

Pediatric Trauma Resuscitation: “Kid’s Aren’t Just Small Adults!”



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Disclosures

No financial interest or other relationships with commercial entities

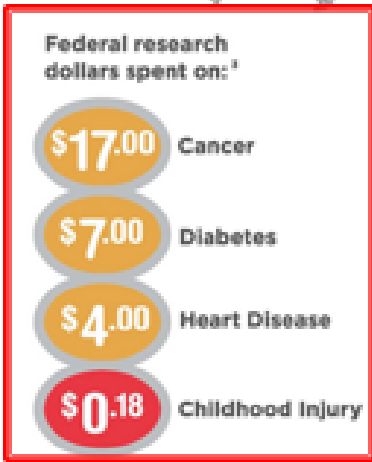


Objectives

- Explain key resuscitation principles unique to pediatric trauma
- Identify strategies for decreasing variability with the pediatric trauma assessment
- Describe the correlations between developmental milestones and mechanisms of pediatric injuries

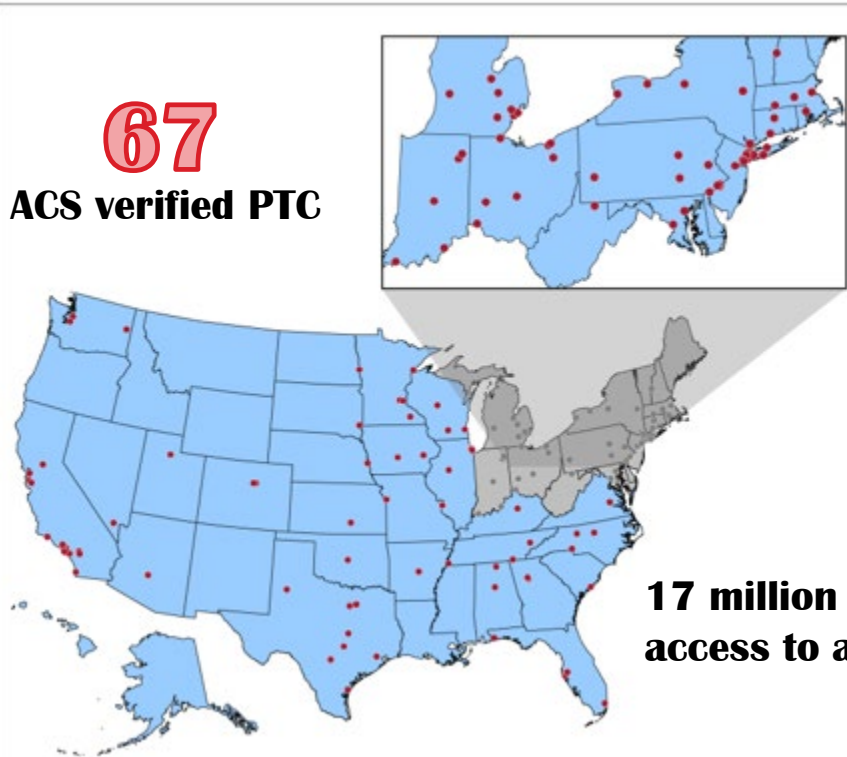
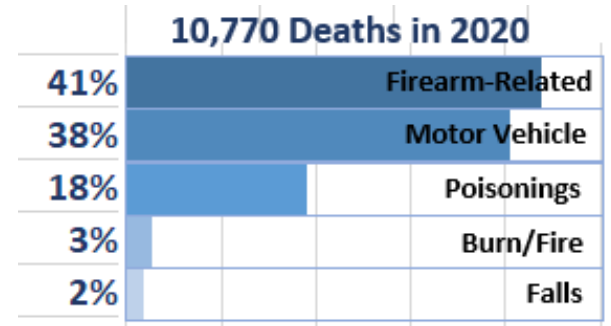


Facts About Pediatric Trauma



8.7 million children are treated in Emergency Departments from injury each year

226,000 injured children admitted annually



>7,000
children and teens age 0-19
died due to unintentional
injuries in 2019

Firearm-related injuries has surpassed MVCs as the leading cause of death from injury

