



Objectives

1. Unique A&P and predisposition to injuries
2. Primary assessment of peds trauma pt
3. Hypoperfusion: recognition/management
4. Priority: ABC's
5. SMR – who, when, and how
6. Safe securing and transport

WHY
 ARE WE
 HERE?

Why this class is important for you

- Most frequent cause of death in children is traumatic injury
- High acuity/low frequency
- Unique peds anatomy & physiologic response to different types of injury
- Awareness of unique A&P, and MOI, guides assessment and anticipation of injuries



Mechanism of Injury

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

Approach to Assessment for All Peds Trauma:

Assume that all kids who sustain trauma have a life-threatening event until it is ruled out!

Assessment: Peds Initial Trauma Care SOP

- Gen impression
- LOC, c-spine
- Obvious bleeding (C-A-B-C-D-E)
- A – ensure secure and patent
- B – ensure oxygenation / ventilation
- C – ensure adequate perfusion, cellular fuel
- D – assess GCS, pupils, pain mgmt, glucose
- E – expose to assess, keep warm (p 86-87)

Unique Pediatric A&P: Head Injury

- 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



Implications and Unique Injury Patterns

- Lead with their heads (falls, deceleration)
- May exsanguinate from scalp laceration
- Hypovolemia w/ epidural bleed < 18 mo.
- Brain easily injured w/o myelin to protect
- Significant brain swelling w/o typical S&S
- EMS plays crucial role in preventing "secondary" head injury (ABCD's)

Traumatic Brain Injury

2,600 deaths; 30,000 life-long disability
 Spectrum of brain insults: bleeding and diffuse axonal injury (DAI)

DAI is most common

- microscopic axon damage
- Not evident on CT
- Potentially devastating

All can cause cerebral edema



Secondary Brain Injury

Results from inadequate oxygenation, ventilation, perfusion, blood glucose extremes

Your most important role: PREVENTION

- ✓ Ensure adequate ventilation / oxygenation
- ✓ Maintain SBP > 70 + 2X age
- ✓ Treat hypoglycemia

One episode of ↓BP has greater effect on peds compared to adult

Assessment: AVPU

A	The patient is awake.
V	The patient responds to verbal stimulation.
P	The patient responds to painful stimulation.
U	The patient is completely unresponsive.

Assessment: Inspect & Palpate

- Size, shape, contour of skull, face (DCAPBLSTIC)
- Fontanelles
- Eyes: telecanthus; obvious globe injury
- Pupils: changes occur later!
- Face: symmetry; mobile segments; drainage
- Oral: teeth; malocclusion; trismus; trauma; bleeding gums
- Drainage/fluid/secretions
- Ears: trauma; otorrhea; Battle's sign

history

Helps determine severity of injury
 Mechanism and time of injury
 Loss of consciousness?
 Did they cry right away?
 Seizure activity?
 Child's ability to recall event

Bleeding from Head Wounds Can Lead to Hypotension in Kids!

Large scalp lacerations

Epidural bleeds in infants

If child w/ head trauma is hypotensive from the start, and the laceration and or blood loss is not large, LOOK ELSEWHERE for the bleeding source!

Concussion: What is It?

Definition debate:

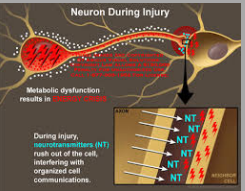
- TBI w/ ↓ degree of diffuse structural change?
- Damage from reversible physiologic changes?

Rapidly evolving injury in the acute phase, w/ rapidly changing clinical S&S

Evolving knowledge & recommendations

Diagnosis requires assessment in multiple areas of functioning (cognitive, physical)

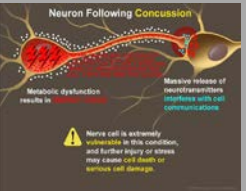
Concussion



Neuron During Injury

Metabolic dysfunction results in...

During injury, neurotransmitters (NT) both end of the cell, interfering with organized cell communications.



