Rapid Pediatric Trauma Emergency Assessment for the EMS Provider

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Discuss major differences in the pediatric patient and how children respond to trauma
Develop a rapid systematic approach to pediatric assessment
Review early management for prehospital care
Discuss specific injuries
- TBI
- NAT
Use case studies to practice the skill of rapid systematic assessment approach

Know the main differences in anatomy and how they would affect responses to trauma & illness
Do not go by memory—carry a reference for:
- Weight estimation
- Vital signs
- Equipment sizes
- Medications
- Review review review...

Children are just small adults

Kids are Special

- One size does NOT fit all!
  - Variable weight and height
  - Smaller body mass
    - Organs closer together—high risk for multi-organ injury
    - Kinetic energy has more profound impact
  - Bone are more flexible
    - Significant injuries easier to miss
  - Don’t understand cause & effect
    - Harm or risk
However, like adult calls...

BSI
- Scene Safe and scene size up
- General Impression + immediate life threats
- Primary Survey
- Patient priority
  - Rapid trauma survey with immediate transport/“load and go”
  - Focused exam
- Secondary survey
- Reassessments

Pediatric Trauma Epidemiology & Mortality
- Leading cause of death in children
- 50% children who die, die on scene
- Platinum 30” matter
- Head traumas are a leading cause of death
- Abdominal trauma most common form of trauma

Most Common Pediatric Trauma

- < 4 years: Drowning leading cause of death
- 5-9 yrs Pedestrian struck leading cause of death
- Blunt trauma often involves TBI in kids

Pediatrics... Defined... Sort of
- Neonates: birth to 1 month
  - Except for NRP
- Infants 1 mth- 12 mths
- Toddlers: 1-3 yrs
- Preschoolers: 3-6 yrs
  - Except for school systems
- School age: 6-12 years
  - But what about the 50kg 9 year old???
- Adolescent: 12-18
  - Except for pediatric trauma centers

Most Pediatric Common Emergencies
- Neonates
  - Infection, neglect
- Infant
  - Infection, neglect, abuse
- Toddler
  - Poisoning, Fall
- Preschool
  - Poisoning, Fall, Peds struck
- School age
  - Ped struck, Fall, Recreational sports
- Adolescent:
  - MVC, OD, Recreation

Patterns of Injury
Why DO we miss important assessment information?

- Lack of systematic approach
- Pediatric calls can be stressful
  - Parents/ family members stressed
  - Rarely used equipment
  - Rarely practiced/ used skills
  - Initial responses to severe injury can be subtle

Prevent secondary injury!
- Protect C Spine
- Forththought of potential problems
  - A B C not just for rule out
- Stop shock cascade
- Reduce occurrences & severity of increased ICP in head traumas

General Principles of Care
- Be Prepared
  - Practice/ Simulations/ Review
  - Know your available equipment
- Carry a reference
  - VS
  - Weight
  - Equipment
  - Medications
  - Age ≤ 8: \( \text{Age} \times 2 + 8 = \text{weight in kg} \)
  - Age ≥ 8: \( \text{Age} \times 3 = \text{weight in kg} \)
- Retrospective Review
  - Case review- Discussions, Video review
  - Self review

Spinal Motion Restriction
- Lift torso with padding for proper neck alignment
  - Avoid passive flexion
- Limit movement
- Allow for proper ventilation
  - Beware of straps
- Prevent aspiration

external meatus aligned with shoulder = neutral spine position

Airway
- Big tongue +
- Big head +
- More secretions +
- Small, Narrow, short airways =
- Many Ways to Obstruct
**Children are Special**
- Infants are nose breathers, they don’t mouth breathe well
  - Short neck
  - Small mandible
- Epiglottis is more U shaped
- Airway is funneled shaped
- Shorter
- Angled vocal cords
- More anterior
  - Easier to obstruct with over extension

**Airway Assessment**
- Is it patent? Are they at risk for it not to be?
  - Position
  - Capnography
  - Sats
  - Beware of occult foreign bodies

*What is the most common cause of airway obstruction in the pediatric patient?*

**Airway Interventions**
- Open airway
  - If not patent:
    - Maintain spinal motion restriction, jaw thrust, suction.
    - 100% oxygen. If they take an oral airway, they need to be ventilated.
- Positioning - unconventional techniques
- Suctioning
- Oral airways
- Intubation

**Pediatric RSI**
- Preoxygenate!!
- Prepare & Contingency Plan
  - Assessment & exam
  - Hx-
  - Preheat with RX
    - Atropine-for all < 1yr, any <3yrs receiving Suce, >3yrs w/ 2 doses of succ
    - Sedation and paralysis (except unresponsive)
  - Airway protection and positioning
  - ETT placement & Confirmation
  - Post intubation management

