NWC EMSS
Continuing Education
August 2017

Pediatric Trauma

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Pediatric Trauma

Goal: To strengthen participants' ability to assess pediatric patients who have or may have sustained trauma, to recognize abnormal findings and anticipate injuries based on unique peds anatomy, mechanism, and known response to specific types of mechanisms, and to promptly formulate and implement an appropriate plan of care based on evidence-based pediatric trauma management guidelines.

OBJECTIVES:

Upon completion of the assigned readings and class, each participant will do the following with at least an 80% degree of accuracy and no critical errors:

1. Discuss anatomical features of children that predispose them to or protect them from certain injuries.
2. Describe assessment of pediatric patients who have / may have sustained trauma.
3. Identify history and exam findings in pediatric trauma patients that require application of spine motion restriction.
4. Demonstrate proper technique for spine motion restriction for the pediatric trauma patient.
5. Perform accurate assessment of neurologic status of the pediatric patient using the Pediatric GCS.
6. Demonstrate and discuss assessment findings that indicate hypoperfusion in the pediatric trauma patient.
7. Discuss interventions for management of hypoperfusion in pediatric patients with trauma, based on kg weight and guided by NWC EMSS SOPs.
8. Discuss pathophysiology of perfusion compensation and deterioration in the pediatric aged patient.
9. Demonstrate pain management for pediatric patients with trauma, using non-pharmacologic methods as well as fentanyl administration, including accurate dose and route determination.
11. Identify, discuss history and exam findings that raise suspicion for potential concussion related to trauma
12. Discuss guidelines and objectives of safe transport of pediatric patients by EMS.
13. Demonstrate safe securing of the pediatric aged patient using provider-specific equipment for the "unstable" patient requiring exposure and access for frequent intervention and monitoring.

Pediatric Trauma

Why this class is important for you: Trauma is the most frequent cause of death in children. It is estimated that between 7-13% of all EMS calls involve pediatric aged patients, and of those calls, about 30% are for traumatic injury. (Pediatric Emergency Care Applied Research Network). This presents a challenge for EMS considering these low numbers compared to calls involving adult patients, and the relative infrequency with which EMS providers treat children with severe injuries. A solid understanding of the unique anatomy of the pediatric patient, and the respective physiologic response to injury, is essential to successful outcomes when assessing and treating a child with traumatic injuries.

Mechanism of injury: Important because it predicts injury patterns. Awareness of mechanism translates into anticipation of injury and directs your assessment.

Unique Pediatric Anatomy, Physiology Related to Trauma

Body Part/System	Unique Anatomy and or Physiology	Unique Injury Patterns & Implications for Injury
Head	• Younger heads larger, heavier • Higher center of gravity • Weak neck muscles • Open fontanelles (< 18 mo) • Thin, non-fused cranial bones • Neural tissue not fully myelinated • Scalp highly vascular	• Lead with their heads (falls, deceleration) • May exsanguinate from scalp laceration • Hypovolemia can occur w/ epidural bleed < 18 mo. • Brain easily injured w/o myelin to protect • Significant brain swelling w/o typical S&S
Chest/thorax	• Chest wall elastic & flexible – underlying structures poorly protected • Rib fx uncommon • Fragile lung tissue • Thin chest wall	• Risk due to fragility, poor protection: o Lung tissue injuries incl pulm contusion, pneumo or hemothorax o Myocardia contusion o Spleen and liver injury • Rib fx & flail uncommon

