



SOCIETY OF TRAUMA NURSES

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General Concepts in Pediatric Trauma Care



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Objectives

**At the conclusion of this presentation
the participant will be able to:**

- Describe at least one difference in the respiratory and cardiovascular system between children and adults
- Discuss assessment of Traumatic Brain Injury in the pediatric patient
- Identify the differences in spinal, thoracic, and abdominal injuries in the pediatric patient relative to adults
- Identify physical differences and specific developmental stages for different age groups and apply assessment and intervention strategies
- Discuss at least two important considerations in the approach to victims of child abuse

Pediatric Trauma: A Major Threat to the Health and Well-Being of Children

Unintentional injury is the leading cause of death among children older than 1 year

Injury exceeds all other causes of death combined for children

More than 7,000 children and teens (ages 0-19) died from unintentional injury in 2019

Racial, ethnic and economic disparities become apparent in Pediatric trauma statistics

Leading Traumatic Causes of Child Deaths

- Birth to 1 year – Non-accidental trauma (NAT)
- 1 - 4 years – Drowning
- 5 -12 years – Accidents – Unintentional injuries
- Teens – Motor vehicle crashes
 - Homicide is the leading cause of death for non-Hispanic black males.
 - Suicide is the 2nd leading cause of death in teens overall.

Physical Growth & Development

Birth – 1 Year – Infancy

- Birth – 28 days – neonate → very little subcutaneous fat, large head with open fontanelles, unable to hold up neck, irregular respiratory pattern, obligate mouth breather, unable to roll over
- 2 months → Posterior fontanelle closes, holds head up with support, starts to push up when lying on stomach
- 4 months → holds head up without support, can roll from tummy to back, can hold toys/swing at hanging toys



Physical Growth & Development – Infancy

- 6 months → rolls over from tummy to back and from back to tummy, sits with support
- 9 months → crawls, sits without support, pulls to a stand
- 1 year → begins to stand alone, takes a few steps



Physical Growth & Development – Toddler

1-2 Years → Toddler

- Anterior fontanelles close by 18 months
- Rapid growth, walking, running, climbing, falling
- Improving gross motor skills, fine motor skills still developing
- Curious – exploring but no sense of risk or danger
- Head still proportionally larger than in adults → REAR FACING car seats until at least age 2



A young child with short, wavy brown hair, wearing a bright red polo shirt, is smiling and looking towards the camera. The child is standing on a playground structure, with their hands resting on a light blue horizontal bar. The background is a blurred outdoor setting with green foliage and a wooden fence.

Physical Growth & Development – Preschool

3-5 Years → Preschool

- Active → increased risk for injury

Physical Growth & Development – School Aged Children



6-12 years → School Aged Child

- Active, curious, organized sports/activities
- Increasing independence → increasing risk
- Fine motor skills improve but coordination may lag

Physical Growth & Development – Teens

13-19 Years → Teens

- Sexual maturation
- Increasing independence → increasing risks and new skills → driving
- Physical growth and development – near adult physical size and physical characteristics



Emotional Growth & Development



- Crying is primary communication
Period of PURPLE Crying® – normal developmental stage from approx. 2 months through about 5 months of age, when some babies cry excessively without a physical cause for the crying, often late in the day, and difficult to soothe
- Learning trust
- Recognize faces and respond accordingly
- Learning self soothing behaviors—thumb sucking, etc.

Emotional Growth & Development – Older Infancy

- Babble, coo or mimic sounds that are heard
- Learning to cry in different ways to express needs
- Begin to play more and will like to play with others
- Becoming curious → everything goes in their mouth
- Can recognize familiar faces and places → object permanence and separation anxiety
- Understand simple words – their name, “No”
- ~ 1 year – can be more shy or nervous around new people or in new places, may show fear



Emotional Growth & Development - Toddlers

- Developing clear preferences, likes/dislikes
- Anger – Temper tantrums
- Start to use language
- Will explore environment as long as parent is nearby



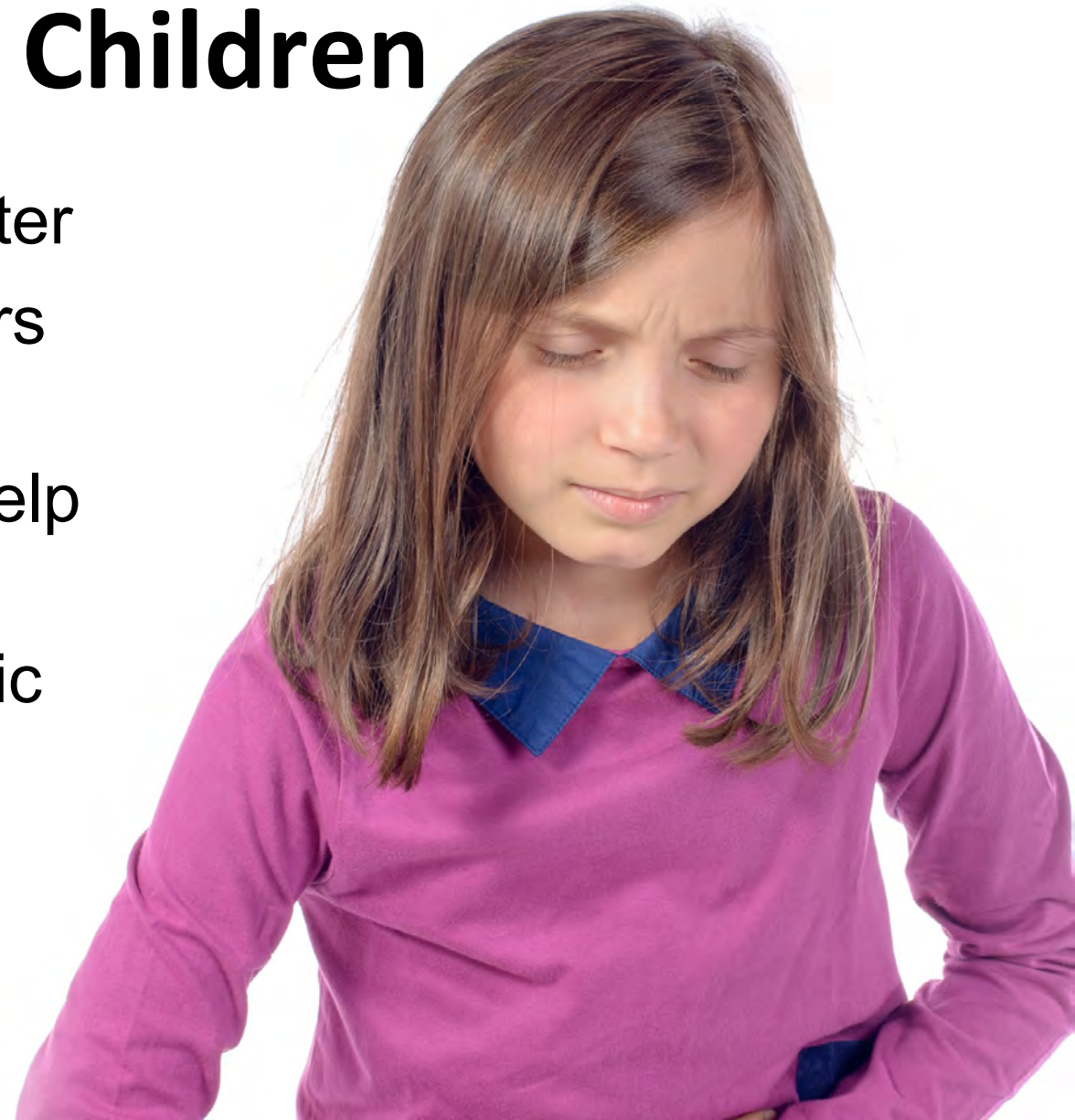
Emotional Growth & Development – Pre-School