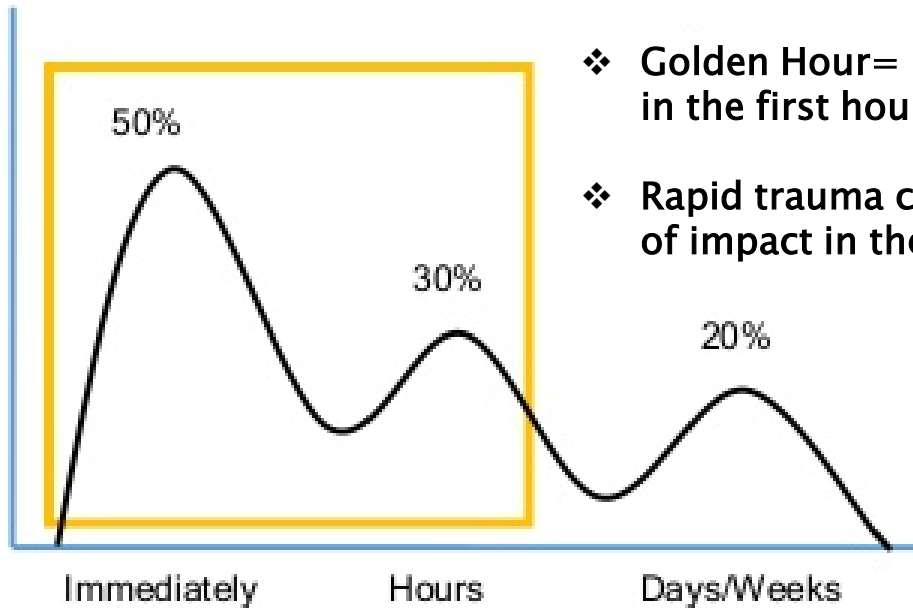
The Problem

- Common
- No pediatric trauma resuscitation scheme
- Children are different than adults
- Resuscitation parameters dependent on patient size
- ***Most injured children are not treated at a pediatric trauma center***



Epidemiology

Trimodal Distribution of Trauma Deaths



- ❖ Golden Hour= 80% of trauma deaths in the first hour after injury
- ❖ Rapid trauma care has greatest level of impact in these patients

Pediatric Trauma Center



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Epidemiology

- ▶ Blunt injury accounts for approximately 90% of all pediatric trauma
 - Small body=higher risk multisystem injuries
- ▶ Estimated increased >40% in Pediatric Firearm Injuries (penetrating trauma management implications)



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Pediatric Vital Signs

- ▶ Normal vital signs change with age in children
- ▶ Heart and respiratory rates are higher than in adults
- ▶ Blood pressure is lower
- ▶ Children can sustain major hemorrhage without hypotension

- ▶ For children 1 to 10 years of age, the 5th percentile systolic blood pressure can be approximated by the following formula:

