CHALLENGING PEDIATRIC TRAUMA CASES: PEARLS FOR CARE

UW Medicine EMS & Trauma Conference
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WHY IS THIS IMPORTANT?

Traumatic injuries are the #1 cause of death for age 1-18 years old
CASE 1

- 3 yo female fell from 2nd story window
- Landed on deck
- Initial assessment at scene:
  - HR 112 BP 112/78 RR 20 Sat 98%
  - Eyes closed, moaning, withdraws to pain

Where do we start?

TRAUMA: PRIMARY SURVEY

Rapid assessment to immediately recognize and intervene on life-threatening injuries

Airway
Breathing
Circulation
Disability
Exposure/Environment

AIRWAY
PEDIATRIC AIRWAY: ANATOMY

- Higher, more anterior glottis
- Larger tongue
- Floppy epiglottis
- Cricoid ring narrowest in peds vs. cords
- Larger occiput

AIRWAY TIPS POLL

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PEDIATRIC AIRWAY

- Endotracheal tube size
  - Age in years/4 + 4
- ETT depth
  - ETT size x 3
  - Age in years/2 + 12
- Laryngoscope blades
  - Newborn: Miller 0
  - 1mo-toddler: Miller 1
  - 18mo-8years: Miller 2
  - >8years: Miller or Macintosh 3
### Pediatric Airway: Anatomy

<table>
<thead>
<tr>
<th>Pediatric Anatomic Feature</th>
<th>Management Significance</th>
<th>Management Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small mouth, large tongue</td>
<td>- Less space for laryngoscope blade and visualization</td>
<td>- Use of smaller straight laryngoscope blade</td>
</tr>
<tr>
<td>Anterior airway</td>
<td>- Acute angle makes nasotracheal intubation difficult.</td>
<td>- Alignment of different airway axes is often better with a straight blade</td>
</tr>
<tr>
<td>Long floppy epiglottis</td>
<td>- Epiglottis can block visualization of the airway</td>
<td>- Straight blade, with a narrower tip can be used to lift it out of the way</td>
</tr>
<tr>
<td>Cricoid ring is narrowest part of airway</td>
<td>- Failure to get good seal with uncuffed ETT</td>
<td>- Use cuffed ETT</td>
</tr>
</tbody>
</table>
**PEDIATRIC AIRWAY: ANATOMY**

<table>
<thead>
<tr>
<th>Pediatric Anatomic Feature</th>
<th>Management Significance</th>
<th>Management Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatric airway smaller and shorter and delicate</td>
<td>Pediatric airway more prone to obstruction, compression</td>
<td>Vigilance with tube placement especially with transfer of child.</td>
</tr>
<tr>
<td>Diaphragm is the main muscle of breathing</td>
<td>Abdominal trauma and distention can cause respiratory compromise</td>
<td>Awareness that BVM can cause abdominal distention</td>
</tr>
<tr>
<td>Small cricothyroid membrane</td>
<td>Cricothyroidotomy contraindicated in children less than 8 years old</td>
<td>Needle cricothyroidotomy with jet insufflation &lt;8yo</td>
</tr>
</tbody>
</table>

**POSITIONING**

[Cervical Collar Image]

https://www.etsy.com/listing/151954092/toddler-ballet-tutu-set-girls-tutu

Flickr.com (GG, ballerina) https://creativecommons.org/licenses/by-nc-nd/2.0/legalcode
**PEDIATRIC AIRWAY: MEDICATIONS**

<table>
<thead>
<tr>
<th>PHASE OF RSI</th>
<th>PEDIATRIC MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>Use length-based system for equipment organization and size and medication dose determination.</td>
</tr>
<tr>
<td>Preoxygenation</td>
<td>5 vital capacity breaths with high flow oxygen can be used if 5 minutes of preoxygenation not available. Children will tolerate only 2-3 minutes of apnea.</td>
</tr>
</tbody>
</table>
| Premedication| Avoid bradycardia:  
- Atropine 0.01-0.02 mg/kg |
| Sedation     | Etomidate 0.3 mg/kg  
- Least cardiovascular effects  
Midazolam 0.3 mg/kg  
Diazepam 0.1 mg/kg  
Morphine 0.1 mg/kg |
| Paralysis    | Depolarizing Neuromuscular blockade:  
- Succinylcholine 1-2 mg/kg  
Non Depolarizing Neuromuscular blockade:  
- Pancuronium 0.1 mg/kg  
- Vecuronium 0.1 mg/kg  
- Rocuronium 1mg/kg |