- Increasingly verbal
- Play with other children – empathy and rules
- Curious
- Vivid imagination – monsters, super heroes

Emotional Growth & Development – School Aged Children

- Understand rules/fairness much better
- Increasingly social – notice behaviors of other children
- Increasing independence – like to help adults, help with tasks like cooking
- Increased body awareness – somatic complaints common, modesty concerns



Emotional Growth & Development – Teens

- Increasing independence and importance of peer group – risk taking, changing preferences – may try different “persona” → rebel, artist, athlete, etc.
- Body image and physical appearance important
- Emotionally labile – ups and downs, sullen



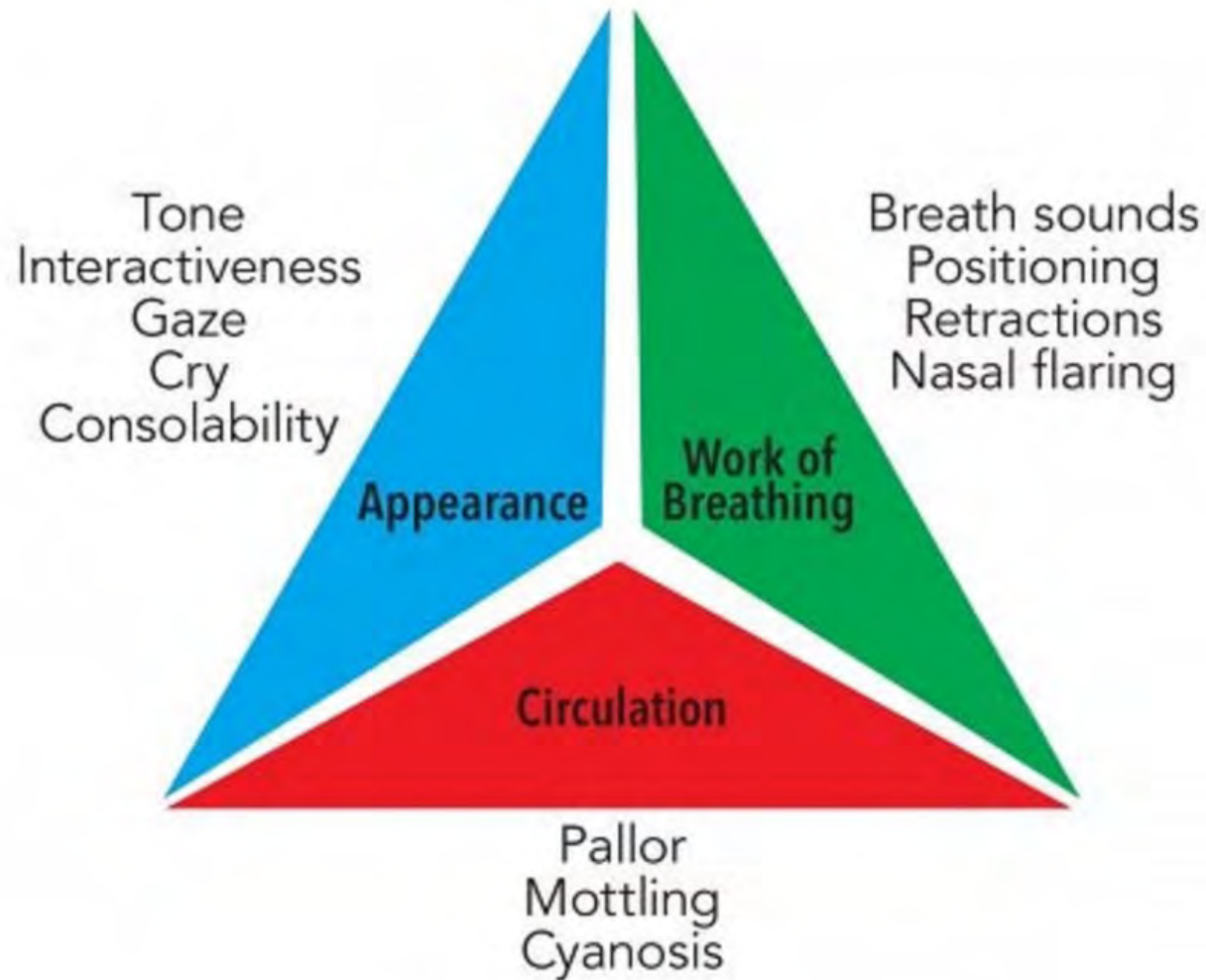
Physical Differences in Children

that influence injury patterns and care...



- Large head and higher center of gravity
- Ligamentous laxity and incomplete fusion of vertebrae
- Bones are more compliant than adults
- Larger relative body surface area – loses heat quickly
- Solid organs are larger – compared to abdominal cavity → increased risk of organ injury

Pediatric Assessment Triangle



Assessment of Children

- “Quick look” – Peds Assessment Triangle
- Parental presence
- Verbal cues
- Non-verbal cues
- Compensatory mechanisms



Vital signs, medication doses and equipment needs highly variable dependent on age/size/weight.