**Intubation**
- More Anterior
  - Easy to obstruct with over extension when intubating
- Diameter smaller, with larger tongues
- Trachea short & funnel shaped:
  - Easy right stem intubation
  - Tube easily dislodged
- DOPE

**Breathing Assessment**

*PEARLS: Kids are more likely to die from hypoxia*
- Progression of respiratory distress to failure then arrest ensues quickly
- One of the first signs of hypoxia and shock is AMS &/or tachycardia
**Children are Special..**

- Lungs are less compliant
- Ribs are more compliant
  - Pliable thoracic cavity & mobile mediastinum
  - Occult injuries common
  - High risk for tracheobronchial injuries, especially tension pneumothorax
  - Weak accessory muscles = poor reserve
  - Horizontally aligned ribs - diaphragm dependent belly breathers. Less abdominal fat - organs move upward when supine
  - Pulmonary contusion common
  - Gastric distention & positioning quickly effects WOB
  - Increased metabolism = ↑ O2 consumption
  - Less tolerant of hypoxia

**Respiratory Exam**

- Assess
  1. WOB
  2. BBS
  3. RR - breathing at an adult rate may mean impending respiratory FAILURE
- Respiratory Distress?
  - ↑ WOB - BEWARE of irregular breathing patterns
  - BBS
  - ↑ or ↓ in RR
  - Grunting: Exhaling against a partially closed glottis in attempt to generate/PEEP & preserve resting lung volume. Always indicator of severe illness
- Respiratory Failure?
  - Cyanosis
  - Poor ventilation
  - Head bobbing = impending failure
  - Apnea OR gasping = Respiratory ARREST

**Breathing Problems**

- Apnea/ Gasping = (CHECK A PULSE)
  - Obstructed airway
    - Position
    - Foreign body
    - TBI/ICP
    - General prolonged hypoxia
  - Pneumothorax
  - Tension pneumothorax

**Interventions**

- Protect C spine
- Suction
- Prevent respiratory arrest
  - Do not constrict abdomen or chest with securing devices
- BVM
  - Avoid soft tissue occlusion
    - Pressure ocular, airway
    - Fingers, mask

**Advanced Respiratory Interventions**

- Size of ETT
  - \((\text{Age} + 16) / 4\)
  - Size of pinky finger
  - Size of nasal
- Needle decompression

**Cardiovascular Assessment**

- It's All About Perfusion...

PEARLS:

- A pediatric patient can be in life threatening shock & still have a normal BP
- HR is one of the 1st VS to change when a child is sick
- Hypothermia ensues quickly and can be the cause of PEA arrest in a sick child
Children are Special

- Metabolism
- HR
- BP
- Thinner skin
- 70-80cc /kg blood volume

Circulatory Assessment

Observation of Color & Hands On Assessment
- Compare pulses:
  - Central vs. distal/peripheral
  - Effected by Edema
  - Large body size
- HR
- Skin temp
- Capillary Refill time

Blood Pressure

<table>
<thead>
<tr>
<th>Age</th>
<th>Lowest acceptable Systolic pressure</th>
</tr>
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<tbody>
<tr>
<td>0 – 28 days</td>
<td>60</td>
</tr>
<tr>
<td>1 month – 1 year</td>
<td>70</td>
</tr>
<tr>
<td>1 year+</td>
<td>70 + (2 x age in years)</td>
</tr>
</tbody>
</table>

Diastolic Pressure should be 2/3 systolic
**Response to Hypovolemia**

- 10-15% loss of volume:
  - Mild tachycardia, prolonged CRT, skin cool, mottled
  - Anxious, irritable, confused
- 30%
  - Severe Tachycardia, diminished peripheral pulses, hypotensive
  - Minimal response to pain
- 30-45%
  - Narrow pulse pressure, weak central pulses
- > 45%
  - Profound hypotension, pale, cold skin, bradycardic
  - Coma

**Pediatric Definition of Shock**

Tachycardia + Poor Perfusion = **SHOCK**

Note that Pediatric patients can be in severe shock and still have normal blood pressure!