$$70 \text{ mmHg} + 2 \times (\text{age in years})$$

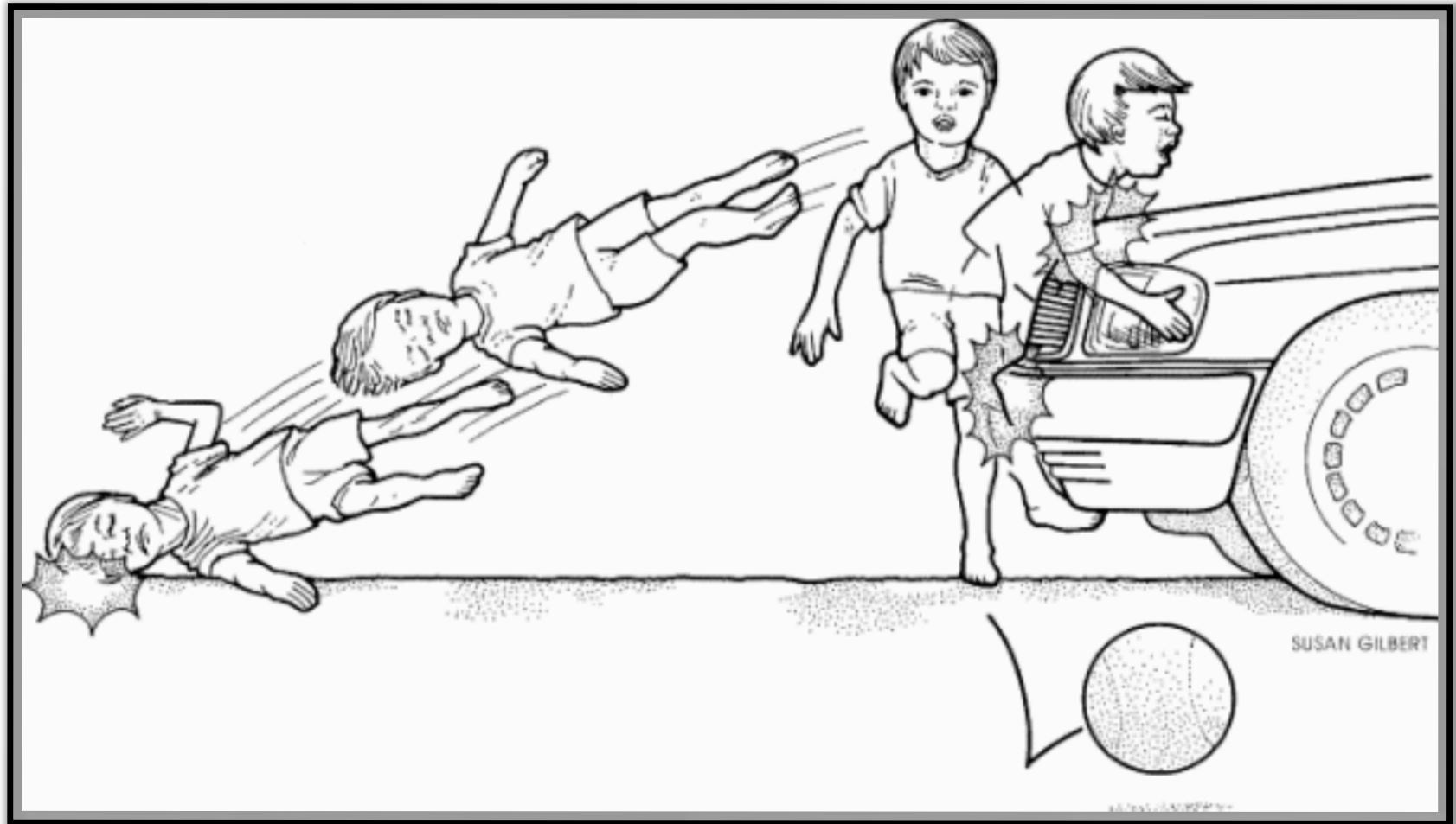


What puts them at risk?

- ▶ More likely to be hit by car
- ▶ Frequently unrestrained or improperly restrained in cars