Pediatric Specific Assessment Tools

Pediatric GCS Provisions

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

Pediatric Pain Tools



Wong Baker Faces Pain Scale

Resuscitation of Children

Airway/respiratory differences

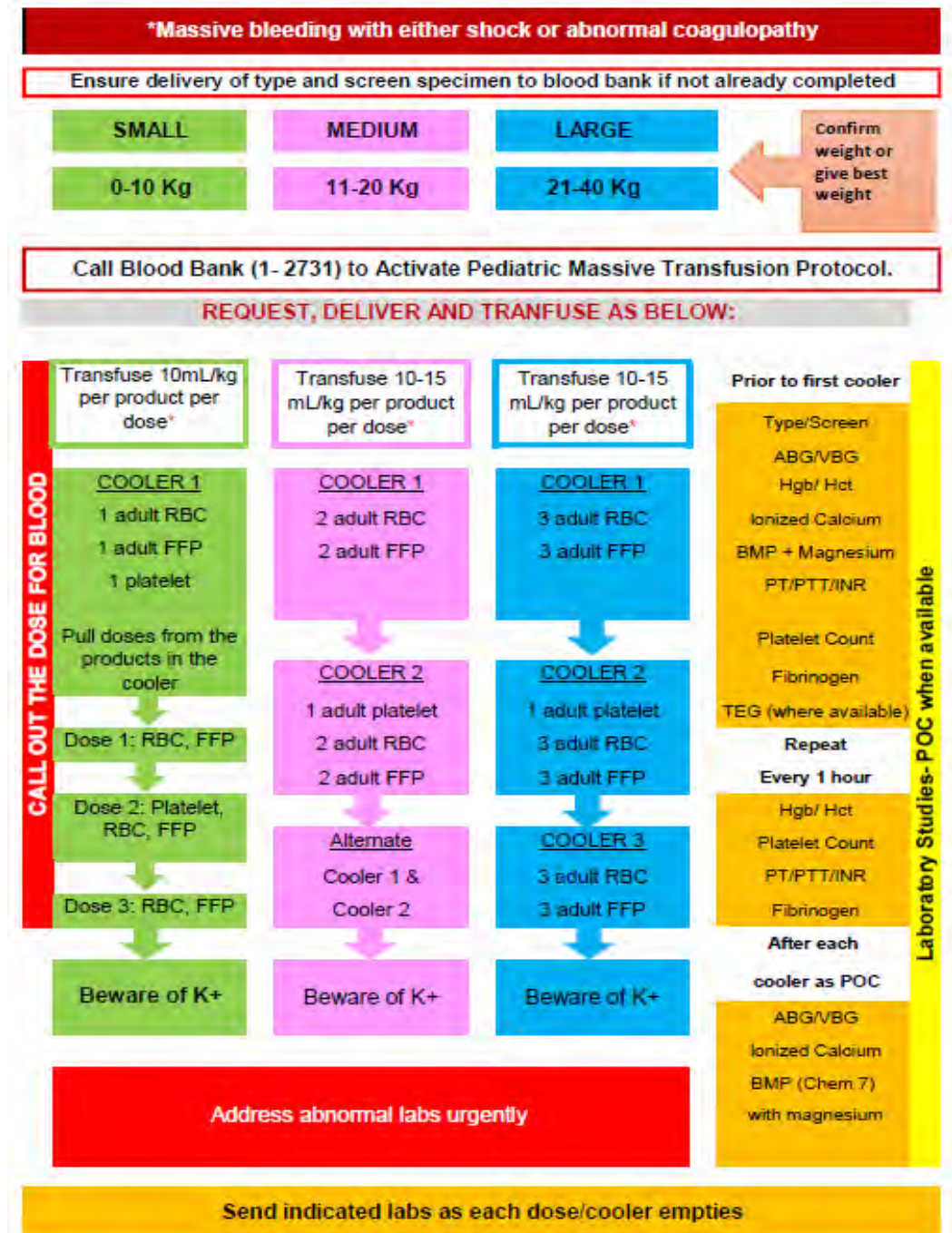
Cardiovascular differences

Body surface area differences

Burn resuscitation formula

Volume Resuscitation

- Weight-based volume administration
- Balanced resuscitation – one crystalloid bolus then transition to PRBC's and consider early MTP → 1:1:1 ratio of blood to FFP and Platelets
 - Avoid hypothermia → blood warmer
 - Avoid electrolyte imbalances → hyperkalemia and hypocalcemia
- Consider early TXA use – TEG/ROTEM to guide resuscitation



Landing Patterns Vary Between Age Groups



Birth to 2 years fall head-first



3 to 10 years tend to fall
on hands and feet



11 and older fall feet first

Traumatic Brain Injury (TBI)

- Significant cause of death in children
 - Hypoxemia and hypotension significantly increase morbidity and mortality
- Secondary to:
 - Motor Vehicle Collisions (MVC)
 - Falls
 - Sports
 - Bicycles
 - Non-accidental trauma

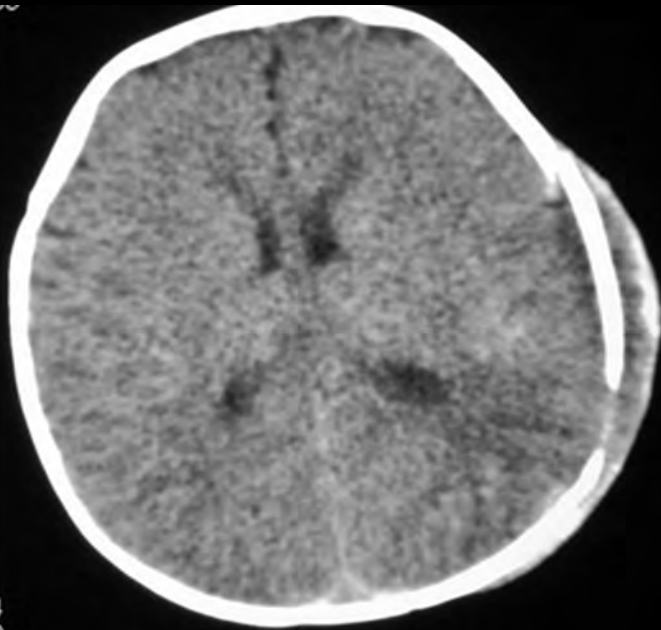
Traumatic Brain Injury Classification



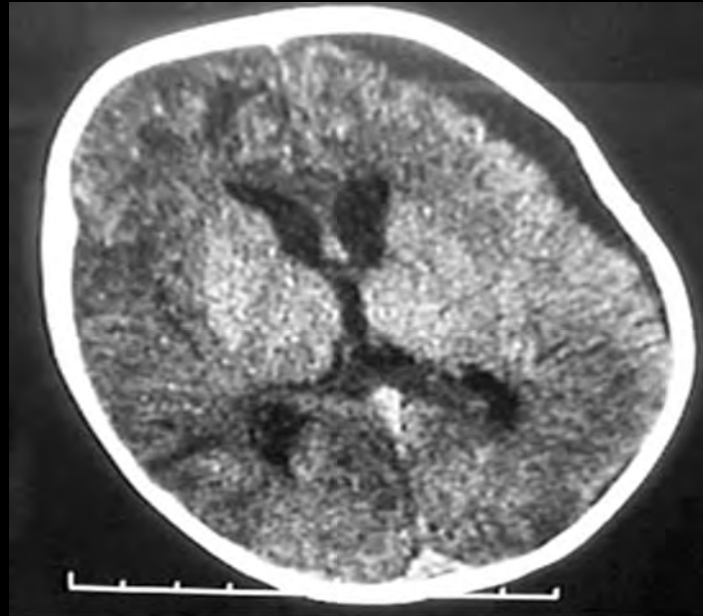
- **Mild (GCS 13-15)**
 - Do well; may have radiographic abnormalities
 - May have headaches, seizures, vomiting
- **Moderate (GCS 9-12)**
- **Severe (GCS 3-8)**
 - LOC, posturing, combative, abnormal neuro exam

