

Pediatric Blunt Abdominal Trauma

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Objectives

- Pediatric trauma is a common occurrence
- Understand the physiologic differences in Pediatric patients, and how they are injured
- Recognize the signs and symptoms of shock in a child
- Review the evaluation and pre-hospital care of a patient with blunt abdominal trauma



Disclosure

- Nothing to disclose



- Called to the scene of a high-speed rollover MVA involving multiple vehicles
- Passenger of one vehicle noted to be a 7 year old child
- Unknown if restrained properly
- One fatality reported



Initial Thoughts?



Pediatric Trauma

- Many differences between infants, children, and adults with respect to
 - Epidemiology of trauma
 - Evaluation
 - Management
- Emergency Medical Technicians need to understand the differences in anatomy, physiology, and psychosocial issues
- ABCD principles of trauma care remain the same as adults
- Resuscitation tools such as Broselow Tape and other references (PemSoft, “code cards”) help in resuscitation for appropriate drugs and equipment and ongoing education



5 Leading Causes of Death by Age Group, US - 2014

RANK	<1	1-4	5-9	10-14	15-24
1	Congenital Anomalies 4,746	Unintentional Injury 730	Unintentional Injury 750	Unintentional Injury 11,836	Unintentional Injury 17,357
2	Short Gestation 4,173	Congenital Anomalies 399	Malignant Neoplasms 436	Suicide 425	Suicide 5,079
3	Maternal Pregnancy Comp 1,574	Homicide 364	Congenital Anomalies 192	Malignant Neoplasms 416	Homicide 4,144
4	SIDS 1,545	Malignant Neoplasms 321	Homicide 123	Congenital Anomalies 156	Malignant Neoplasms 1,569
5	Unintentional Injury 1,161	Heart Disease 149	Heart Disease 69	Homicide 156	Heart Disease 953

Data Source: National Vital Statistics System, National Center for Health Statistics, CDC.

5 Leading Causes of Injury Deaths by Age Group

Highlighting Unintentional Injury Deaths, US - 2014

RANK	<1	1-4	5-9	10-14	15-24
1	Unintentional Suffocation 991	Unintentional Drowning 388	Unintentional MV Traffic 345	Unintentional MV Traffic 384	Unintentional MV Traffic 6,531
2	Homicide Unspecified 119	Unintentional MV Traffic 345	Unintentional Drowning 125	Suicide Suffocation 225	Homicide Firearm 3,587
3	Homicide Other 83	Homicide Unspecified 149	Unintentional Fire/Burn 68	Suicide Firearm 174	Unintentional Poisoning 3,492
4	Unintentional MV Traffic 61	Unintentional Suffocation 120	Homicide Firearm 58	Homicide Firearm 115	Suicide Firearm 2,270
5	Undetermin. Suffocation 40	Unintentional Fire/Burn 117	Unintentional Other Land Transport 36	Unintentional Drowning 105	Suicide Suffocation 2010

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Data Source: National Vital Statistics System, National Center for Health Statistics, CDC.