Neuron Following Concussion

Metabolic dysfunction results in...

Massive release of neurotransmitters interferes with cell communications.

⚠️ Nerve cell is extremely vulnerable in this condition, and further injury or stress may cause cell death or serious cell damage.

Neuro disturbances (memory problems, ataxia, delayed responses, dizziness) are due to disruption of metabolism, ionic movement, and physiologic responses in the neurons.

Concussion: Features

- Impulsive force transmitted to head
- Rapid onset brief impairment of neuro function that resolves spontaneously
- Resolution / impairment may be prolonged
- Range of S&S evolve over minutes to hours
- Functional disturbance but NOT structural injury
- No abnormality seen on imaging
- May or may not have loss of consciousness

Concussion: Acute S&S

Headache

Confusion

Dizziness

Amnesia

N&V

Fatigue

Irritability

Drowsiness


Slowed reaction

Balance impairment



Vestibular & Oculomotor Abnormalities in Concussion

- Voluntary eye movement difficulty
- Balance problems
- Near-vision difficulties
- Gaze instability



Concussion Management

- Activity restrictions have changed!
- Brief period of rest (24-48 hrs)
- Gradual ↑ activity *below* level of symptoms exacerbation threshold
- Progress to next level no sooner than 24 hrs
- Avoid vigorous exertion
- Successful return to school should precede return to sports/activities
- Return to full activity/sports upon physician's OK

EMS Responsibility

- Recognize S&S
- Assess for spine injury
- Encourage transport
- Support
 - removal from play
 - rapid sideline assessment
 - urgent follow up w/ MD
- Refusal? Observed by adult

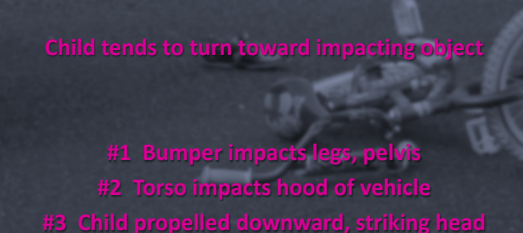


Pedestrian MOI: Waddell's Triad

Pattern of injuries in high-velocity blunt trauma


Child tends to turn toward impacting object

- #1 Bumper impacts legs, pelvis
- #2 Torso impacts hood of vehicle
- #3 Child propelled downward, striking head



Predictable Injuries

- #1: Fx pelvis, femur; internal hemorrhage
- #2: Chest, abd, facial, head & neck injury
- #3: Head/neck/spine injuries, fractures



Significance: Potential for large amounts blood loss

Unique Pediatric A&P: Chest and Thorax

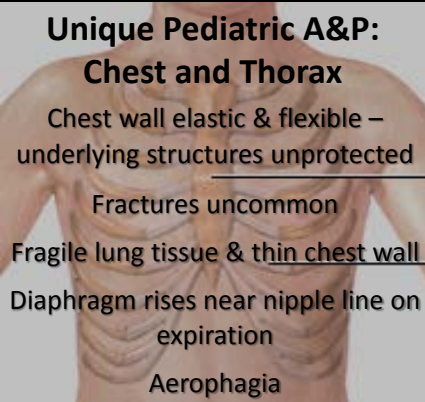
Chest wall elastic & flexible –
underlying structures unprotected

Fractures uncommon

Fragile lung tissue & thin chest wall

Diaphragm rises near nipple line on
expiration

Aerophagia




Implications

Fragile lung tissue & lack of protection results in
 pulm contusion
 pneumo or hemothorax
 spleen or liver injury
 myocardial contusion

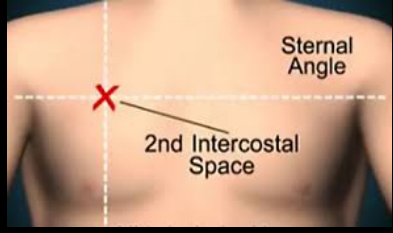
Rib fx requires tremendous force – high suspicion for
injury!

