 - swelling
 - open wounds
 - deformity
 - absence of pulse
 - loss of voluntary motion

Special Pediatric Trauma Topics

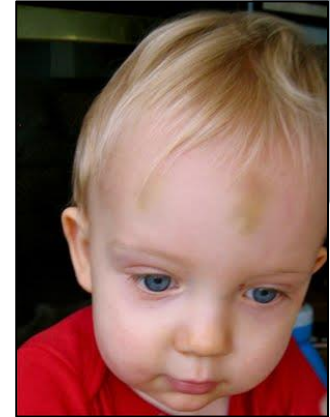
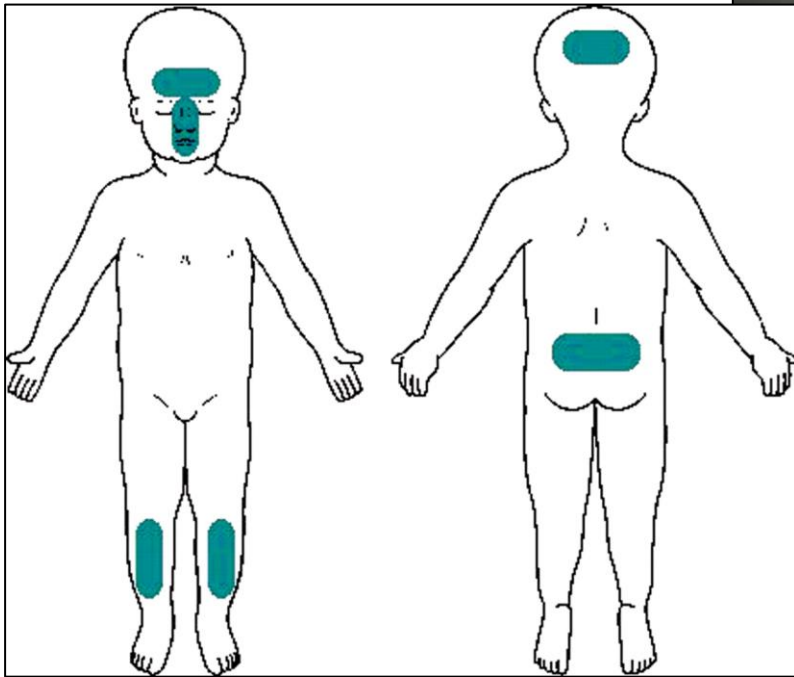
- *Child Abuse*
- *Burns*

Accidental vs non-accidental injury

- Sometimes difficult to distinguish
- Keep high level of suspicion
- EMS providers are **mandated reporters** for child abuse and neglect

- Neglect includes failure to provide
 - Adequate supervision
 - Medical care/attention
 - Food
 - Clothing
 - Shelter