**PEDIATRIC AIRWAY: SURGICAL**

- Age < 8yo  
  - Needle cricothyroidotomy with jet insufflation  
- Age 8yo or greater  
  - Cricothyroidotomy

**PEDIATRIC AIRWAY: ANATOMY**

![Image of larynx demonstrating anatomy](image.png)

**FIG. 12.1, Cricothyroid membrane.** Comparative size of the adult (LEFT) versus pediatric (RIGHT) cricothyroid membrane. Note that not only is the larynx smaller, but the actual membrane is smaller proportionally in comparison involving 1/4 to 1/8 of the anterior thyroid cartilage and varies 1/2 to 1/3 in the adult versus 1/8 to 1/16 in the pediatric, which accommodates a 4.4-mm ID tube.
NEEDLE CRICOTHYROIDOTOMY

• Large bore needle (14 to 18 gauge)
• Through cricoid membrane
• Either
  • Oxygen tubing with side hole for insufflation
  • 3mL syringe with plunger removed and 7.5 ETT adaptor inserted (can use BVM)
• 1 second on, 3 seconds off
• Temporizing measure

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NEEDLE CRICOTHYROIDOTOMY

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JET INSUFFLATION IN A PINCH

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CASE CONTINUED

• Back to our 3 year old…
• Intubated for airway protection
  • Size of ETT?
  • Depth?
• Breathing
  • How to assess?
  • What to consider?

BREATHING

PEDIATRIC BREATHING

• Anatomy
  • Pliable ribcage
  • Less likely to have palpable rib fx
  • More likely to have contusions than ptx
• Tension pneumothorax
  • Needle decompression (16 to 18 gauge)
• Ventilation
  • 5-8mL/kg tidal volume, use pedi BVM
BACK TO OUR CASE

- Decreased breath sounds on left
- No crepitus or bruising
- Action?

CASE 1 CONTINUED

- Check depth of ETT quickly
  - Depth was 17cm
  - Once readjusted, symmetric BS
  - CXR with no ptx bilat
- Moving on…

CIRCULATION
PEDIATRIC CIRCULATION

• Circulation
  • How to assess?
  • How long should capillary refill be?
  • How do we treat hypovolemia?

PEDIATRIC CIRCULATION: ANATOMY

• Total blood volume less
  • 70-80mL/kg
• Vulnerable internal organs
• Flexible ribcage
• BP differs by age and size
  • 70 + (2 x age in years)

PEDIATRIC VITAL SIGNS

<table>
<thead>
<tr>
<th>Age</th>
<th>HR</th>
<th>SBP (lower limit)</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth-6mo</td>
<td>80-180</td>
<td>60</td>
<td>30-60</td>
</tr>
<tr>
<td>6mo-1yr</td>
<td>70-170</td>
<td>70</td>
<td>30-50</td>
</tr>
<tr>
<td>1-3yr</td>
<td>90-150</td>
<td>70-75</td>
<td>25-40</td>
</tr>
<tr>
<td>3-5yr</td>
<td>65-135</td>
<td>75-80</td>
<td>20-34</td>
</tr>
<tr>
<td>5-12yr</td>
<td>60-120</td>
<td>80-90</td>
<td>15-30</td>
</tr>
<tr>
<td>12yr-adult</td>
<td>60-100</td>
<td>90</td>
<td>12-20</td>
</tr>
</tbody>
</table>
SIGNS OF SHOCK

• Delayed capillary refill (>2 sec)
• Mottled skin
• Tachycardia
• Narrowed pulse pressure
• Decreased level of consciousness
• Hypotension a LATE sign in kids
  • >20% total blood volume loss

PEDIATRIC CIRCULATION: ACCESS

• IVs
• Intraosseous lines

INTRAOSSEOUS LINE

• Indications
  • Inability to obtain IV access in child requiring volume or medications
• Contraindications
  • Open fracture at site
  • Proximally disrupted venous return
• Up to 72-96 hours
INTRAOSSEOUS LINE

PEDIATRIC CIRCULATION POLL

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PEDIATRIC CIRCULATION: VOLUME

- 20mL/kg bolus of NS or LR
- May repeat
- If needed, 10mL/kg bolus PRBC
- Key: locate source of volume loss
**CASE 1 CONTINUED: DISABILITY**