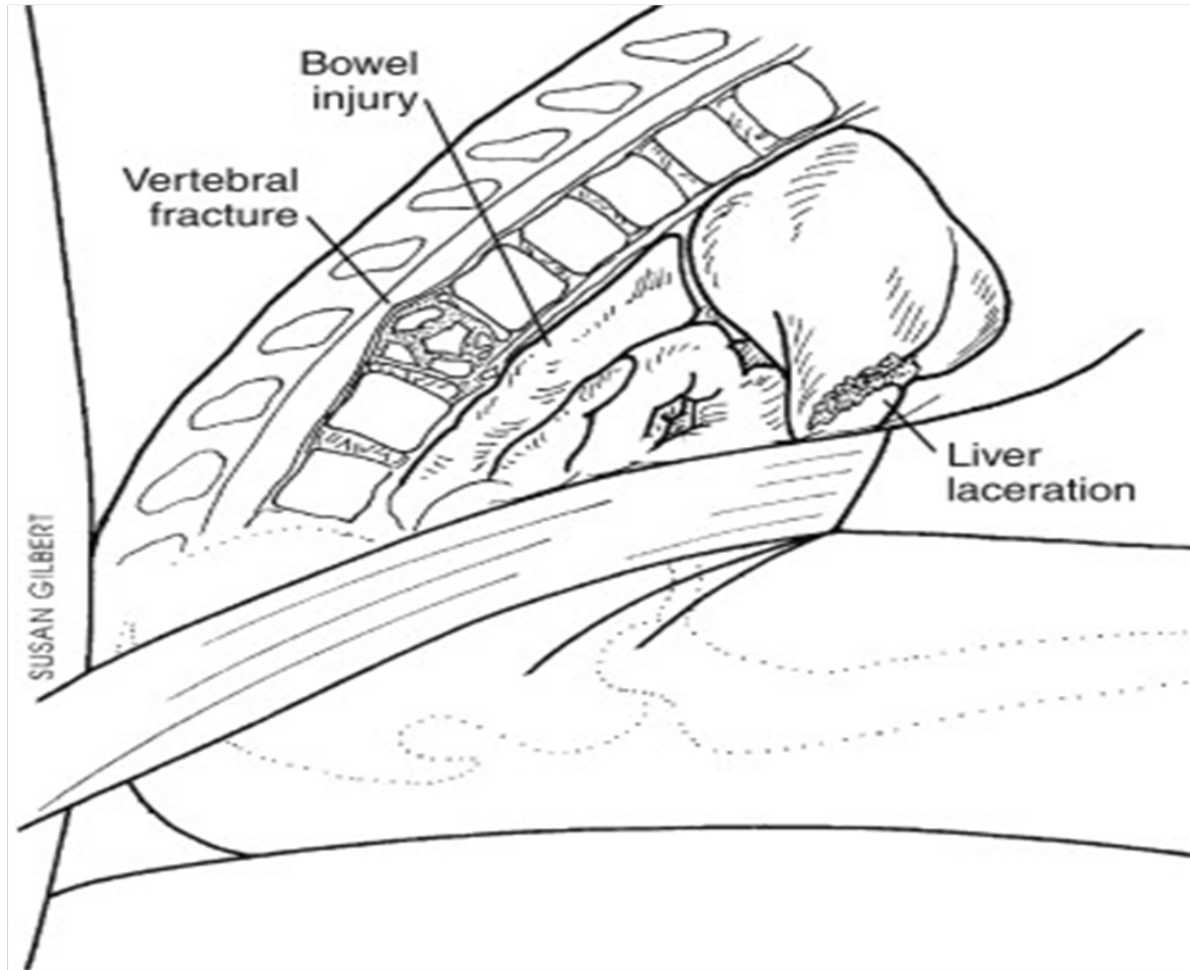


Common Presentations



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Common Presentations



What puts them at risk?

- ▶ More likely to be hit by car
- ▶ Frequently unrestrained or improperly restrained in cars
- ▶ Inexperienced, distracted drivers
- ▶ Participation in youth sports
- ▶ ATV crashes more common for youth drivers
- ▶ Non-accidental trauma



Unique Pediatric Considerations

- Head
 - < 8 yrs have disproportionately large heads



Unique Presentations



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Unique Pediatric Considerations

➤ Head

- < 8 yrs have disproportionately large heads
- Infants have open sutures and brains have larger subarachnoid space and increased extracellular space
- Thinner, less protective cranium



Unique Pediatric Considerations

➤ Chest

- Compliant chest wall
- Mobile mediastinal structures

➤ Abdomen

- Liver and spleen less protected by the rib cage



Unique Pediatric Considerations

- Musculoskeletal System
 - Immature bones with growth plates
- Vascular access may be difficult



EMS Gets the Call



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Case Review #1

- ▶ 5 month old arrived being carried in by father who reported a history of trouble breathing, fever to 102 and lethargy
- ▶ Father stated that earlier in the day, he force fed the patient using a syringe
- ▶ Intake assessment noted easy respirations, clear lung fields, broken blood vessels to sclera, tachycardia, awake and looking around, anterior fontanelle flat



- ▶ Initial VS Temp 104.8 HR 228 RR 28 BP 87/51
 - ▶ Weight– 3.25kg
 - ▶ While PCA was obtaining initial VS she noted bruising to the left cheek and notified the nurse
 - ▶ RN assessment
 - alert, looking around with disconjugate gaze
 - decreased responsiveness, not crying or making any noise
 - blood
 - bruise
- Nurse activated level 2 alert
and carried infant to trauma
room**



Primary Assessment

- ▶ **A**lertness– eyes open but unresponsive
- ▶ **A**irway– Patent with manual c–spine control
- ▶ **B**reathing– Spontaneous, unlabored breathing
- ▶ **C**irculation– Cool, pale with brisk capillary refill and strong central pulses
- ▶ **D**isability– GCS 8 (E4 V1 M3), Pupils unequal and sluggish
- ▶ **E**xposure– Patient exposed and covered with warm blanket