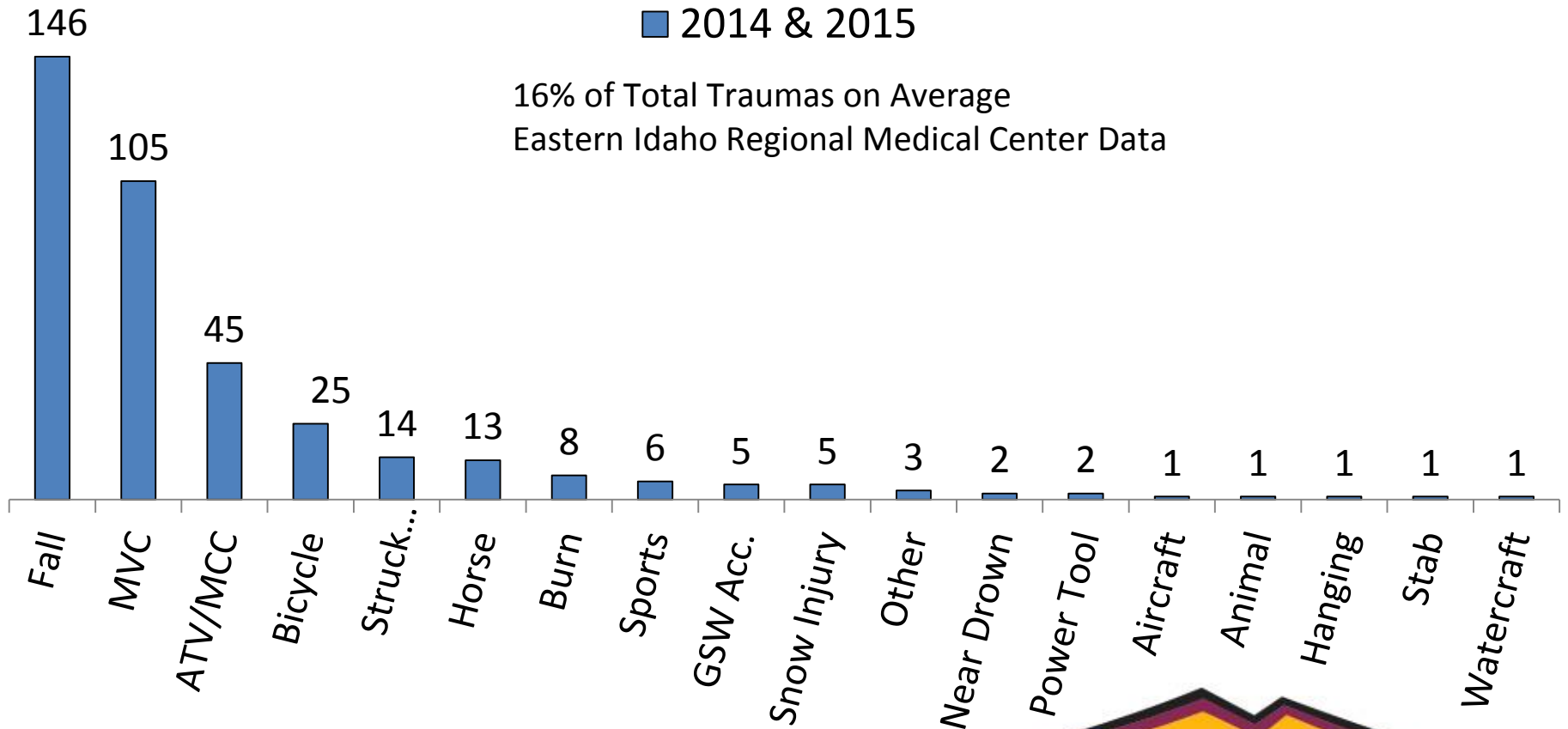
EIRMC Pediatric Trauma Volume

Pediatric: Age \leq 14

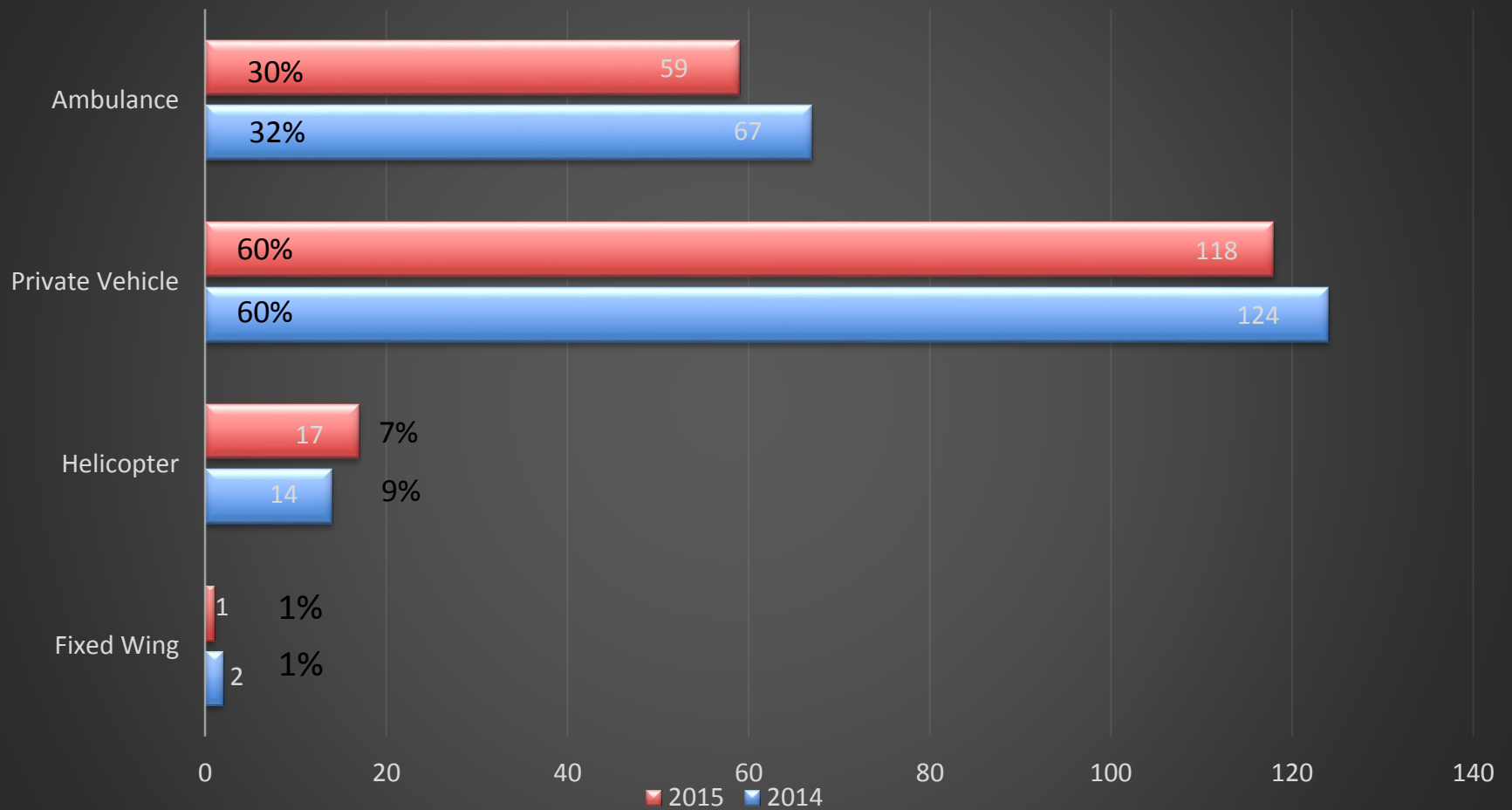
Year	Total Volume	ED Death	Admit EIRMC	Transfer Out	ED Treat and Release
2015	195	3	61 (31%)	2 (1%)	129 (66%)
2014	209	1	64 (31%)	7 (3%)	134 (64%)
2013	128	1	35 (27%)	8 (6%)	84 (65%)