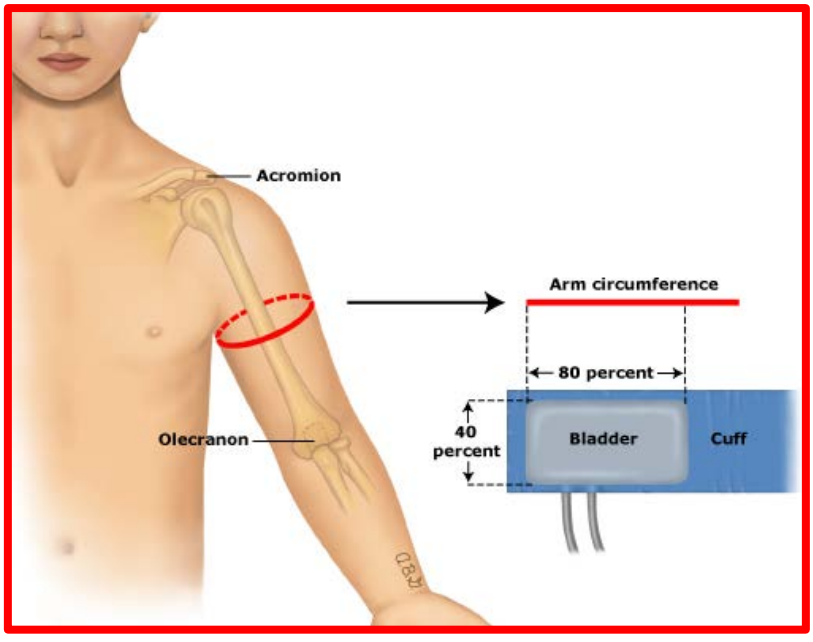
	• Diaphragm rises to nipple line w/ expiration	• Fx requires tremendous force-look for other injury! • Internal injury not suggested by ext findings
Abdomen	• Organs large, close together • Liver & spleen highly vascular • Thin, weak, pliable abd wall + immature abd muscles = less protection • Pliable ribs and pelvis = less protection • Kidneys anterior, lack protective fat	• Deep penetration of blunt force w/ no sign of surface trauma • Unprotected liver, spleen, lungs easily injured • Close proximity of organs → single blunt force injures multiple organs • Hemorrhage presentation may be subtle – exam + hx + mechanism very important • Reliable exam hampered by guarding, pain, fear • Anticipate resp distress / impairment
Pelvis/GU	• Bladder is located in intra-peritoneal space • Kidneys mobile, poorly protected • Organs close together	• Risk for massive, occult bleeding into pelvis • Bladder position makes it easily injured • Suspect accompanying abd organ injury w/ findings of pelvic injury • Suspect injury to lower spine w/ if pelvic injury +
Spinal cord	• ↓ neck muscle mass: can't restrict rapid motion • Flat/horizontal spinous facets + flexible ligaments + elastic spine cartilage → vertebral bodies slide forward → results in cord damage w/ no abnormality on radiologic studies (SCIWORA) • Resp neurons housed in cervical spine • 50% spine injuries occur in the absence of spinal fracture	• Injuries usually @ cervical level • Careful assessment is ESSENTIAL since Xray/CT not usually helpful in diagnosing injury • Assess resp function frequently! • Assume SCI in any unresponsive child • Must include motor & sensory assessment - deficits may mask injury! • 50% occur WITHOUT spinal fx • Injury often partial, initially asymptomatic! • Predictors / risk of C-spine injury o Neck pain o Substantial torso injury o Predisposing conditions o Shallow water diving accidents o High speed MVC, esp w/ ejection o Torticollis
Circulatory / Perfusion	• Strong catecholamine capabilities • Same volume loss as adult = larger total % loss • Less Hgb than adults = less O2 carrying capacity • Compensatory mechanisms o ↑ HR o Vasoconstriction • Hypotension does not occur until volume loss reaches 25-30%	• Solid abd organ hemorrhage is most freq cause of hypotension in peds trauma • Other etiologies for hypotension: pneumothorax, spine injury, cardiac contusion or tamponade • BP is late indicator of hypoperfusion • Best indicators of hypoperfusion: o Sustained tachycardia o Cool/cold and pale or mottled skin o Mental status change • May be in shock despite a normal BP
Pedestrian MOI		• Pattern of injuries in high-velocity blunt trauma • Child tends to turn toward impacting object • Multiple impacts follows typical pattern #1 Bumper impacts legs, pelvis #2 Torso impacts hood of vehicle #3 Child propelled downward, striking head • Predictable Associated Injuries: #1: Fx pelvis, femur; internal hemorrhage #2: Chest, abd, facial, head & neck injury #3: Head/neck/spine injuries, fractures • Potential for significant blood loss