Upgraded to Level 1 Neuro



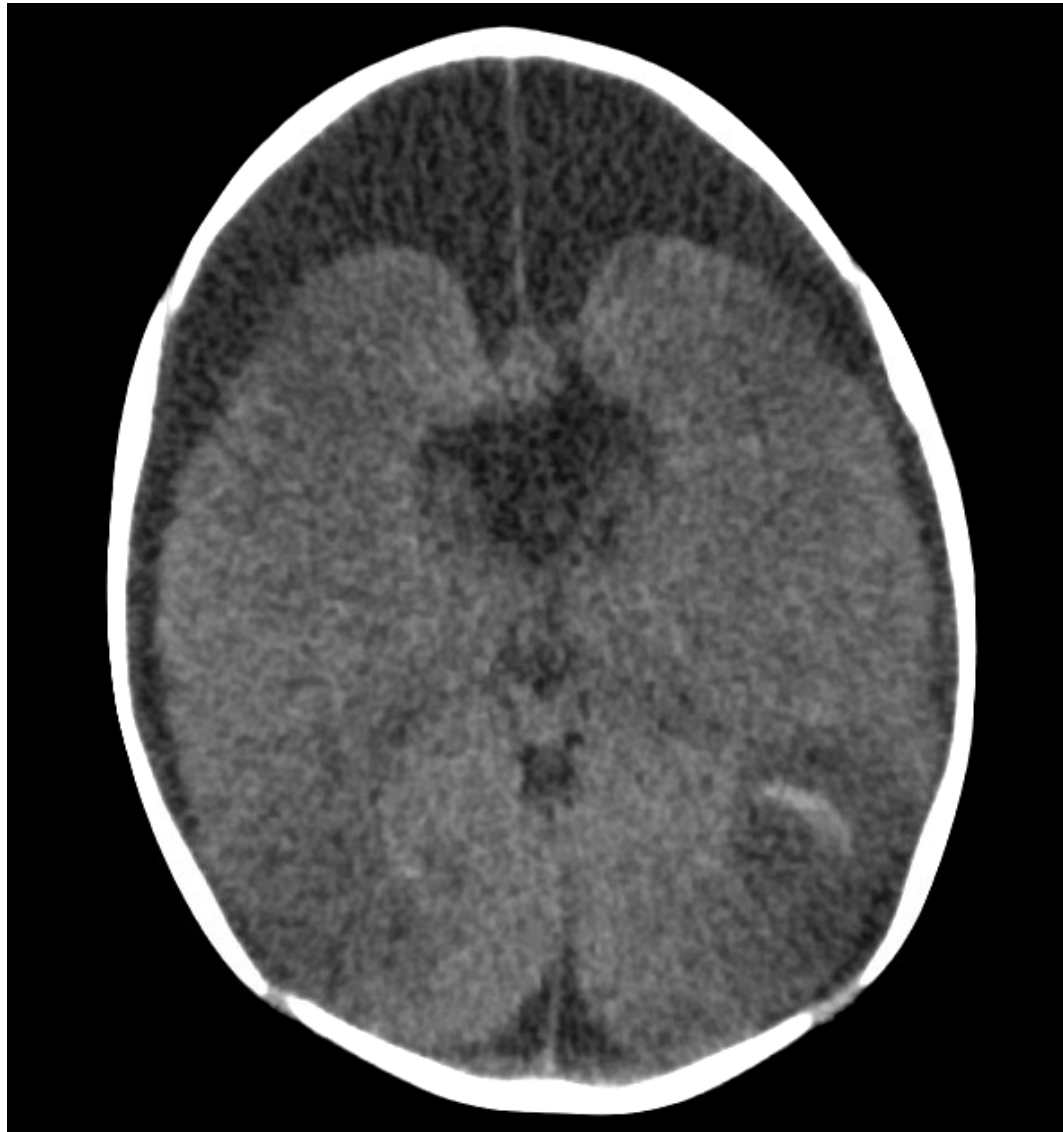
Ongoing Resuscitation

- ▶ Unable to obtain IV access and IO placed
- ▶ Ativan 0.3mg given IO
- ▶ RSI meds given and patient intubated with 3.5ETT