Pediatric (Age ≤ 14) Traumas by Mechanism



Pediatric trauma - Mode of Arrival to EIRMC



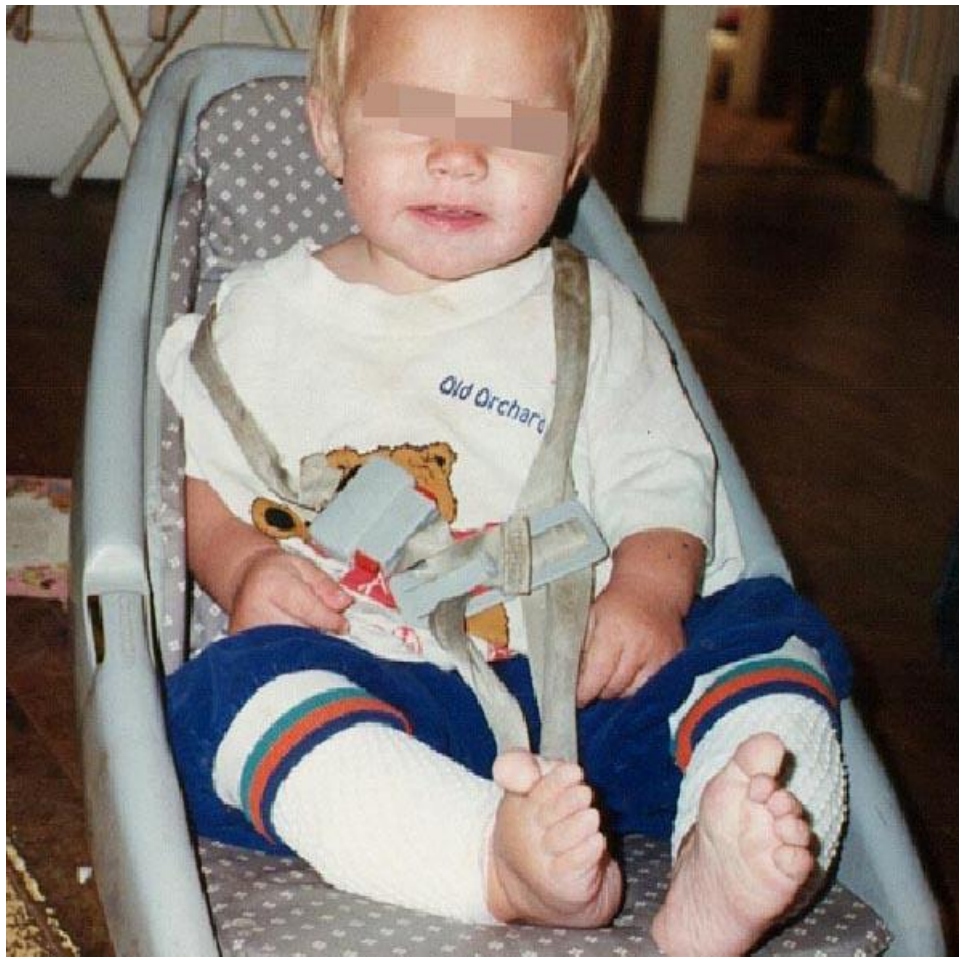
Prevention and Safety: Reduce the risk

- In 2013, restraint use saved the lives of 263 children ages 4 years and younger.
- Car seats reduce the risk of death in car crashes by 71% for infants and 54% for toddlers ages 1 to 4.
- Booster seats reduce the risk for serious injury by 45% for children ages 4 to 8 years.
- Between 1975 and 2013, child restraints saved an estimated 10,421 lives of children ages 4 and younger.



Content source:

[National Center for Injury Prevention and Control](https://www.cdc.gov/ncepi/)



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REAR-FACING CAR SEAT

Birth up to Age 2*
 Buckle children in a rear-facing seat until age 2 or when they reach the upper weight or height limit of that seat.



FORWARD-FACING CAR SEAT

Age 2 up to at least age 5*
 When children outgrow their rear-facing seat, they should be buckled in a forward-facing car seat until at least age 5 or when they reach the upper weight or height limit of that seat.



BOOSTER SEAT

Age 5 up until seat belts fit properly*
 Once children outgrow their forward-facing seat, they should be buckled in a booster seat until seat belts fit properly. The recommended height for proper seat belt fit is 57 inches tall.



SEAT BELT

Once seat belts fit properly without a booster seat
 Children no longer need to use a booster seat once seat belts fit them properly. Seat belts fit properly when the lap belt lays across the upper thighs (not the stomach) and the shoulder belt lays across the chest (not the neck).

Child safety seat recommendations: American Academy of Pediatrics.

Graphic design: adapted from National Highway Traffic Safety Administration.



Scene Assessment

What do you want to know?



Scene Assessment

- History
 - Time and mechanism of injury
 - MVA
 - Restrained v unrestrained passenger, car seat, helmet
 - Pedestrian
 - Damage to vehicle, buildings
 - Location of child in vehicle
 - Details of accident, speed of vehicle
 - Injuries to other, dead on scene
 - Ejection



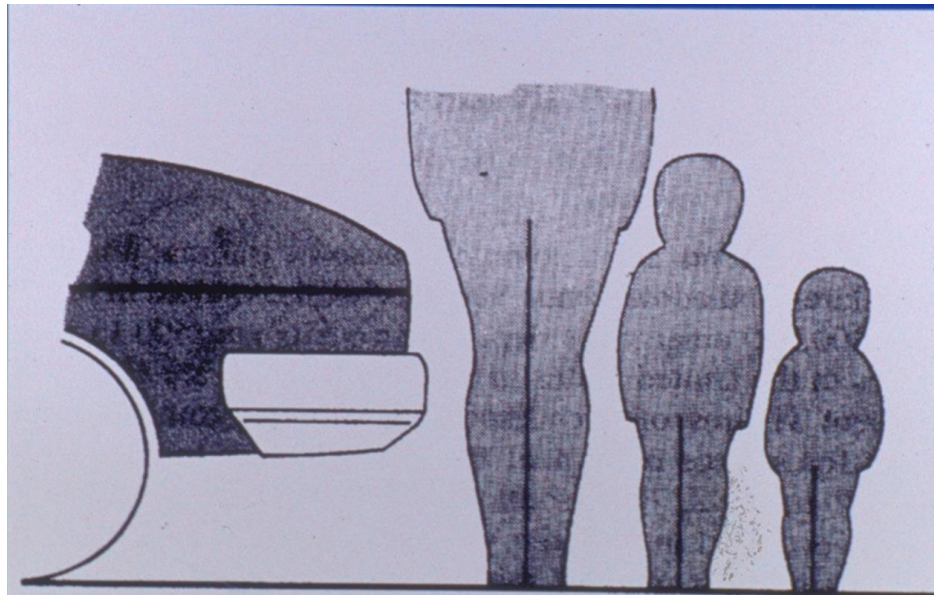
Scene Assessment

- Falls from height
 - High risk of injury from falls;
 - Moderate fall (5-15ft)
 - High fall (>15ft)
 - Lower risk of injury
 - Age dependent, but around 2-4 feet



Variations in Mechanism

Auto vs. Pedestrian



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Variations in Mechanism Blunt Abdominal Trauma