- Receives bolus, now on to D
- On exam, obvious head trauma, periorbital ecchymosis bilaterally
- Exam prior to intubation
  - Eyes closed, moaning, withdraws to pain

### GCS

<table>
<thead>
<tr>
<th>Area of Assessment</th>
<th>Score</th>
<th>Adults</th>
<th>Children &lt; 3 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eye Opening</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneous</td>
<td>Spontaneous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To verbal command</td>
<td>To verbal command</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To pain</td>
<td>To pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Verbal Response</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oriented</td>
<td>Sticks, oriented to sound, following</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confused</td>
<td>Crying, consolable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inappropriately</td>
<td>Crying, inappropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inconsolable</td>
<td>Crying, inconsolable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Motor Response</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oriented pain</td>
<td>Oriented pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Withdraws to pain</td>
<td>Withdraws to pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal flexion to pain</td>
<td>Abnormal flexion to pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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CASE 2

• 11yo male, skateboarding unhelmeted
• Jumped up ramp 5-6 feet
• Fell, landed on cement
• +LOC
• Came in BB/CC
• HR 98 BP 110/82 RR 16 Sat 99% RA
• Alert, oriented, amnestic to brief event
• Symmetric and normal neuro exam
• ABCs all stable

HEAD INJURY POLL

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RADIATION PRINCIPLES

CAUTION
X-RAY
IN USE

ALARA
As Low As Reasonably Achievable
PEDIATRIC TBI TREATMENT

- Large heads are at risk of injury
  - Majority of fatal pediatric traumas have head injury
- Avoid hypotension and hypothermia
- End-tidal CO2 30-35
- Protect C-Spine
CASE 3

• 2 yo male, ejected in carseat in rollover highway speed MVC
• General: Eyes closed, making no sounds, no movement of extremities
• VS: HR 135 BP 65/palp RR 30 shallow, Sat 95%

Where do we start?

CASE 3

A: In addition to GCS=3, no gag response
   • Intubation with C-spine immobilization
   • ETT size and depth?
B: Bags easily, symmetric lung sounds
C: Tachycardic and hypotensive
   • Bolus?
D: Concerning for head and/or spinal cord injury
   • ET CO2 30-35
   • Avoid hypotension and hypothermia
### CASE 3 OUTCOME

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Diffuse axonal injury and SAH in brain&lt;br&gt;• Atlantoaxial dissociation</td>
<td>• Devastating head injury and spinal cord injury&lt;br&gt;• Died after 3 days in ICU</td>
</tr>
</tbody>
</table>

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### CASE 4

**4 yo female, c/o leg pain after fall from standing at home**

- **General:** Tearful, won't make eye contact, won't provide history by herself
- **HR 100, BP 95/60, RR 18, Sat 100%**
- **ABCD intact, GCS=15**
- **Deformity of L femur noted**

**Where do we start?**

**Where do we start?**

---

### CASE 4

- **Traction splint applied, transported**
- **Medics note odd affect of caregiver**
- **Injuries**
  - Acute left femur fracture
- **Outcome**
  - Medics' report and RN questions prompts evaluation
  - Pt found to have multiple old fractures
  - CPS referral made for suspected child abuse
CHILD ABUSE

• Tragically common
  • 3-4 million reported cases per year in U.S.
• Most vulnerable
  • Infants, children with disabilities
  • Age <4 yo comprises 75-80% of deaths from abuse
• Mandatory reporting in all states

CHILD ABUSE: CLUES

• Multiple recurrent injuries
• Inconsistent history
• Inappropriate child-caregiver interactions
• Multiple bruises in various stages
• Age-inappropriate injuries
• Delays in seeking treatment
• Think about it!

CASE 1 OUTCOME: 3YO FALL

• Injuries
  • Bilateral epidural and subdural hematomas
  • Splenic laceration
  • Facial fractures and lacerations
• Outcome
  • Extubated after 12 hours
  • Did not require surgery
  • Discharged 2 days later
  • 2 month follow-up back to regular health
### TRAUMA ABC: RECAP

**Airway**
- ETT Age/4 + 4
- Depth ETT size X 3

**Breathing**
- Use pediatric BVM to get appropriate tidal volume, 5-8mL/kg

**Circulation**
- Look at cap refill
- 20mL/kg bolus IVF (Broselow for estimate)

**Disability**
- Clinical decision rules helpful
- Avoid hypotension and hypothermia
- End-tidal CO2 30-35

**Other**
- Consider child abuse

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### ANY QUESTIONS?

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### THANK YOU!

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