Assessment Findings Relative to Volume Loss and Shock in Pediatric Trauma

Stage of Shock and Percentage of Volume Loss				
	Class I 15%	**Class II 15-30%**	**Class III 30-45%**	**Class IV > 45%**
Assessment findings				
Mental Status	Slightly anxious	Mildly anxious; restless	Altered; lethargic; apathetic; decr pain response	Extremely lethargic; unresponsive
Muscle tone	Normal	Normal	Normal to decreased	Limp
Ventilatory Effort, Rate	Normal	Mild tachypnea	Mod. tachypnea	Severe tachypnea to agonal
Skin color	Normal	Pale; mottled	Pale; mottled; mild peripheral cyanosis	Pale; mottled; central and peripheral cyanosis
Skin temperature	Cool	Cool	Cool to cold	Cold
Capillary refill	Normal	Poor (> 2 sec)	Delayed (> 3 sec)	Prolonged (> 5 sec)
Heart rate	Normal if gradual volume loss; increased if loss is sudden	Mild tachycardia	Significant tachycardia; possible dysrhythmias; periph pulses weak, thread, or absent	Marked tachycardia to bradycardia
Blood pressure	Normal	Lower range of normal	Decreased	Severe hypotension
Pulse pressure	Normal or increased	Narrowed	Decreased	Decreased
		Compensated Shock	**Decompensated Shock**	**Irreversible Shock**

Source: Aehlert, B. Paramedic Practice Today: Above and Beyond, Volume 2. P 97

BP Measurement in Pediatric Patients



Accurate blood pressure measurement requires use of a properly sized cuff. A cuff that is too small will yield a falsely high reading. The reading will be falsely low if the cuff is too large. Use the following guidelines to determine the correct cuff size and cuff placement for your pediatric patient:

- If one cuff is too small but the next available cuff is too large, opt for the next size larger
- Avoid choosing a cuff based on an “age group” label on the cuff
- Place cuff over midpoint of upper arm
- The bladder length should cover 80-100% of the arm circumference
- Ideally there should be 2-3 cm space below the cuff for stethoscope placement

Safe Transport of Pediatric Patients (Sources: *Recommendations for the Safe Transportation of Children in Emergency Ground Ambulances*. NHTSA, August 2010; *Safe Transport of Children by EMS: Interim Guidance*. NASEMSO, March 2017)

Safe securing of pediatric patients for transport in an ambulance is done with the intent of achieving these 3 goals:

- Prevention of forward motion / ejection
- Securing of the torso to the stretcher
- Protecting the head, neck and spine

Doing so may prove challenging depending on variables such as patient size, intervention and accessibility requirements relative to the level of the child's particular illness or injury, and the specific transport devices available to caregivers. The following actions/processes are among those supported by the National Assoc of EMS Officials (NASEMSO):

- All EMS agencies that transport children should develop specific policies and procedures that address, at minimum the following elements:
    - Methods, training (initial and continual), and equipment to secure children during transport in a way that reduces both forward motion and possible ejection. The primary focus should be to secure the torso, and provide support for the head, neck, and spine of the child, as indicated by the patient's condition.
    - Considerations for the varied situations that a child who needs transport to a hospital or other point of care may present to the EMS professional.
    - Prohibits children from being transported unrestrained, e.g. held in arms or lap
    - Provision for securing all equipment during a transport where a child is an occupant of the vehicle
    - Only use child restraint devices in the position for which they are designed and tested
- EMS agencies should have appropriately-sized child restraint system(s) readily available on all ambulances that may transport children. Additionally, personnel should be initially and recurrently evaluated and trained on the correct use of those restraint systems.
    - The device(s) should cover, at minimum, a weight range of between five (5) and 99 pounds (2.3 - 45 kg), ideally supporting the safest transport possible for all persons of any age or size
    - Only the manufacturer's recommendations for the weight/size of the patient should be considered when selecting the appropriate device for the specific child being transported

Recommendations from NHTSA identify four options for child restraint systems in ground ambulances:

1. Integrated seats
2. Conventional CRSs designed for use in passenger vehicles
3. Cot-mounted devices
4. Board and harness systems

NHTSA's *Recommendations* document provides 2 options for achievement of safe transport practices:

- *The Ideal*: - This is the ultimate goal for safely and appropriately transporting children in emergency ground ambulances and is the first option for transporting a child in each of the five situations.
- *"If the Ideal is not Practical or Achievable"* - This recommendation provides guidance to EMS professionals for the safe transportation of children if the Ideal cannot be achieved.