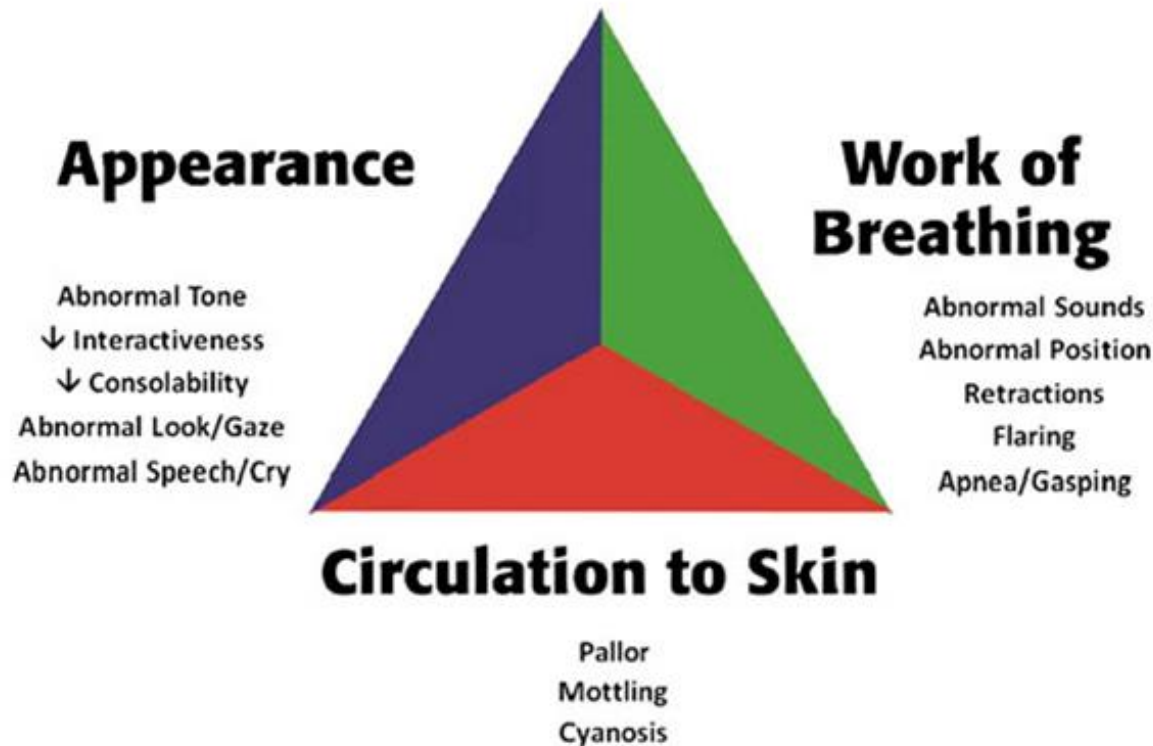
- Blunt injury about 85% of all trauma injuries
 - Seat belt sign
- External signs often obscure injury
 - Handle bar injury



- 7 year old male child
- Restrained with seat belt in back seat
- Crying, not cooperating with exam
- Significant damage to vehicle, difficult extrication