Significant internal injury can be present without
external injury findings

Easily transmitted breath sounds –may miss critical
exam findings



Needle Thoracostomy in Peds



Similar to procedure in adults.
Catheter size: 14 G

Assessment: Inspect & Palpate

Gen rate, depth, effort/WOB
 Lung sounds; symmetry; accessory muscle use
 SpO2, ETCO2

Inspect:

deformities	contusions
abrasions	penetrations
burns	lacerations
swelling	discoloration


Palpate: Tenderness, swelling, instability,
crepitus

Unique Peds A&P: Abdomen

Organs large, closer 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



Implications

Deep penetration of blunt force occurs w/ no sign
of surface trauma

Liver, spleen, and lungs easily injured (unprotected)

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

Assessment

S&S: pain, cramping, N&V, distention

Inspect :

ecchymosis, tire tracks, seat belt marks
 bruising (navel, flank=retroperit hemorrhage)
 contour/symmetry (msr across navel)
 puncture wounds/intactness of skin


Palpate:

tenderness, guarding, rigidity, rebound
 tenderness

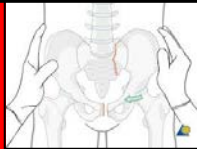
Done w/ side of hand, clockwise from
 quadrant away from pain

Unique Pelvis/GU A&P and Injury

- Risk for massive bleeding (occult!)
- Bladder location in peds (intra-peritoneal) lends
to easy injury
- Kidneys vulnerable: mobile, poorly protected
- Suspect accompanying abd injury w/ findings of
pelvic injury
- Suspect bowel, bladder injuries, lower spinal



Assessment




- S&S: pain, urge to void
- Inspect:
 - contusion, discoloration, soft tissue wounds
 - scrotal edema, priapism
 - blood at meatus/vaginal outlet
 - perineal edema, butterfly-shaped hematoma
- Palpate:
 - gentle downward outward pressure on iliac crests
 - gentle depression on symphysis pubis
 - TIC
- Pregnant ?

Unique Spine/Cord A&P

↓ neck muscle mass: can't restrict rapid motion

Flat/horizontal spinous facets
 +
 flexible ligaments
 +
 Elastic spine cartilage
 ↓
 vertebral bodies slide forward →
 Cord damage w/o xray evidence (SCIWORA)




Unique Spine/Cord A&P Injury Implications

Assess resp function frequently!
 Injuries usually @ cervical level
 Assume SCI in any unresponsive child
 Motor, sensory deficits may mask injury! Assess!
 50% occur *WITHOUT* spinal fx
 Injury often partial, *initially asymptomatic!*
Detailed exam is essential!

Predictors of C-Spine Injury

Neck pain
 Substantial torso injury
 Predisposing conditions
 Shallow water diving accidents
 High speed MVC, esp w/ ejection
 Torticollis

neck stiffness w/ 1-sided spasm
 head tilts to 1 side
 indicative of muscle, ligament injury



Assessment



- Reliable?
- Pain assessment:
 - w/ movement of head or neck
 - present or on palpation
- Vertebrae: palpate posterior processes
 - pain, point tenderness, or deformity
 - prominence, pain w/ motion, bruising, swelling, visible deformity, paravertebral muscle spasms
- Motor and sensory

Pediatric SMR

Anticipate need for padding, support
 Padding helps align airway, spine
 SMR : *entire body* secured and supine
 No straps / tape across lower chest, abdomen
 Avoid restraints that impair ventilation
 Leave room for chest expansion
 If C-collar does not fit properly, secure by other methods

Spine Motion Restriction



SOP p 49 - 50

Hypoperfusion in Peds Trauma

Solid abd organ hemorrhage is most freq cause
 Other etiologies:
 pneumothorax
 spine injury
 cardiac contusion or tamponade
 BP *not* your best indicator (very late indicator!)
 Strong catecholamine capabilities
 If hypotensive, suspect decompensated shock
 Role of MAP not yet determined for peds