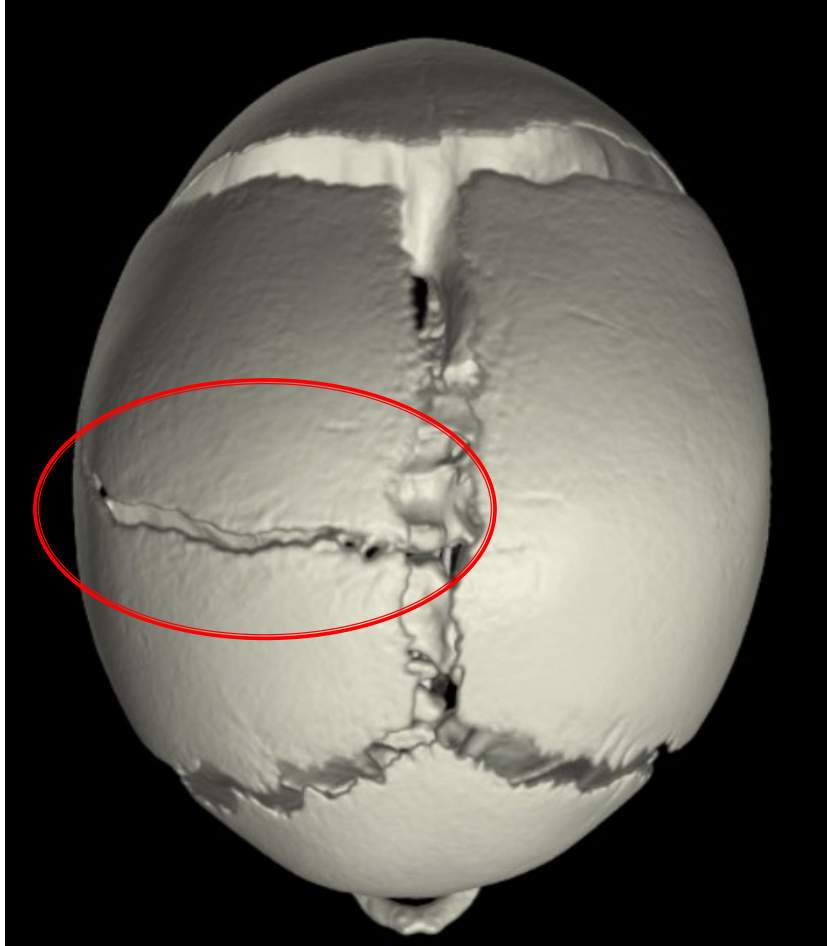
- ▶ Secondary assessment without additional injuries noted

- ▶ Transported to CT





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Non-Accidental Trauma

- Comatose infant brought to ED from home– child abuse top of differential
- Consider with healthy infant and new onset seizures



NAT Challenges

- **Child abuse is a unique disease in that the caregivers do NOT want you to detect it**
- Child abuse can be difficult to detect in the ED:
 - Injuries may be subtle or confusing
 - Story may be inconsistent
 - History may not be compatible with injuries
 - Child may visit several different emergency rooms



Case Study #2

- ▶ 14 year old hit by car crossing street with head phones on
- ▶ + LOC with seizure like activity at scene
- ▶ HR 176; no fluids PTA
- ▶ Estimated 40kg

Level 1 trauma alert called



Primary Assessment

- ▶ **A**irway– Airway patent with c-collar on
- ▶ **B**reathing– Spontaneous, unlabored breathing with equal breath sounds
- ▶ **C**irculation– Pale with cool extremities with cap. refill 4 seconds; strong central pulses; HR 176 BP 78/60
- ▶ **D**isability– GCS 6 (E1 V1 M4), Pupils equal and brisk, 3mm
 - Preparing for intubation
- ▶ **E**xposure– Patient exposed and covered with warm blanket



Interventions

- ▶ Sats decreased to 83% and patient ventilated per BVM
- ▶ RSI meds given
- ▶ Intubated with 6.0 ETT– with difficulty due to large amount of emesis



Secondary Assessment

- ▶ Multiple abrasions/contusions
- ▶ PERRL 3mm brisk
- ▶ Abdomen soft, non-distended
- ▶ Pelvis stable
- ▶ No obvious bony abnormalities



Ongoing Resuscitation

- ▶ 1000ml 0.9NS given x1 on rapid infuser
- ▶ HR 146 BP 132/76
- ▶ 1 unit PRBC given x2
- ▶ Airway suctioned for large amount of secretions
- ▶ Patient with ongoing hemodynamic instability and MTP implemented