Types of Traumatic Brain Injuries

Shaken Baby Syndrome



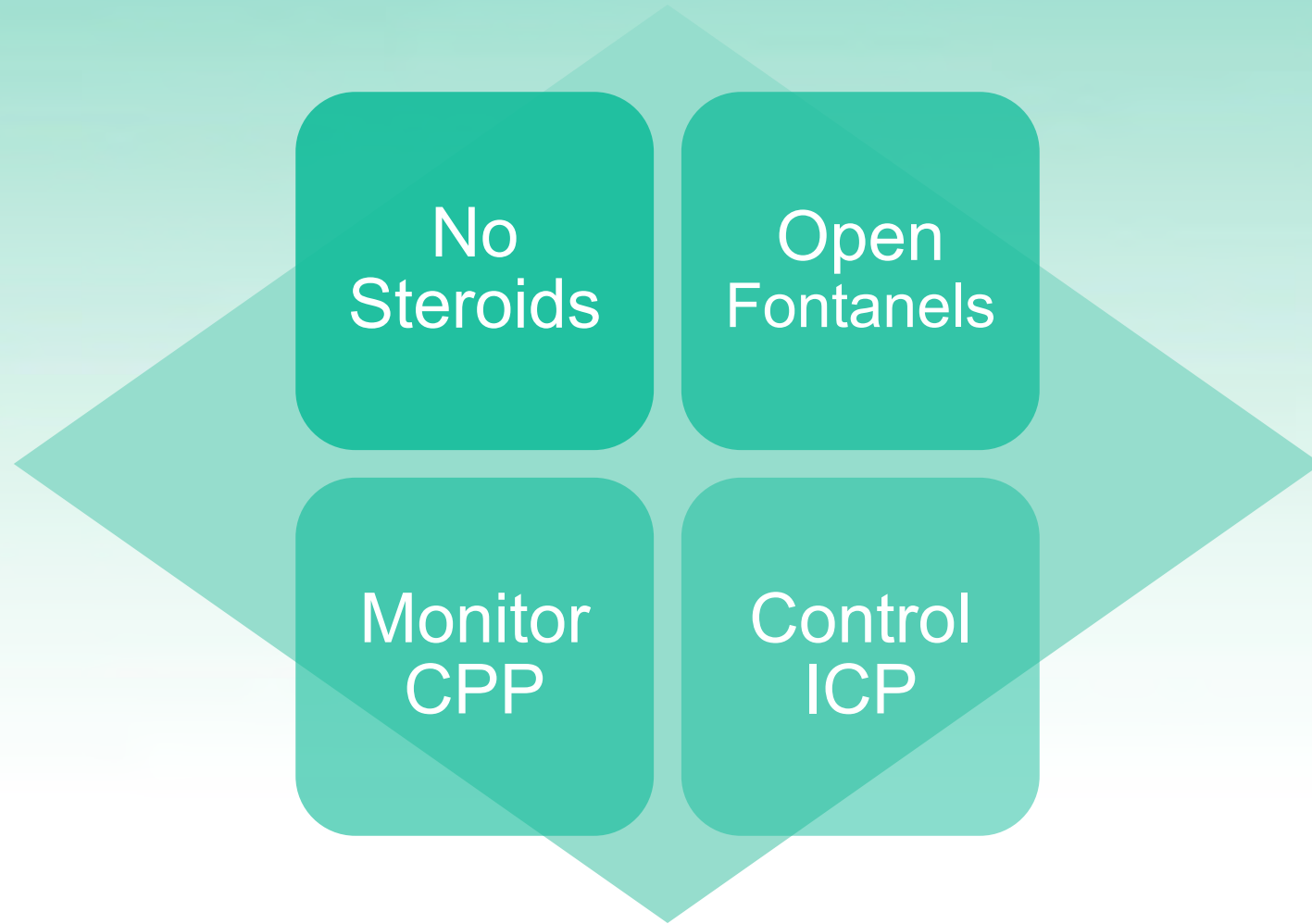
Subdural Hematoma



Epidural Hematoma



Traumatic Brain Injuries: Considerations



Concussion Management

- Most concussion symptoms resolve within 7-14 days.
- Brain rest – step-wise approach to normal activity:
 - First 24-72 hours: Limit texting, screen time (TV, video games, computer use), reading, school work, etc.
 - Stage 2: Limited return to school – ½ days, limit reading to short periods, no tests or quizzes
 - Stages 3-6: Increasing academic load as child tolerates
- Return to physical activity/sports
 - SLOW → Second Impact Syndrome → Often lethal, rapid brain swelling after a second blow to the head before a patient has fully recovered from previous concussion

Parent and Coach Education

Each Emergency Department and Inpatient Pediatric Unit should be educated on and have access to tools for parent and coach education.



CONCUSSION FLOWSHEET

Use this checklist to record activity levels and review with your health care provider.

Name: _____ Date of Concussion: _____ Checklist Started: _____

Use the appropriate score for the number of times that
1 = Few 2 = Often 3 = Constant

PHYSICAL CHANGES	WEEK 1					
	M	T	W	T	F	S
HEADACHE						
DIZZINESS						
FATIGUE						
NAUSEA/VOMITING						
SENSITIVITY TO LIGHT OR NOISE						
LOSS OF COORDINATION/BALANCE						
VISUAL DISTURBANCE						
RINGING IN EARS						
SCHOOLWORK						

EMOTIONAL CHANGES	WEEK 1					
	M	T	W	T	F	S
FUSSY, IRRITABLE, RESTLESS						
SADNESS/DEPRESSION						
PERSONALITY CHANGE						
ANXIOUS OR PANICKY						
EMOTIONAL LABILE						
APATHETIC						

COGNITIVE CHANGES	WEEK 1					
	M	T	W	T	F	S
MENTAL FOGGINESS						
DIFFICULTY WITH CONCENTRATION						
EASILY DISTRACTED						
CONFUSION						
DIFFICULTY WITH MEMORY/ FORGETFULNESS						
SLOW TO LEARN/ UNDERSTAND INFORMATION						
CHANGE IN HOMEWORK (SLOW OR REFUSES TO DO)						
NEGATIVE CHANGES IN SCHOOL REPORTED BY TEACHER						

SLEEP CHANGES	WEEK 1					
	M	T	W	T	F	S
DROWSINESS						
SLEEPING MORE						
SLEEPING LESS						
DIFFICULTY FALLING OR STAYING ASLEEP						



Begin the following exercises after _____ of rest.
If any symptoms return, discontinue these exercises and contact your physician immediately.