Assessment: Pediatric triangle of ABC's

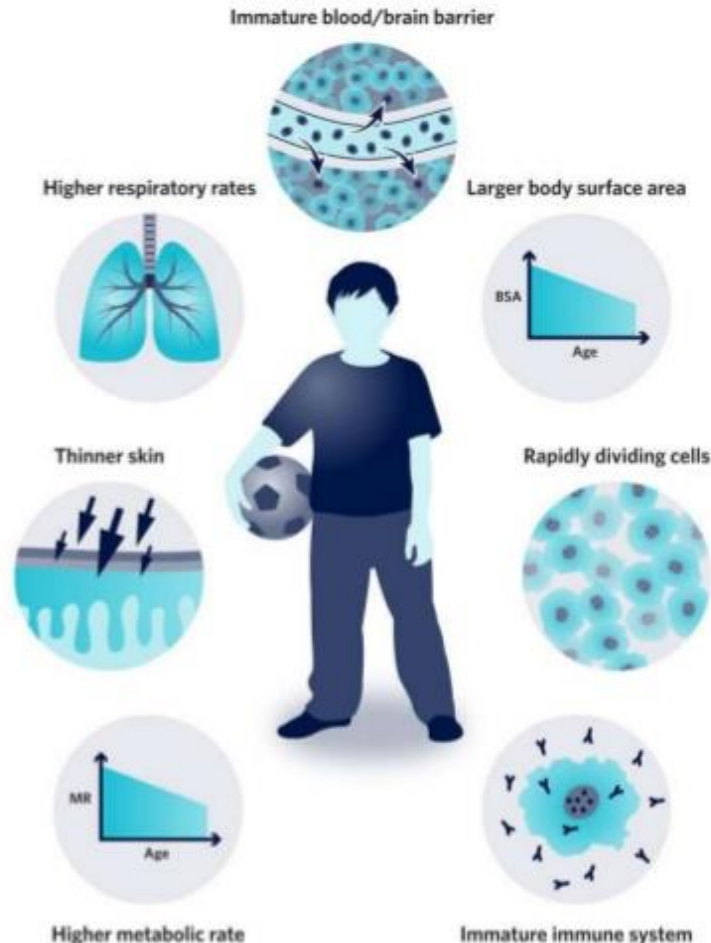


Important Physiological Considerations

Children have increased metabolism and therefore higher O₂ consumption compared to an adult

Because of their larger body surface area to size ratio, children are vulnerable to hypothermia in the setting of injury

Vital to avoid hypothermia when caring for children



Important Physiological Considerations

- Vital signs vary with age



Vital signs

Heart Rate

AGE	AWAKE RATE	SLEEPING RATE
Newborn to 3 months	85 – 205	80 - 160
3 months to 2 years	100 – 190	75 - 160
2 to 10 years	60 – 140	60 - 90
> 10 years	60 – 100	50 - 90

Respiratory Rate (breaths/min)

AGE	RATE
Infant	30 - 60
Toddler	24 - 40
Preschooler	22 - 34
School-aged child	18 - 30
Adolescent	12 - 16

Hypotension by Systolic Blood Pressure and Age

AGE	Systolic BP (mm Hg)
Term neonates (0 – 28 days)	<60
Infants (1 – 12 months)	<70
Children 1 – 10 years	<70 + (age in years x 2)
Children > 10 years	<90

Determining blood pressure in children

- Normal systolic blood pressure in children:
 $90 + 2(\text{age in years})$
 - Example: in a 7 year old, $90 + 2(7) = 104$
- Hypotension (decompensated shock):
 $70 + 2(\text{age in years})$
 - Example: 7 year old, $70 + 14 = 84$



Important Physiological Considerations: SHOCK

- Children are able to maintain normal blood pressure despite significant blood loss
 - Decompensated shock (low blood pressure) represents severe blood loss
 - Hypotension is a late sign of volume depletion
- Total blood volume
 - Neonates: 90cc/kg
 - Infants/Children: 80cc/kg
- Evaluation
 - Blood pressure
 - Heart rate, irritability (mental status), respiratory rate will increase with acidosis (hypoperfusion)
 - Capillary refill, skin perfusion, mottling, urine output



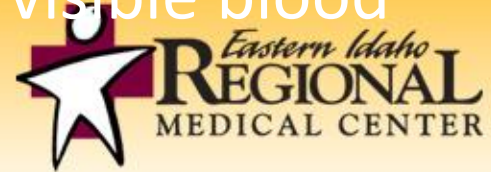
Systemic Responses to Blood Loss

System	Mild Blood Volume Loss (<30%)	Moderate Blood Volume Loss (30%-45%)	Severe Blood Volume Loss (>45%)
Cardiovascular	Increased HR; weak, thready peripheral pulses; normal SBP, normal pulse pressure	Markedly increased HR; weak, thready central pulses; absent peripheral pulses; low normal SBP, narrowed pulse pressure	Tachycardia followed by bradycardia; very weak or absent central pulses; absent peripheral pulses; hypotension; narrowed pulse pressure
Central Nervous System	Anxious; irritable; confused	Lethargic; dulled response to pain	Comatose
Skin	Cool, mottled; prolonged capillary refill	Cyanotic; markedly prolonged capillary refill	Pale and Cold
Urine Output	Low to very low	Minimal	None



Fluid Resuscitation

- Isotonic crystalloid
 - Lactated ringers
 - Normal saline
- 20cc/kg bolus
 - Give bolus rapidly over 10-15 minutes
 - Reassess after bolus
 - Search for source of blood loss
 - Consider intraabdominal source if no visible blood