Guidelines excerpted from the Recommendations document address 5 "situations" for securing the patient:

Situation 1 - For a Child who is uninjured/not ill	
The Ideal	Transport using a size-appropriate child restraint system that complies with FMVSS 213 in a vehicle other than a ground ambulance.
If the Ideal is not Practical or Achievable	• Transport in a size-appropriate CRS that complies with FMVSS 213 appropriately installed in the front passenger seat (air bags off) of the ground ambulance; or • Transport in the forward facing EMS provider's seat (currently rare in the industry) in a size-appropriate CRS that complies with FMVSS 213 inside ambulance; or • Transport in the rear facing EMS provider's seat in a size-appropriate CRS that complies with FMVSS 213 (convertible or combination seat but not infant only seat, using a forward facing belt path) or in an integrated CRS (certified by manufacturer) to meet the injury criteria FMVSS 213; or • Consider delay of transport of the child with appropriate adult supervision until additional vehicles are available (patient is transported in EMS vehicle separately); or

	• Per the judgment of EMS personnel on the scene (and in consultation with medical control, when possible), consider delay of transport (to the extent the patient's safety and medical condition are not in any way compromised), patient care continued on scene (monitoring) until an additional vehicle is available for transport.
Situation 2 -For a Child who is ill and/or injured and whose condition does not require continuous and/or intensive medical monitoring and/or interventions	
The Ideal	Transport child in a size-appropriate child restraint system that complies with the injury criteria of FMVSS 213—secured appropriately on cot.
If the Ideal is not Practical or Achievable	• Transport child in the EMS provider's seat in a size-appropriate child restraint system that complies with the injury criteria of FMVSS 213 or an integrated seat in the EMS provider's seat that is certified by the manufacturer to meet the injury criteria of FMVSS 213; or • Transport child on cot using three horizontal restraints across the child's torso (chest, waist, and knees) and one vertical restraint across each of the child's shoulders.
Situation 3 -For a Child whose condition requires continuous and/or intensive medical monitoring and/or interventions	
The Ideal	Transport child in a size-appropriate child restraint system that complies with the injury criteria of FMVSS 213—secured appropriately on cot.
If the Ideal is not Practical or Achievable	• Secure the child to the cot; head first, with three horizontal restraints across the torso (chest, waist, and knees) and one vertical restraint across each shoulder. • If the child's condition requires medical interventions, which requires the removal of some restraints, the restraints should be re-secured as quickly as possible as soon as the interventions are completed and it is medically feasible to do so. • In the best interest of the child and the EMS personnel, the vehicle operator is urged to consider stopping the ambulance during the interventions. • If spinal immobilization of the child is required, see recommendation for Situation 4.
Situation 4 -For a Child whose condition requires spinal immobilization and/or lying flat	
The Ideal	• Secure the child to a size-appropriate spine-board and secure the spine board to the cot, head first, with a tether at the foot (if possible) to prevent forward movement.• • Secure the spine board to the cot with three horizontal restraints across the torso (chest, waist, and knees) and a vertical restraint across each shoulder.
If the Ideal is not Practical or Achievable	Secure the child to a standard spine board with padding added, as needed, (to make the device fit the child) and secure the spine board to the cot, head first, with a tether at the foot (if possible) to prevent forward movement. Secure the spine board to the cot with three horizontal restraints across the torso (chest, waist, and knees) and a vertical restraint across each shoulder.
Situation 5 -For a Child or Children requiring transport as part of a multiple patient transport (newborn with Mother, multiple children, etc.)	
The Ideal	• If possible, for multiple patients, transport each as a single patient according to the guidance shown for Scenarios 1 through 4. • For mother and newborn, transport the newborn in an approved size-appropriate child restraint system that complies with the injury criteria of FMVSS 213 in the rear facing EMS provider seat with a forward-facing belt path that prevents both lateral and forward movement (convertible or integrated child restraint system and not an infant only seat), leaving the cot for the mother.
If the Ideal is not Practical or Achievable	• When available resources prevent meeting the criteria shown for situations 1 through 4 for all child patients, including mother and newborn, transport using space available in a non-emergency mode, exercising extreme caution and driving at reduced (i.e., below legal maximum) speeds. • If additional units may be needed based upon preliminary reports, backup units should be put on standby.