**Disability...**

- Kids have a larger body surface area to size:
  - Set up for hypothermia
  - Immature temperature regulation
- Larger head to body ratio:
  - Higher risk for TBI

**Level of Consciousness**

Responsiveness to stimulation

- Awake- alert without stimulation
- Verbal
- Pain
- Unresponsive

Children who are quiet after a traumatic event are most always in shock
Level of Consciousness

This is the normal response in a child who has been hurt

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Exposure & Emotions

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Secondary Survey & Reassessments

Done En Route to Trauma Center

- Head to Toe eval
- SAMPLE
- H’s & T’
- ABD decompression
- Additional IV site
- Look for missed injuries

IF a Child decompensates at any point, go back to the A B C assessment!

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Secondary Assessments

- Remember: atropine (if given for RSI) will dilate pupils but does not cause FIXED pupils
- Some life threatening injuries may be missed on the initial A B C exam (ie open chest wound) do not move on to next phase of care until initial A B C’s are stabilized
- If your intervention did not stabilize the problem, recheck your intervention, then look for another reason for the problem

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2015 AHA Recommendations

- The available evidence does not support the routine use of atropine preintubation of critically ill infants and children.
- It may be reasonable for practitioners to use atropine as a premedication in specific emergency intubations when there is higher risk of bradycardia (eg, when giving succinylcholine as a neuromuscular blocker to facilitate intubation). (Class III, LOE C-LD)
- NEW: OCT 2015
- A dose of 0.02 mg/kg of atropine with no minimum dose may be considered when atropine is used as a premedication for emergency intubation. (Class III, LOE C-LD)
- This new recommendation applies only to the use of atropine as a premedication for infants and children during emergency intubation.
Secondary Assessment
- Abd tenderness could indicate significant trauma.
- Abd distension consider significant trauma until proven otherwise.

H's & T's
- Not are they only the reason a child could present in extremis, they are also the reason they could decompensate while in our care.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoxia</td>
<td>Tablets/TOXINS</td>
</tr>
<tr>
<td>Hydrogen ion - acidity</td>
<td>Tamponade (cardiac)</td>
</tr>
<tr>
<td>Hyperkalemia / Hypokalemia</td>
<td>Tension pneumothorax</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>Thrombosis, coronary (ACS)</td>
</tr>
<tr>
<td>Hypoglycemia &amp; other metabolic disorders</td>
<td>Thrombosis, pulmonary (embolism)</td>
</tr>
<tr>
<td>Hypovolemia</td>
<td>Trauma</td>
</tr>
</tbody>
</table>

Having a well practiced systematic approach keeps everyone focused on the priorities on hand

Traumatic Brain Injury
- 1 million children evaluated yearly - 7000 pediatric deaths per year
- 80-90% are mild
- Most common cause of mortality and morbidity

Etiology:
- Infants: abuse
- Toddlers: abuse and falls
- School aged: play and sports injuries and MVC
- Adolescents
  - MVC and assault

Predisposed
- Large heads
- Poor neck muscle control
- Thin, pliable skulls

Pathophysiology
- Acceleration
  - Stationary head hits by moving object
  - Least fatal
- Deceleration
  - Moving head hits stationary object
  - Most severe for brainstem injuries
- Rotational
  - Vigorous back and forth movement
  - Head hit at an angle
  - Diffuse injury, large SDH
- Direct blow
  - Causes fracture
  - Meningeal artery or dural venous tear causes EDH

Munro-Kellie Doctrine
- In the skull:
  - Brain
  - Blood
  - CSF
- Cushings triad
Level I = MUST DO!
- Monitor Sats
- Maintain IV
- Give pain & sedation Rx
- Monitor Capnography

Level II
Should be Considered
All the previous intervention AND:
- Avoid Steroids (often given prior to extubation)
- Avoid Hypothermia (DCR)
- Consider 3% NS for increased ICP, ulcer prophylaxis, TF, foley

Level III
May be Considered
(Who knows??) all the previous +
- ICP Monitoring, ICP drain, HTS, pressers, paralytics, ventilation
- Sz Rx, Diuretics

Avoid Secondary Injury
- Single episode of hypotension or hypoxia can increase risk of mortality by 150%
- Airway & C Spine
  - Control
  - Breathing
  - Beware of gastric distention = vomit = ICP = Secondary injury
- Circulation
  - Treat hypovolemic shock aggressively

TBI Treatment
- Prevent secondary injury
- Cardiovascular: 1 episode of hypotension doubles mortality
  - Avoid hypotension and hypoperfusion
  - Assess frequently, shock occurs BEFORE hypotension
  - HOB 30 degrees
  - Correct coagulopathy
  - Volume
  - Pressors
  - Keep MAP > 50 infants > 60 child > 70 in adolescent