Ongoing Resuscitation

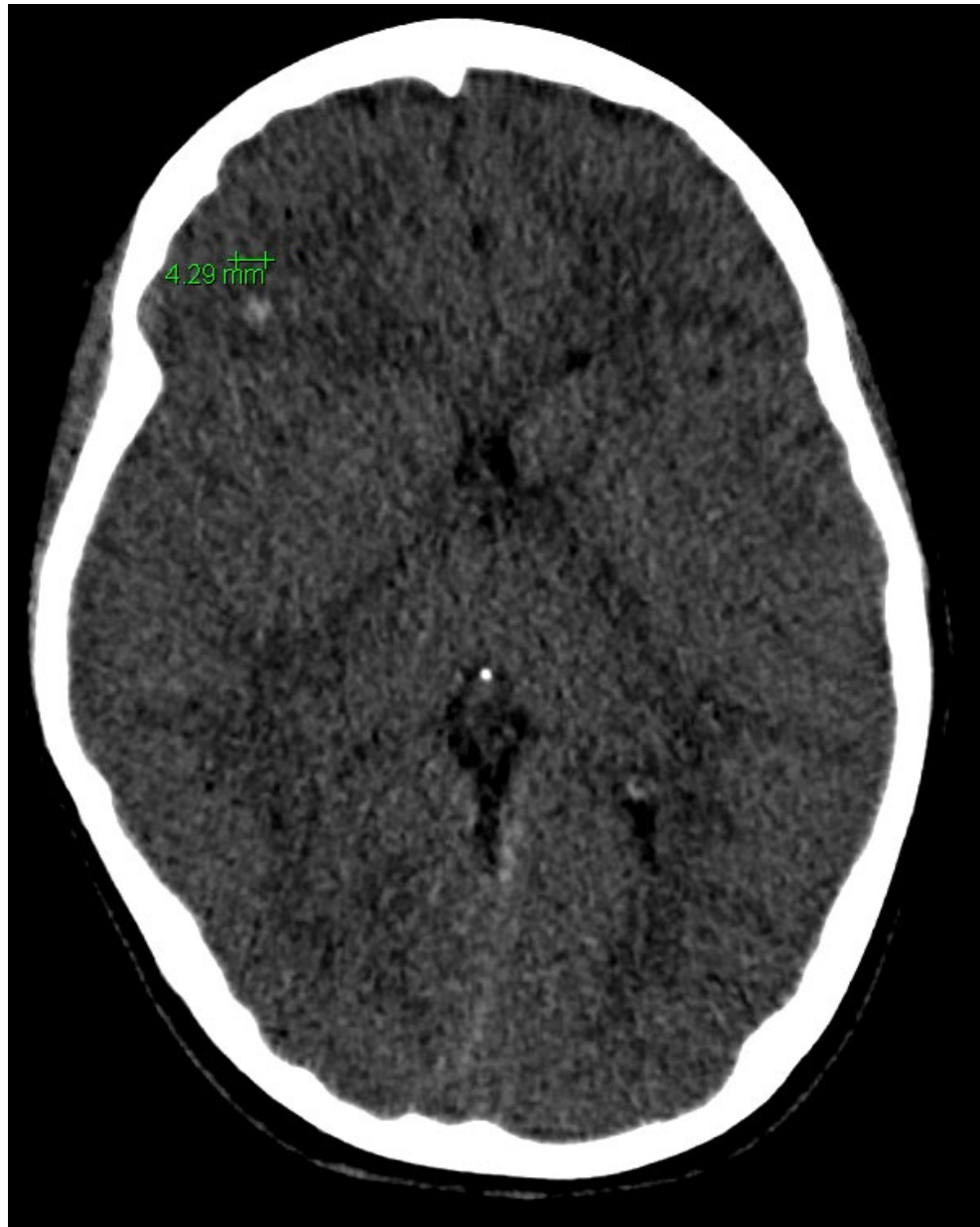
- ▶ Patient's sats decreased to 30s and left side extremely diminished
- ▶ Bradycardic
- ▶ Needle decompression on left side done with improvement in sats
- ▶ Chest tube placed



Ongoing Resuscitation

- ▶ CXR obtained
- ▶ Patient with transient improvement in VS after total 3 units PRBC, 2 units FFP and 2 units platelets
- ▶ Decision made to transport to CT





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Due to ongoing extravasation on CT with hemodynamic instability, decision made to go to OR



Non-operative management in blunt splenic trauma

- Non-operative management in hemodynamically stable pediatric patient
- Management in pediatric trauma center
- Indications for laparotomy include hemodynamic instability, ongoing blood loss or evidence of hollow viscous injury or peritonitis

Gates et al. Non-operative management of solid organ injuries in children: An American Pediatric Surgical Association Outcomes and Evidence Based Practice Committee systematic review. J Pediatr Surg. 2019 Jan 31. epub