Bruises: Unintentional Injury



Normal bruises are usually on bony prominences

Bruises: Intentional Injury

Red Flags

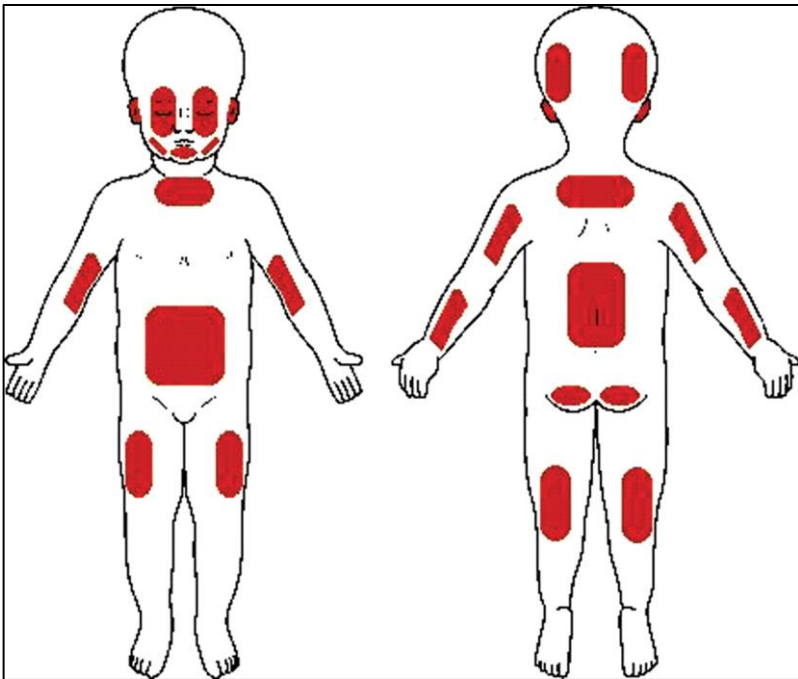
Multiple bruises

Unusual locations

- Lower back
- Buttocks
- Cheeks
- Ears
- Neck
- Patterned bruises



Bruises: Intentional Injury



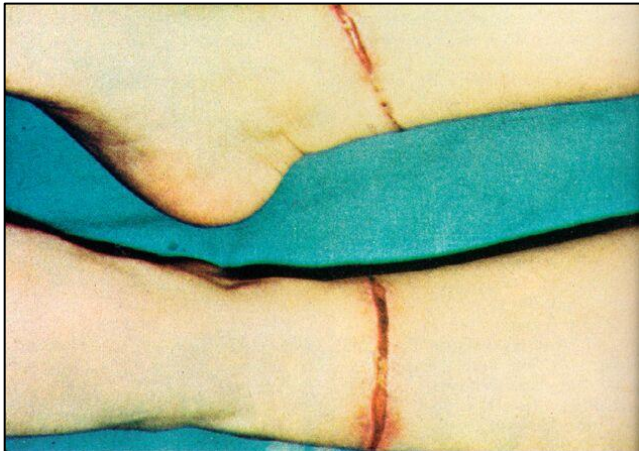
Abnormal bruises are often on soft tissue areas



Bruises: Intentional Injury



Bruises: Intentional Injury



Non-accidental trauma

- Biggest key is to keep this on your mind when evaluating and treating pediatric trauma patients
- Expose, expose, expose
 - In age-appropriate fashion
 - Out of sight of bystanders

Intentional Burn: Hot Objects



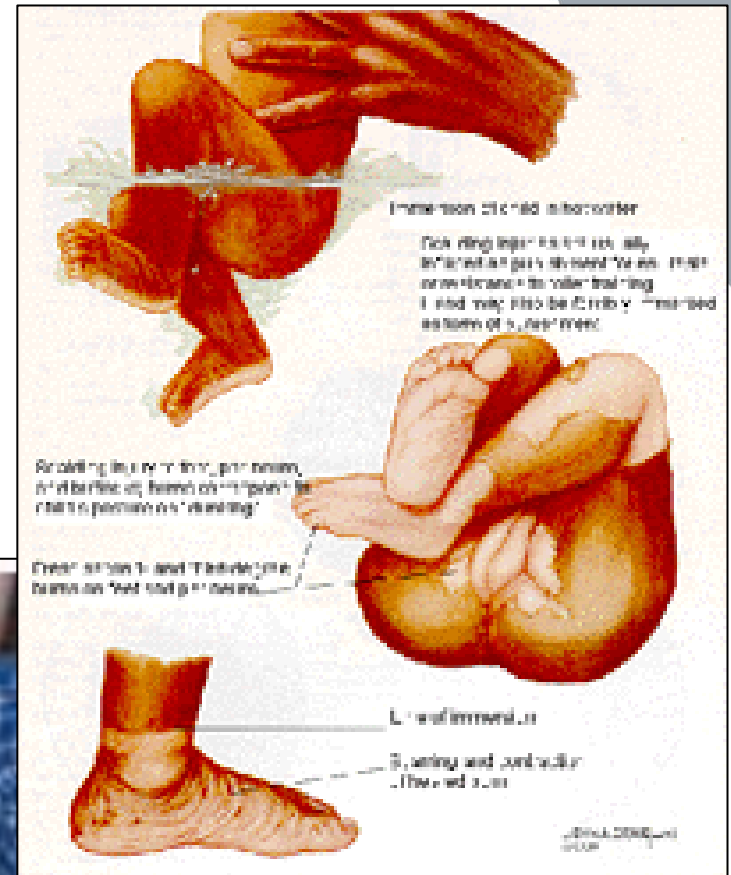
Burn/Scald injury

- Unintentional burns involving liquid usually involve splash marks
- Intentional burns may indicate forced dunking or immersion, may have a clear line of demarcation