DAY 1:
LIGHT AEROBIC EXERCISE

The Goal: Minimal increase in heart rate or perceived exertion
The Time: 5-10 minutes
The Activities: Stationary bike, walking, or light jogging; no weight lifting, jumping or hard running

DAY 2:
LIGHT AEROBIC EXERCISE

The Goal: Minimal increase in heart rate or perceived exertion
The Time: 15-20 minutes
The Activities: Stationary bike, walking, or light jogging; no weight lifting, jumping or hard running

DAY 3:
MODERATE EXERCISE

The Goal: Introduce sport-specific activities
The Time: 15-30 minutes
The Activities: Moderate jogging, moderate-intensity stationary bike or moderate-intensity weight lifting

DAY 4:
MODERATE EXERCISE

The Goal: Continue sport-specific activities
The Time: Up to 30-45 minutes
The Activities: Moderate jogging, moderate-intensity stationary bike or moderate-intensity weight lifting

DAY 5:
NONCONTACT EXERCISE
FULL EQUIPMENT

The Goal: More intense sport-specific activities, but noncontact, performed in full equipment
The Time: Close to typical routine
The Activities: Running, high-intensity stationary bike or regular weight lifting routine, noncontact sport-specific drills

DAY 6:
PRACTICE

The Goal: Reintegrate into full contact practice

DAY 7:
PLAY

The Goal: Return to competition

Notes: _____

Motor Vehicle Crashes & the Pediatric Patient

- In the US in 2015, three children were killed and an estimated 502 children were injured every day in traffic crashes.
- 40% of children killed in MVC were unrestrained.

(National Center for Statistics and Analysis, 2019)



Improper Seating and Restraints

Children need to be rear facing in the back seat until at least the age of 2 *or until they reach the highest height and weight allowed by the car seat.*

(American Academy of Pediatrics, 2018)

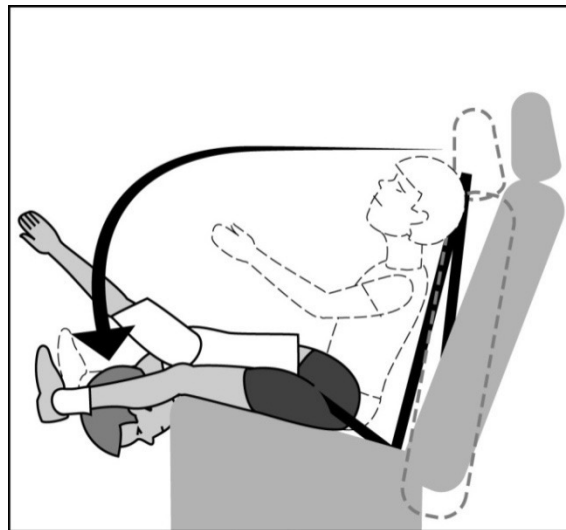


Improper Seating and Restraints

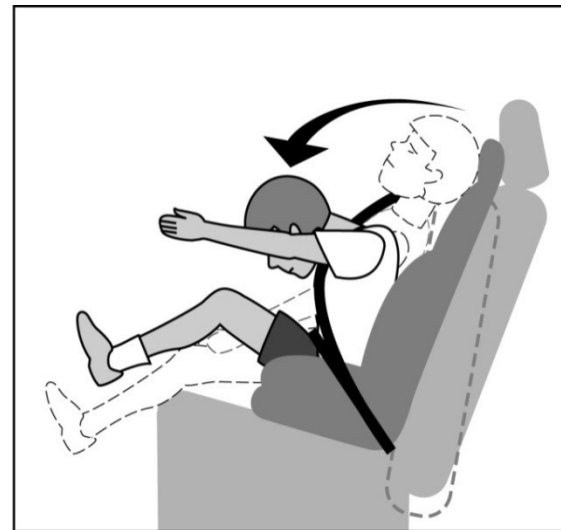
The Need for Booster Seats

- Children under 4 ft 9 inches without a booster seat tend to place the shoulder strap behind back and sit towards the front of the seat.
- The child's higher center of gravity and poorly developed iliac crests contributes to head and seat belt injuries.

Child without a booster



Child in a booster seat



Bicycle Crashes

Childhood Risk Factors



- 25% of all bike related deaths and 50% of all injuries occur in children between the ages of 5-14.
- The crash usually takes place:
 - At non-intersections
 - Close to home/minor roads
 - Summer/late afternoons

Bicycle Crashes

70% of the time child's head hits the ground first

Helmet use can reduce the risk of injury by 85%

45% of children always wear a helmet while bicycling

Bicycle Crash Mechanisms

Over the handlebars

Collisions with motor vehicles

Handlebar injuries



Pedestrian Injuries

- The number of pedestrian deaths and injuries in children 14 and under has decreased, but in 2019 there were still 181 deaths, and an estimated 8,000 injuries in the US.
- Of the 181 child pedestrian fatalities, 173 were killed in single-vehicle crashes, and 8 were killed in multiple-vehicle crashes.
- 24 of the 233 child pedestrians killed were struck by a hit and run driver.

(National Highway Traffic and Safety Administration, 2019)



Waddel's Triad

- Classic pediatric injury pattern
- Vehicle impacts
 - Upper leg
 - Chest and/or abdomen
- Child is then thrown hitting head



Pediatric Spinal Injuries

Cervical Spine

- Uncommon in younger children
- Higher risk in those > 11 years
- Mortality is 15-20% usually due to secondary brain injury

Thoracic Trauma

- Accounts for up to 30% of pediatric trauma admissions
- Primarily blunt mechanisms, though children can have penetrating injuries from GSW or stabbing
- ~5% mortality as stand-alone injury
- Mortality increases to ~25% with concomitant head or abdominal injuries, and up to 40% with all three body regions.

Why Are Pediatric Thoracic Injuries Different than Adult Thoracic Injuries?