TBI Treatment
- Establish spinal movement restriction
- Establish airway control
- Monitor ETCO2 & Pulse ox immediately
- 100% FIO2 for all pediatric TBI
  - Avoid hypoxia
  - Avoid hypo and hyper ventilation. ETCOs 35-45
- Avoid hyperglycemia & hypoglycemia
- Avoid hyperthermia & hypothermia
- ? Decompressive craniotomy
  - ? Saves pt? Not brain
**Signs of Increased ICP**

- **Neuro Changes**
  - AVPU
- Pupils
- Vomiting
- Cushings triad

**Herniation Syndromes**

<table>
<thead>
<tr>
<th>Location</th>
<th>Eye Findings</th>
<th>Gross Motor Findings</th>
<th>Respiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncal (lateral transtentorial)</td>
<td>Bilateral fixed pupils, dilatation and ptosis</td>
<td>Pupillary decussation, hemiparesis</td>
<td>Irregular</td>
</tr>
<tr>
<td>Diencephalic</td>
<td>Small midpupils, but reactive to light</td>
<td>Decorticate posturing, hypertonia</td>
<td>Cheyne-Stokes (episodes of apnea and tachypnea)</td>
</tr>
<tr>
<td>Midbrain</td>
<td>Midpoint fixed pupils</td>
<td>Decerebrate posturing</td>
<td>Hyperventilation</td>
</tr>
<tr>
<td>Medullary</td>
<td>Dilated and fixed pupils</td>
<td>No response to pain</td>
<td>Irregular or gasping</td>
</tr>
</tbody>
</table>

**Hyperventilation**

- Transient or bridging hyperventilation only indicated in cerebral herniation
  - Decerebrate posturing
  - Rapidly decreasing GCS
  - Flaccid (motor score of 1)
  - Unequal pupils or fixed and dilated pupils
  - ETCO2 > 30-35
- Ventilate
  - Infants 35 bpm
  - Children 30 bpm

**Hypertonic Saline**

- Hypertonic saline decreases ICP
- Preserves intravascular volume
- Theoretically restores normal cell resting membrane potential, inhibits inflammation, stimulates atrial natriuretic peptide release and enhances cardiac output
- 0.1-1 cc/kg/hr or 1-6 cc/kg bolus
- Keep serum osmolality < 360

**Non Accidental Trauma**

Exact numbers hard to detect-est. 10% of ED visits from trauma in children <3 yrs are NAT
40% have no signs of external trauma on initial exam
80% of deaths from head trauma in children <2yrs are NAT Injuries
1. Skin lesions
2. Head trauma, injury
3. Fractures

**EMS Calls & ED Visits**

**CHIEF COMPLAINTS**

- Viral gastritis
- Seizures
- Flu
- Accidental head trauma
- Rule out sepsis
- Injuries

**INJURIES FOUND**

- Femur fx in children <1yr
- Humeral shaft fx in <3 yr
- Sternal fx
- Posterior rib fx
- Digit fx in children who are non ambulatory
**High Suspicion**

- Story inconsistent with child's developmental ability
- Exam pts carefully for acute and chronic trauma
  - Femur fx in children < 1yr
  - Humeral shaft fx in <3 yr
  - Sternal fx
  - Posterior rib fx
  - Digit fx in children who are non ambulatory

**Shaken Baby Syndrome**

- Life threatening injury in children <2yrs
- Mechanism
  - shaking the baby back and forth causing rapid acceleration and deceleration of the cranial contents against the skull. Shearing injuries of vessels, cervical spine injury and intraocular injury results.
- C/C: “not acting right”, sleepy, lethargic, seizures
- Often no external signs

**NAT**

- Careful documentation
- EMS Report to ED

**Take Home Points**

1. Children are not little adults
2. Recognize children can decompensate in minutes
3. Having a well rehearsed systematic method of assessment & treatment priorities saves lives

**New Concepts in TBI**

- DCR- Damage Control Resuscitation
- Hemostatic Resuscitation: Improving Outcomes by Early Reversing of ATC (Acute Traumatic Coagulopathy) -
  - Early Hemorrhage Control- DCS
  - Permissive hypotension
  - Limit dilution by limiting fluids
  - Target Coagulopathy
- 23.4% HS for rescue bolus 0.75cc x kg over 30” (instead of Mannitol)
- Avoid hypercloremia
- Care may be guided by biomarkers

**References**

- [https://www.youtube.com/watch?v=9T7jQM015j](https://www.youtube.com/watch?v=9T7jQM015j)
- [https://www.youtube.com/watch?v=MxeStUoWqE4](https://www.youtube.com/watch?v=MxeStUoWqE4)