ACR4 Child Restraint System: Awareness level information only.

This CRS is a flexible and fully adjustable harnessing system that allows full access to the pediatric patient (head to waist) while fully restrained. The device accommodates newborns and children weighing as little as 4 lbs, up to patients weighing as much as 99 lbs. It is machine-washable.

The ACR4 uses 4 color-coded restraints for easy selection in 4 different sizes:

- EXTRA SMALL 4-11 lbs,
- SMALL 11-26 lbs,
- MEDIUM 22-55 lbs
- LARGE 44-99 lbs.

The restraint tightens in the mattress of the stretcher, not into the child; thus preventing additional injury. It works on any stretcher or backboard without a bracket.

Concussion: What's New?

What follows is a sampling of updated findings and recommendations published following the Fifth International Conference on Concussion in Sports. (Source: *Consensus Statement on Concussion in Sports: the 5th Internat'l Conference on Concussion*. October 2016.)

What is the definition of SRC (sports related concussion)? Traumatic brain injury induced by biomechanical forces.

Common features of SRC:

- Caused either by direct blow to the head, face, neck or elsewhere…with an impulsive force transmitted to the head
- Typically results in the rapid onset of short-lived impairment of neuro function that resolves spontaneously.
- Signs and symptoms may evolve over a number of minutes to hours.
- Injury may result in neuropathological changes, but the acute clinical S&S are mostly reflective of a functional disturbance rather than a structural injury. Thus, no abnormality is seen on neuroimaging studies.
- Presentation includes a large range of clinical S&S that may or may not include loss of consciousness.
- Resolution of clinical and cognitive features usually follow a sequential course, but may be prolonged in some cases.

Sideline evaluation: Assessment of patients with suspected SRC is best done by examiners in multiple disciplines and levels of expertise. Sideline eval is still considered an important part of evaluation for possible SRC and must be done rapidly following injury.

Rest: "There is currently insufficient evidence that prescribing complete rest achieves these objectives (becoming symptom-free). After a brief period of rest during the acute phase (24-48 hrs) after injury, patients can be encouraged to become gradually and progressively more active while staying below their cognitive and physical symptom-exacerbation thresholds (ie, activity level should not bring on or worsen their symptoms). It is reasonable…to avoid vigorous exertion while…recovering. The exact amount & duration of rest is not yet well defined in the literature and requires further study."

Graduated return to sport: "A brief period of physical and cognitive rest is advised after SRC, followed by symptom – limited resumption of activity. Children and adolescents should not return to sport until they have successfully returned to school. However, early introduction of symptom-limited physical activity is appropriate."

Excerpt: Abstract: *Vestibular and vision deficits following concussion in children under 12*. C. Master., A Curry, R Kessler, M Pfeiffer, M Grady, R Robinson, K Arbogast. http://bjsm.bmj.com/content/51/11/A22.1. Vestibular and oculomotor visual (VOM) deficits are becoming commonly noted as characteristic findings in pediatric patients with concussion. In a study involving 871 patients under the age of 12 yrs. with concussion, 58% had a least one VOM deficit. Of those:

- 44% had balance abnormalities
- 39% had saccadic dysfunction (difficult with voluntary eye movement)
- 28% had deficits in gaze stability
- 10% had convergence insufficiency

Significance to EMS: These deficits should be assessed for when presented w/ a patient with potential concussion.

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Gen impression		
PAT: Gen appearance		
PAT: WOB		
PAT: Circulation		
LOC (AVPU)		
C-spine/SMR?		
Major bleeding?		
Airway		
C-spine		
Breathing		WOB:
		Rate:
		Depth:
		Air movement:
		Symmetry:
		Accessory muscle use or retractions:
		SpO2 on room air:
		ETCO2:
Circulation		Pulses:
		Skin:
		Cap refill:
		Heart sounds:
		ECG:
Disability		Pupils:
		Blood glucose:
		Peds GCS:
		Motor and sensory:
Expose		
Transport decision		
Baseline VS		
SAMPLE		S&S:
		Allergies:
		Meds:
		PMH:
		Last oral/LMP:
		Events:
Review of systems		
SUSPECTED INJURIES		
ESSENTIAL REASSESSMENT & MONITORING		

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