Smaller blood volume

Smaller body mass

Thorax compliance

Gastric distention

Concomitant injuries

Mediastinum is not fixed

Few require thoracotomy

Higher metabolic demands

Thoracic Injuries

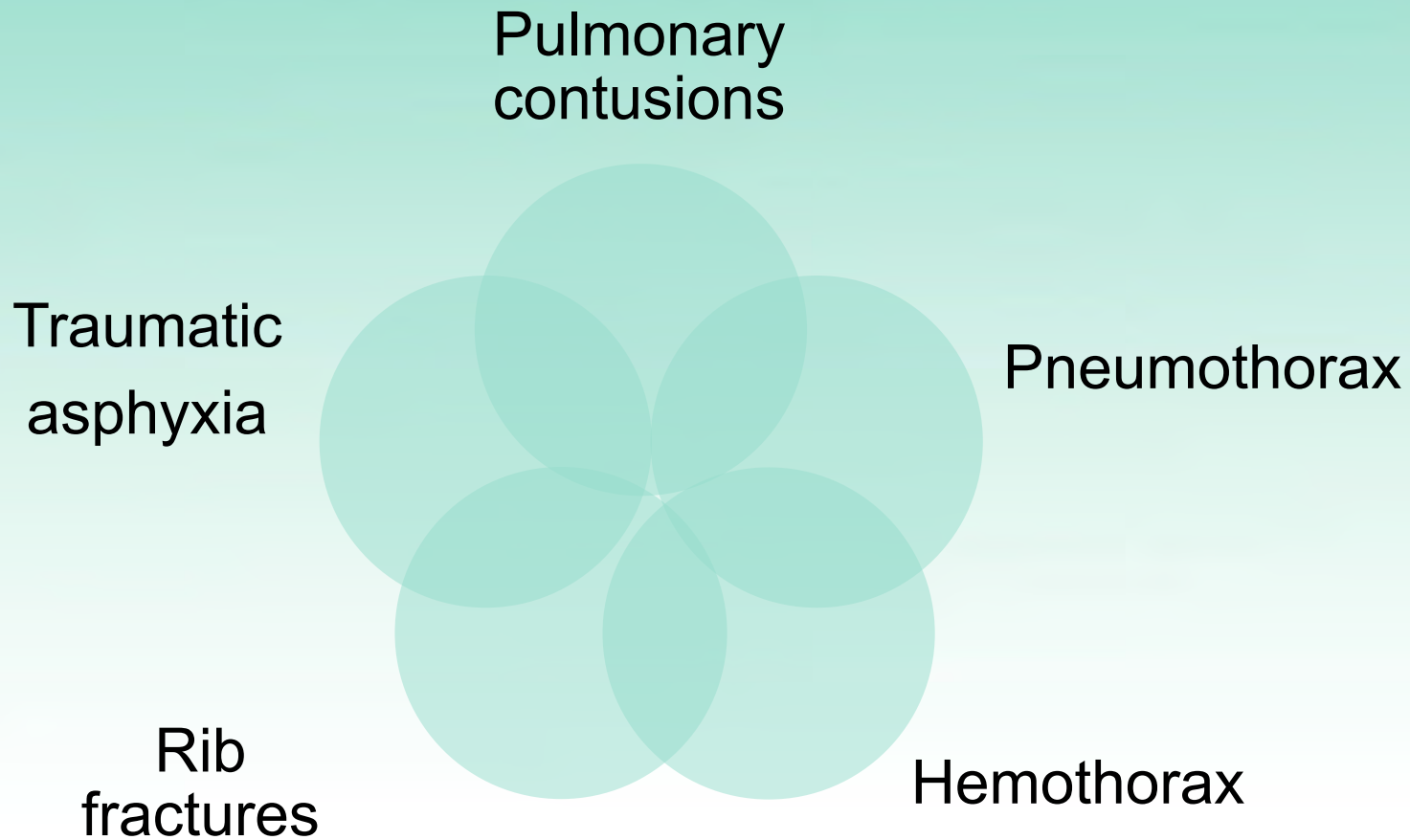



Image credit: amyselleck

- Mechanism of Injury
- Vital sign trends
- Signs and symptoms of thoracic injury



Evaluation of Thoracic Injuries

Diagnostics



CXR
CT
EKG
Echo
Labs

Abdominal Trauma

- Nearly 10% of all trauma admissions
- Large majority = blunt mechanism
- Liver most commonly injured, followed by small bowel, colon, stomach and spleen and kidneys



Why Are Pediatric Abdominal Injuries Different than Adult Abdominal Injuries?