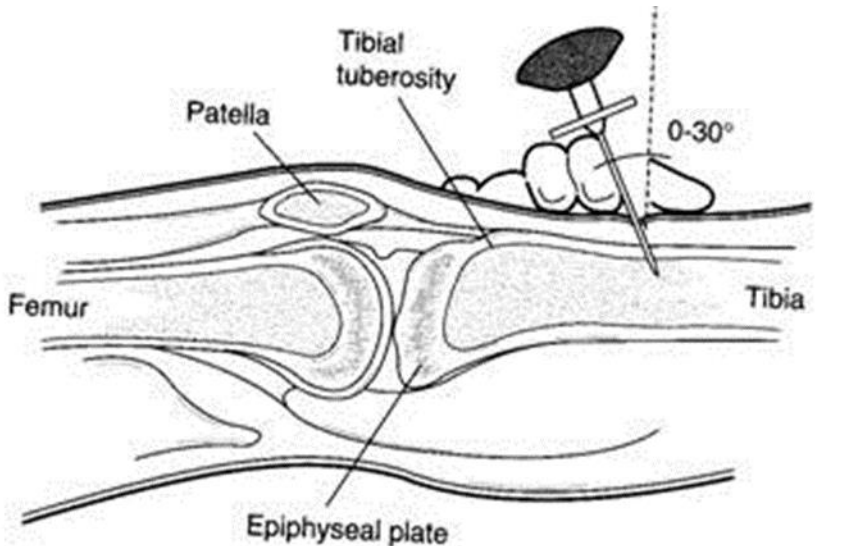


IV Access

- Best site of insertion: proximal tibia
- Can infuse crystalloid, drugs, blood through IO needle
- Various types of needles will work
 - 16 gauge hypodermic needle
 - spinal needle,
 - bone marrow needle



Draw



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IO Line Technique

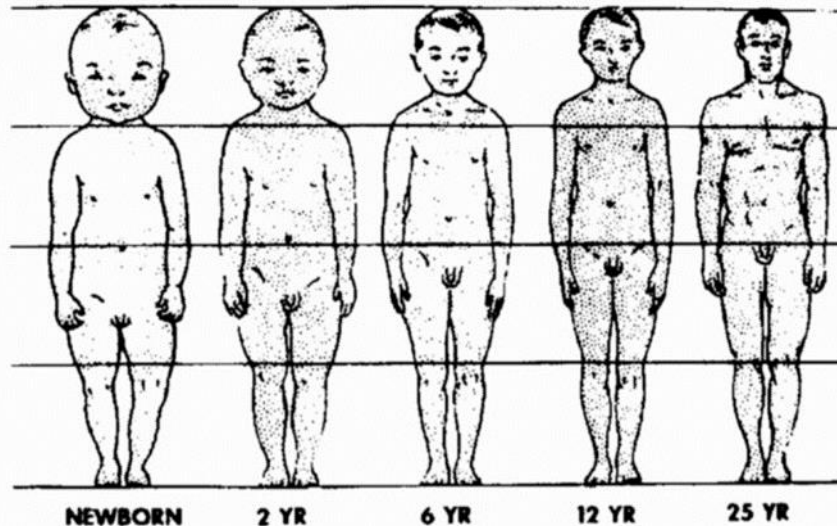
- Use of a 3-way stopcock will allow you to push fluids faster into a pediatric patient who needs rapid fluids



- Contraindications:
 - Fracture of bone
 - Skin infection over site
 - Prior attempts in that bone

Important Physiological Considerations

- Temperature regulation
 - Body surface area to mass larger
 - Lose body heat more easily
- Distribution of trauma impact
 - Smaller body mass to dissipate energy of impact
 - Potential for internal injury without external signs



Important Physiological Considerations

- Vital signs vary with age
- Compensatory response to hemorrhage
 - Ability to maintain adequate blood pressure with vasoconstriction and HR until decompensated shock
- Temperature regulation
 - Body surface area to mass larger
 - Loose body heat more easily → warm blankets, rig, fluids
- Distribution of trauma impact
 - Smaller body mass to dissipate energy of impact
 - Potential for internal injury without external signs



- Child is uncooperative and scared
- Multiple abrasions on face, chest abdomen
- Skin is mottled and peripheral pulses are thread
- Large bruise extends across mid abdomen
- Vitals: HR 164, RR 38, Bp 80/57, O2 sat 86%



Concerns?



Urgent First Impression-Trauma

For a child with signs of hypoperfusion but no obvious external bleeding:

- Presume that child to have additional injuries causing internal bleeding.
- Continue to assess and reassess.
- Maintain airway and support breathing.
- Transport as soon as possible.