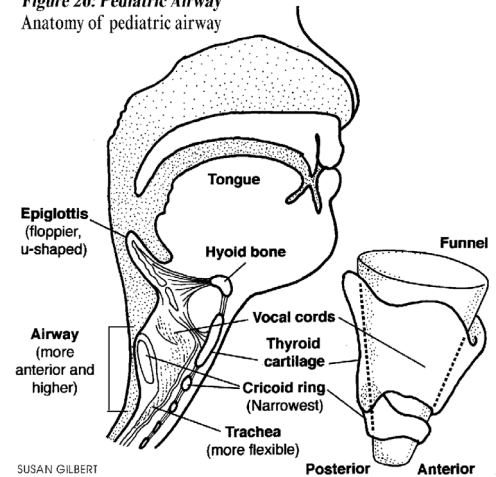


Pediatric Resuscitation Tips

▶ Airway

- Predisposed to airway obstruction–
 - Small oral cavities and relatively large tongues and tonsils
 - Relatively large occiput
- Endotracheal intubation is a practice–based skill
- Proficiency improves with repetition
- Assume cervical spine injury in multi–trauma patient

Figure 26: Pediatric Airway
Anatomy of pediatric airway



Keys to Success

- ▶ Alertness: Is the child alert?
- ▶ If not:
 - Does this child have a traumatic brain injury? (assess GCS)
 - Is this child in shock?
- ▶ Proceed with the ABCs
- ▶ Airway:
 - Pediatric airways are small and prone to obstruction
 - Endotracheal intubation requires practice and repetition (simulator)



Pediatric Resuscitation Tips

▶ Breathing

- Respiratory failure is more common (and insidious)
- The pediatric chest has greater compliance than the adult chest
 - Risk of rib fracture from blunt trauma is lower
 - Risk of pulmonary contusion is greater
 - Severe pulmonary contusions may occur without rib fractures **or even external signs of trauma**
 - Rib fractures suggest a significant force has occurred
- Noisy trauma room makes auscultation challenging



Pediatric Resuscitation Tips

▶ Circulation

- Shock recognition difficult
 - greater compensatory mechanisms
 - mostly blunt trauma (bleeding not visible)
 - blood pressure is age dependent
- Tachycardia usually the first sign of hypovolemia
- Hypotension is rare – and usually a sign of impending arrest
- Other assessment findings– delayed capillary refill, altered mental status, narrowing of the pulse pressure to <20mmHg, skin mottling, cool extremities, and dulled response to pain





5 Liters =
Circulating blood volume of an adult



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**360 ml =
the blood volume of a full term infant
weighing 4.5 kg or 10#**



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Keys to Success

- ▶ Circulation
 - Circulating blood volume= 80ml/kg
 - Pediatric fluid bolus= 20ml/kg (max 40ml/kg crystalloid)– WARMED
 - MTP is essential in the setting of major trauma



Pediatric Resuscitation Tips

- ▶ Hemorrhage Control
 - Apply direct pressure when possible
 - Rapid closure of severe bleeding from scalp wounds
- ▶ Reduction and splinting of long bone fractures
- ▶ Suspected pelvic fracture with hemodynamic instability



Assessed Response	Score
Best Eye Response	
Spontaneously	4
To Speech	3
To Pain	2
None	1
Best Verbal Response	
Smiles, Coos and Babbles	5
Cries But is Consolable	4
Cries in Response to Pain or Intermittently Consolable	3
Inconsolable or Moans Only to Pain	2
No Vocal Response	1
Motor	
Moves spontaneously	6
Withdraws to Touch	5
Withdraws to Pain	4
Abnormal Flexion Posture	3
Abnormal Extension Posture	2
Flaccid	1



Disability (con't)

- ▶ Beware of the infant or child with a fluctuating mental status
- ▶ The child who cries out once with painful stimulation and then immediately becomes somnolent is NOT “fine”
- ▶ Repeating neurologic exam is a must



Keys to Success

▶ Disability

- You must physically touch the patient to do an accurate GCS
- Traumatic brain injury is the #1 killer in injured children
- Adherence to TBI guidelines is associated with improved outcomes

Any child < 5 years old injured in the home has an increased risk of child abuse



Pediatric Resuscitation Tips

- ▶ Environment/Exposure
 - Prevent hypothermia
 - Completely undress any trauma patient
 - Use active warming measures



Stabilized...Now What?

- ▶ Avoid excess radiation exposure
 - Carefully consider injury mechanism and clinical factors when determining if a CT scan should be performed in the pediatric trauma patient
- ▶ Children have amazing cardiovascular reserve but do decompensate quickly
 - Maintain the basic principles of trauma care- ABC
- ▶ Don't forget to consider non-accidental trauma
- ▶ Family centered care



Questions?



"I appreciate the text, Kate, but next time you can just raise your hand."

BY MARK ANDERSON,



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