Thinner musculature

Rib compliance

Relative size of intra-abdominal organs

Lower fat content

Intestinal attachment

Bladder position

Hypothermia

Abdominal Injuries

- Solid organ injury
- Lap belt syndrome
- Hollow organ injury

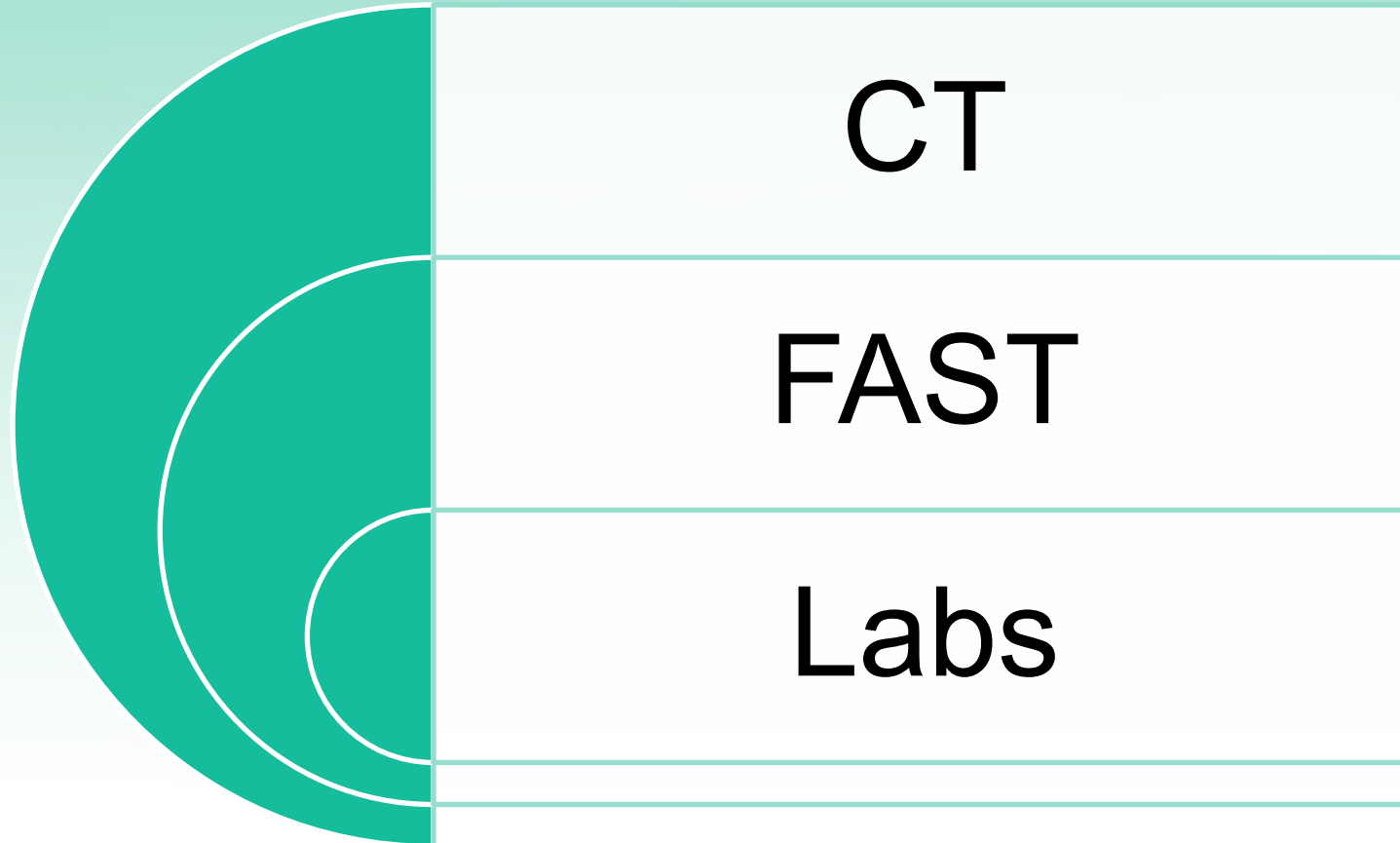




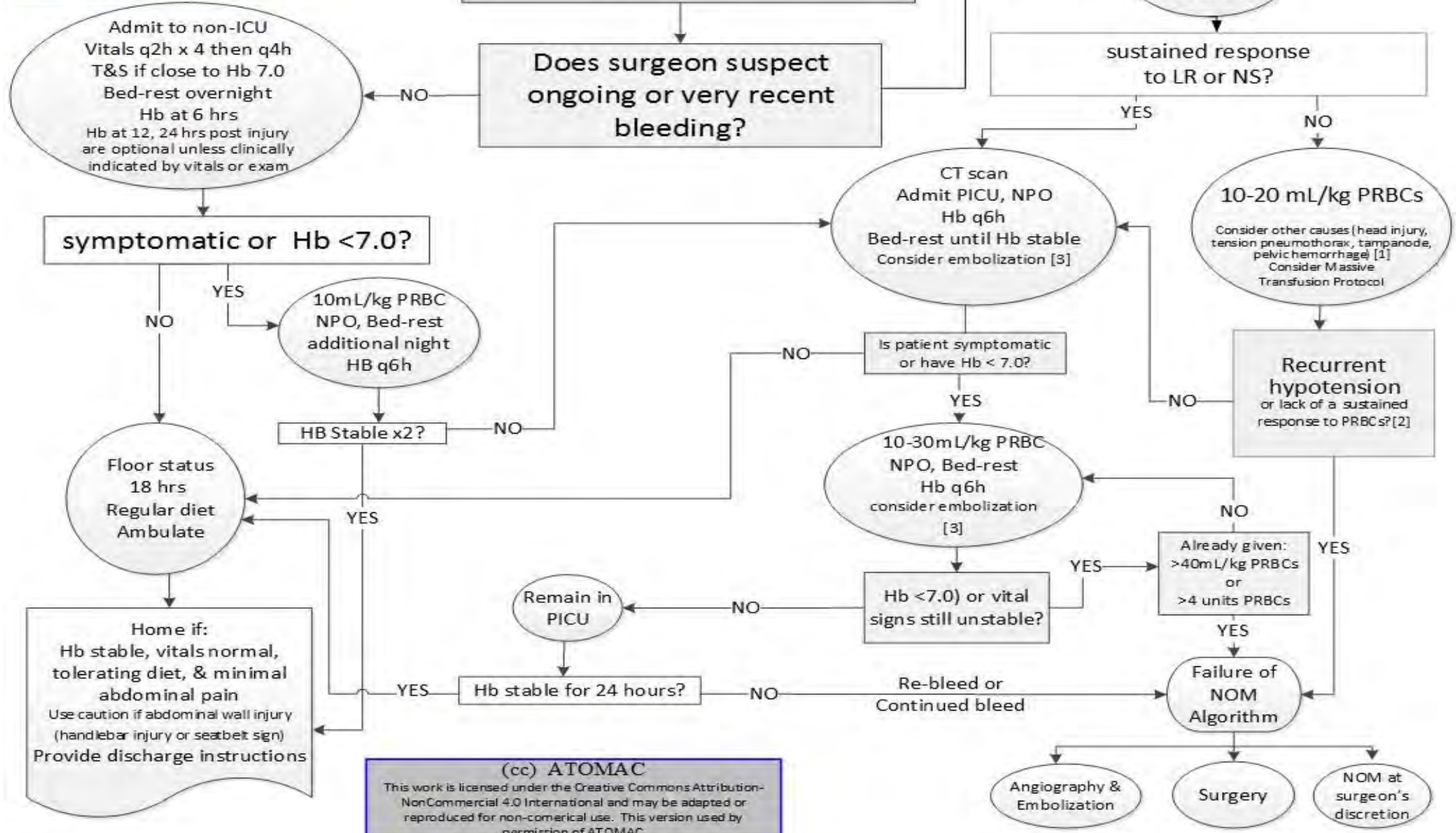
Evaluation of Abdominal Injuries

- Inspection, auscultation, palpation
- Presence of distention
- Tenderness on palpation requires further diagnostics to determine presence of injuries.

Diagnostics



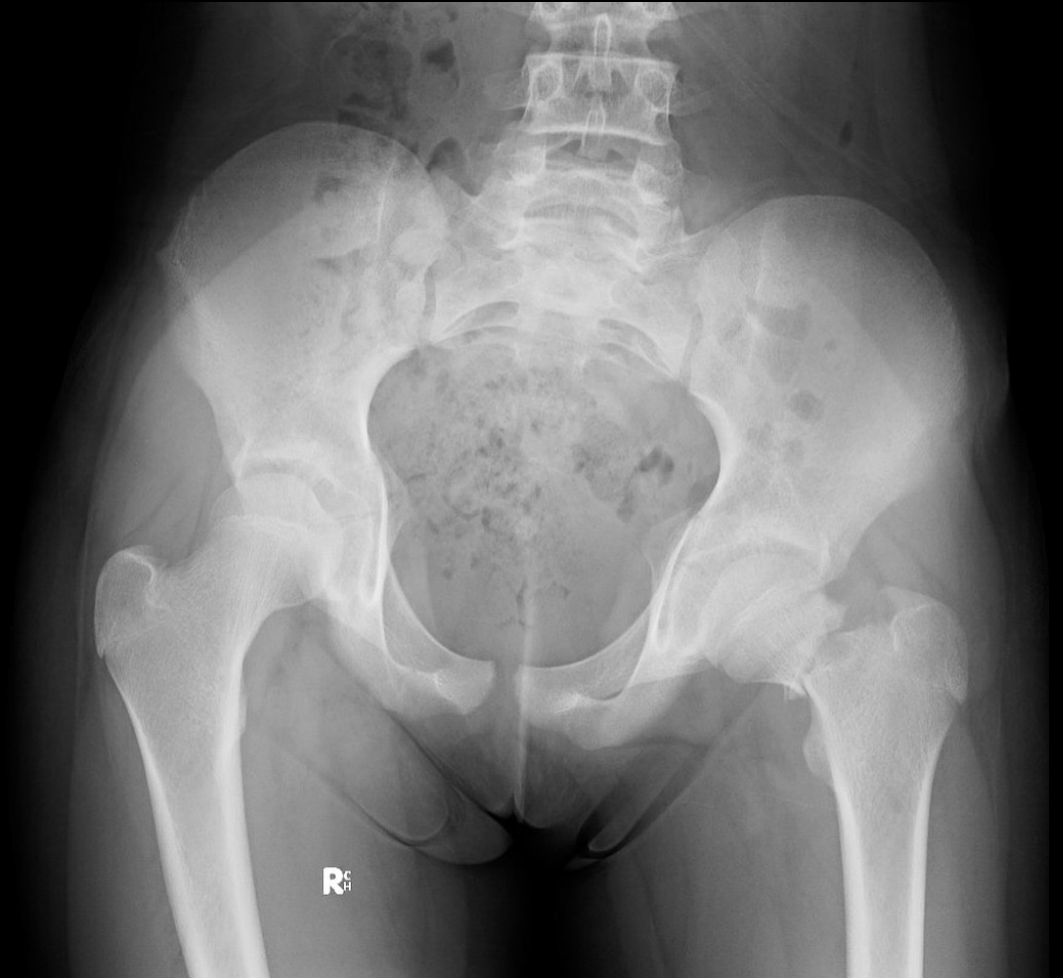
ATOMAC
Blunt Pediatric Liver/Spleen Injury
Guideline v11.0