Unique Physiology: Perfusion

- Same volume loss as adult = larger total % loss
- Less Hgb = less O₂ carrying capacity
- Compensatory mechanisms
 - ↑ HR
 - Vasoconstriction
- Best indicators of hypoperfusion:
 - Sustained tachycardia
 - Cool/cold and pale or mottled skin
 - Mental status change

Pediatric BP Measurement

Accuracy requires properly sized cuff
Cuff too small → falsely high reading
Opt for next size larger if one is too small
Avoid choosing cuff based on "age group"
Place cuff over midpoint of upper arm
Bladder length covers 80-100% arm circumference
2-3 cm space for stethoscope

BP Cuff Sizing

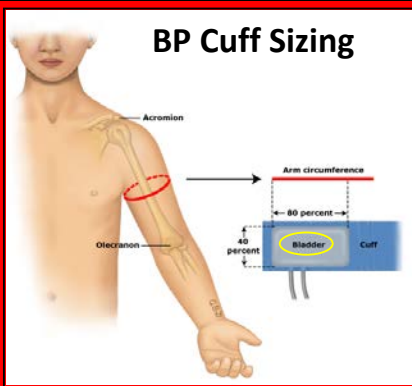


TABLE 37-6 Response to Fluid and Blood Loss in the Pediatric Patient

	Class I	Class II	Class III	Class IV
% Blood volume loss	Up to 15%	15%–30%	30%–45%	>45%
Mental status	Slightly anxious	Mildly anxious; restless	Altered; lethargic; apathetic; decreased responsiveness	Extremely lethargic; unresponsive
Mucous membranes	Normal	Normal	Normal to dry	Very dry
Vital signs	Normal	Mild tachycardia	Moderate tachycardia	Severe tachycardia to agonal (preterminal event)
Skin color (extremities)	Pink	Pale, mottled	Pale, mottled, mild peripheral cyanosis	Pale, mottled, central and peripheral cyanosis
Skin turgor	Normal	Poor: sunken eyes and fontanelles in infant or young child	Poor: sunken eyes and fontanelles in infant or young child	Severe
Skin temperature	Cool	Cool	Cool to cold	Cold
Capillary refill	Normal	Prolonged (2–3 sec)	Prolonged (3–5 sec)	Prolonged (>5 sec)
Heart rate	Usually normal if gradual volume loss; increased if sudden loss of volume	Mild tachycardia	Significant tachycardia; possible dysrhythmias; peripheral pulse weak, thready or absent	Marked tachycardia to bradycardia (preterminal event)
BP	Normal	Lower range of normal	Decreased	Severe hypotension
Pulse pressure	Normal or increased	Normal	Decreased	Decreased
Urine output	Normal	Decreased	Minimal	Minimal to absent

Reprinted from Kotter, B. (2005). Comprehensive pediatric emergency care. St. Louis: Mosby, an imprint of Elsevier.

Pediatric BP

Age	Weight (kg)	Normal Systolic BP (Age 1–10: 90 + (2 X age in yrs))	SBP minimums (70 + (2 X age in yrs))	Heart rate	Resp rate
Neonate (0–28 days)	3	>90 mmHg	>70 mmHg	100–160	30–60
Infant 1–12 mos	4–10	>90 mmHg	>70	110–160	30–60
2 yr	12	>94	>70	100–150	24–40
4 yr	16	>98	>75	90–150	22–34
6 yr	20	>102	>80	70–120	18–30
8 yr	25	>106	>85	70–120	18–30
10 yr	32	>110	>90	70–120	18–30
12 yr	41	>110	>90	60–110	12–18

Minimum SBP heralding hypotension is
70 + 2X age in years

TAKE HOME POINT

Child may be in shock despite a normal BP. Shock assessment is based on clinical S&S, not just a BP reading!