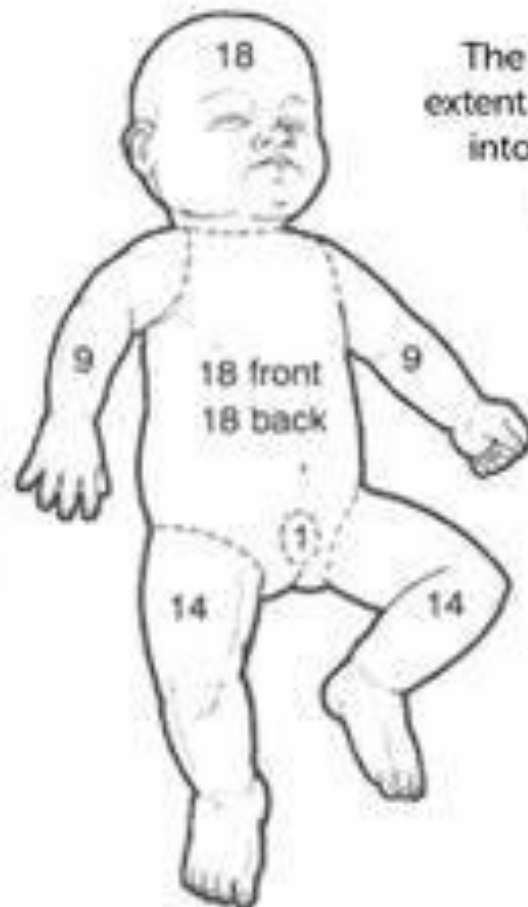
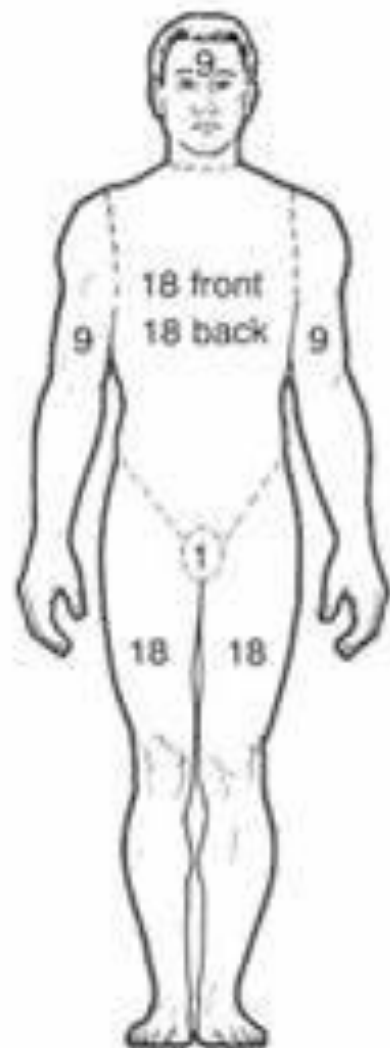
Burn/Scald injury

- Often clear lines of burn demarcation
- Sparing of knees





Rule of Nines



The Rule of Nines is a quick way to estimate the extent of burns in adults through dividing the body into multiples of nine and the sum total of these parts is equal to the total body surface area injured.

EMERGENCY MEDICAL RESPONDER/EMT

- Routine Medical Care/Routine Trauma Care
- If in cardiac arrest due to electrical injury, see *Cardiac Arrest Guidelines*
- Get the patient away from the heat source. Remove burned, hot, warm, and/or contaminated clothing
- Oxygen 2-4 LPM per nasal cannula or 10-15 LPM per non-rebreather if needed to maintain SpO₂ > 94%
- If the patient is unconscious without a gag reflex, consider oropharyngeal airway or nasopharyngeal airway.
- Remove rings, bracelets, and other constricting items as soon as possible
- Keep the patient warm with dry blankets
- Provide comfort and reassurance
- Place patient in Trendelenburg Position in cases of shock
- If less than 10% body surface area (BSA), dress burns with wet saline dressings or approved burn dressing, but be careful not to induce hypothermia
- If burns are more than 10% BSA, use dry dressings or clean sheets, or approved burn dressing
- Consider non-visualized airway device and request ALS response for advanced airway
 - If airway burns are evident
 - Carbonaceous sputum
 - singing of nasal hairs
 - swelling of the lips, tongue or pharynx due to burns
 - hoarse voice or stridor
 - There is increasing respiratory distress
 - There is decreased level of consciousness with no gag reflex
- **Albuterol** per breathing difficulty guideline

PARAMEDIC

- IV/IO Lactated Ringers
 - Unburned sites are preferred, but burned sites are acceptable
- Monitor ABC's and vitals closely
- <25% BSA, IV TKO, >25% BSA IV wide open for up to 1000ml. Keep track of fluid infused.
- Continue pain control, refer to *Pain Management Guidelines*.
- Consider RSA
 - If the patient remains alert or has an intact gag reflex AND there is carbonaceous sputum, singing of nasal hairs, swelling of the lips, tongue or pharynx due to burns, a hoarse voice or stridor, or other signs of respiratory distress. Refer to *Respiratory Distress Guidelines*

Definitive Care

- Know the location of the closest appropriate pediatric hospital to the scene
- Is it the local community hospital, an adult trauma center, or pediatric trauma center?
- Note that the closest pediatric trauma center may be in Madison, Milwaukee, Chicago, or Peoria
 - Consider HEMS transport from the scene for critical patients



Questions?