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Extremity Injuries

- Incomplete calcification contributes to injury patterns.
- Growth plate injury
- Strong ligaments result in fx vs. ligamentous injury
- Fracture type determines treatment and outcomes.
- Antibiotics for open fractures
- Assessment of joint above and below fracture



Child Abuse Considerations

- High index of suspicion
- Advocacy
- Multidisciplinary Team
- Fatality rates



Gun Violence

- Eight children die each day from gun violence.
- 32 more children are shot and injured.
- 39% of parents wrongly believe that children don't know where the firearm is stored in the home.
- School shootings – more than 278,000 children have experienced school gun violence since Columbine.
- Gang violence

Mental Health and Trauma in Children

- Assess for substance use/abuse in child and parents
- Depression and anxiety – especially in school aged children and teens → was injury self inflicted?
- Acute stress response and PTSD in children – educate parents
 - Acute stress response normal → some regression in behaviors, nightmares, fearful, “clinginess”, etc.
 - Usually resolve within 30 days
 - If symptoms last longer than 30 days – PTSD → evaluation by Pediatric mental health specialist

Assessing and Treating Pain in Children

- Neonates and children experience pain, and long-term consequences can result from exposure to repeated painful stimuli.
- Assessing pain in infants and children requires special, age-appropriate scales.
- There are many validated pain scales available for use, but an organization should select one for each specific population.

Assessing and Treating Pain in Children

Most children three years old and older can rank their pain using one of several validated tools.

Wong-Baker Faces Pain Scale



Pain Management

- Children in pain may not act like an adult in pain.
 - Withdraw or become quiet
 - Play – try to distract from pain
- Non-pharmacologic methods (distraction, comfort, etc.) are often useful → Child Life Specialists
- Multi-modal pain control to minimize opioids for severe pain
 - Local anesthesia, topical anesthetics, regional anesthesia/nerve blocks
 - Non-narcotic options: Ketamine, Dexmedetomidine, Acetaminophen, Ibuprofen

Trauma Complications in Children

Complication rates much lower
in children than adults but still
occur

Special vigilance
with non-ambulatory
children or toddlers

Radiation
exposure

Transfer to Pediatric Trauma Center

- Depressed or worsening neurologic status
- Respiratory distress or failure, Intubated children
- Shock; any child requiring a blood transfusion
- Hemodynamically unstable children requiring vasopressors, ICP monitoring or invasive monitoring
- Fractures with neurovascular compromise
- Spinal cord injuries
- Traumatic amputations
- Significant MOI with associated injuries
- Whenever the primary caregiver believes the child requires specialized pediatric care

Transfer Considerations

- Transport Mode
- Diagnostics
- Airway, Breathing, Circulation, IV access, sedation, pain control, cervical spine immobilization
- Family-centered care



Emerging Trends

- Whole blood administration in children
- Hospital Based Violence Intervention Programs - HBVIPs
- Nursing working for health equity

Summary

- Pediatric trauma care should be based upon the developmental and anatomic differences in children.
- All trauma centers should have equipment and protocols specific to pediatric resuscitation.
- Transfer to Pediatric Trauma Center when indicated.

Pediatric Trauma Care

1. Young children have a larger head in proportion to the rest of their body. In light of this, which statements are true?

- a. The child's head/body proportion becomes the same as an adult's by age 10.
- b. The large head causes the child to have a lower center of gravity.
- c. A young child is likely to hit their head when they fall over the handlebars of a bike.

2. A child comes into the ED after a frontal collision motor vehicle crash. Pre-hospital care states that the child is 11 months old and was in a front-facing car seat in the back of the car. What injuries would you look for?

- a. None since the child was properly restrained
- b. Leg fractures from the child hitting his legs against the back seat
- c. Neck injuries since he was front-facing

3. An 8 year-old child is brought to their pediatrician with abdominal pain. The mother states that the child fell from his bike the day before. On exam, he only has a small round mark on the upper right quadrant of his abdomen. His pulse is 130 and he is slightly pale. He is listless and complaining of abdominal pain. The pediatrician should:

- a. Send the boy home and tell him to rest. He probably has the flu.
- b. Send the boy to the ED of a local trauma center immediately, preferably one with pediatric capabilities.
- c. Refer the child to a local surgeon for work up of an acute abdomen.

4. What factors may impact outcomes of the pediatric TBI patient?

- a. Control of hypovolemia
- b. Control of Intracranial Pressure
- c. Use of ventilation strategies
- d. All of the above

5. Which statement is false regarding spinal injuries in pediatric patients?

- a. Cervical spine injuries uncommon in younger children
- b. Spinal cord injury may occur without radiographic evidence
- c. Pediatric patients < 11 years old have strong neck muscles
- d. Mortality is increased due to secondary brain injury

6. What is the one physiologic aspect of a child's thorax that makes an injury pattern different than an adult with similar mechanism of injury?

- a. Smaller body mass
- b. Smaller blood volume
- c. Greater rib compliance
- d. Greater gastric distention

7. What is the one physiologic aspect of a child's abdomen that makes an injury pattern different than an adult with similar mechanism of injury?

- a. Thinner musculature
- b. Increased rib compliance
- c. Relative size of intra-abdominal organs
- d. Lower relative fat content

8. What is the development stage/goal for the preschool age child?

- a. Trust versus mistrust
- b. Industry versus inferiority
- c. Initiative versus guilt
- d. Autonomy versus shame

9. Which statement is true about pain in infants and children?

- a. Infants have immature nervous systems and do not perceive pain as much as older children and adults do.
- b. Children must be at least 7 years old to be able to rank their pain level using a validated tool.
- c. There is no long-term consequence to untreated pain in infants and children.
- d. Infants and children experience pain and should be appropriately assessed for pain using a validated pain scale/tool.

10. What fact is true about child abuse versus unintentional injury fatality rates?

- a. Fatality rates are identical.
- b. Fatality rates are higher in child abuse patients than in those with unintentional injury.
- c. Fatality rates in patients with unintentional injuries are higher than in child abuse.

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References

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