Assessments:

Pulses: rate, quality, central/peripheral

Pulse pressure

Mental status: restless, irritable, lethargic, unconscious

Skin color, temp, moisture

Cap refill if warm



Safe Transport of Children

Overview of Recommendations

The Ultimate Goal is to:

1. Prevent forward motion/ejection;
2. Secure the torso; and
3. Protect the head, neck, and spine of all children transported in emergency ground ambulances.

Achieving this Goal ensures that:

The safety of transporting children from the scene of a crash or medical emergency in all situations will be greatly improved.

Overview of Recommendations



For each situation, there are two options presented.

- 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 can not be achieved.

Overview of Recommendations	
Identifying the "Situations" for Transporting Children in Emergency Ground Ambulances	
Scenario	Description
1	For a Child who is uninjured / not ill
2	For a Child who is ill and/or injured and whose condition <i>does not</i> require continuous and/or intensive medical monitoring and/or interventions
3	For a Child whose condition <i>requires</i> continuous and/or intensive medical monitoring and/or interventions
4	For a Child whose condition <i>requires</i> spinal immobilization and/or lying flat
5	For a Child or Children who <i>require</i> transport as part of a multiple patient transport (newborn with Mother, multiple children, etc.)

Overview of Recommendations	
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	<ol style="list-style-type: none"> 1. 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 2. 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.

Overview of Recommendations	
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	<ul style="list-style-type: none"> • Secure the child to the cot; head first, with <u>three horizontal restraints across the torso (chest, waist, and knees)</u> and one <u>vertical restraint across each shoulder</u>. • If the child's condition requires medical interventions, which requires the removal of some restraints, the restraints should be <u>re-secured as quickly as possible as soon</u> 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 <u>stopping the ambulance during the interventions</u>. • If spinal immobilization of the child is required, see the recommendation for Situation 4.

Overview of Recommendations	
Situation 4 - For a Child whose condition requires spinal immobilization and/or lying flat	
The Ideal	<ul style="list-style-type: none"> • Secure the child to a size-appropriate spineboard and secure the spineboard to the cot, head first, with a tether at the foot (if possible) to prevent forward movement. • Secure the spineboard 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	<ul style="list-style-type: none"> • <u>Secure the child</u> to a standard spineboard with <u>padding</u> added, as needed, (to make the device fit the child) and secure the spineboard to the cot, head first, with a <u>tether at the foot (if possible)</u> to prevent forward movement. • <u>Secure the spineboard</u> to the cot with three horizontal restraints across the torso (chest, waist, and knees) and a vertical restraint across each shoulder.

Overview of Recommendations	
Important Issues for all Situations for Transporting Children in Emergency Ground Ambulances	
<ul style="list-style-type: none"> • The Working Group recommends that all EMS systems "pre-plan", i.e., plan in advance for those situations where multiple infants and children may be on the scene - as primary patients or not - so such events can be successfully mitigated. Pre-planning for such events must also involve other public health, public safety and other partners to be most successful. 	
<ul style="list-style-type: none"> • All children transported on a cot shall be restrained to the cot with the 5-point cot restraint system that includes three horizontal restraints across the torso (chest, waist, and knees) and one vertical restraint across each shoulder. 	

The ACR4



The only ambulance child restraint that meets interim guidance from NASEMSO

The ACR4

- Accommodates pts weighing 4lbs – 99lbs
- 4 color-coded restraints for size ranges
- Allows complete access from the airway to the waist while the patient remains restrained
- Restraint tightens in the mattress of the stretcher, not into the child
- Fully adjustable

The ACR4

- Works on any stretcher or backboard, without a bracket
- Replaces the need to carry multiple devices to restrain all size pediatric patients
- Fully crash-tested under the strictest of standards
- Machine washable



Peds Trauma Assessment



Activity



Secure child to your cot using agency-specific equipment. The patient requires continuous accessibility for monitoring and interventions.



Is there any information that you still need?