Secondary Survey

- After ABC's and Primary Survey
- Evaluation for injury



Considerations for the assessment of the abdomen

- Abdominal wall with less fatty tissue
 - Bowel/pancreas at greater risk for injury
- Liver
 - Newborn liver 4% of total body weight
 - By puberty weighs 10x more
 - Almost entirely deep to the right lower ribs
 - Ribs are elastic, provide minimal protection and offer a route for transmission of force
- Spleen
 - Minimal protection from rib cage
- Kidneys
 - Occupy a large volume
- Bladder
 - As a child grows, descends towards pelvis where protection is improved



Detailed Physical Exam-Abdomen

- Check for:
 - Distention
 - Ecchymosis (bruises)
 - Abrasions
 - Penetrating injuries
 - Vomiting → blood or bile



Detailed Physical Exam-Abdomen

- Gently feel for tender areas
- Note guarding
 - Where child tenses abdominal muscles over a painful area
 - May be a sign of serious internal injuries
- A child with guarding is treated as potentially unstable, even if they appear stable.



Detailed Physical Exam-Abdomen

- Remember – the liver and spleen are poorly protected by the abdominal wall
- Blunt force to a child's abdominal area makes damage to internal organs likely
 - Always be concerned for internal bleeding with little or no outward sign
 - Pediatric patient's ability to compensate can mask serious injury

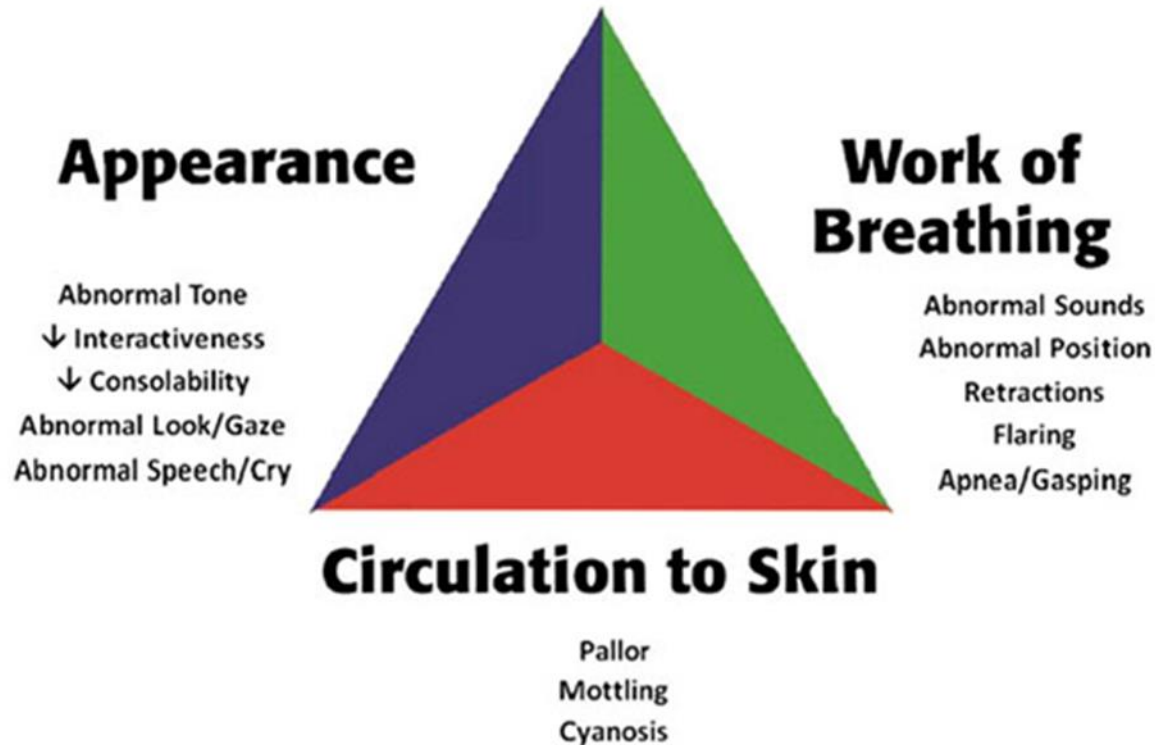


Detailed Physical Exam-Abdomen

- Findings associated with hypoperfusion
 - Guarding in abdominal area
 - Altered mental status
 - Enlarged appearance to abdominal area
 - Stomach decompression may be indicated if regional protocols exist
- There may be NO abdominal signs



Reassess!!!



Assessment: Pediatric triangle of ABC's

- Airway and appearance
 - Speech/cry, muscle tone, inter-activeness, look/gaze, movement
- Work of Breathing
 - Absent or abnormal airway sounds, use of accessory muscles, nasal flaring, body positioning
- Circulation
 - Pallor, mottling, cyanosis, capillary refill



Prehospital Care

- Treat airway and breathing
- Don't neglect spinal precautions and immobilize based on assessment
- The unresponsive child poses challenges with assessment, and relies on physical findings
- Transport as quickly as possible to the nearest facility
- Enhanced monitoring during transport results in shorter length of stay

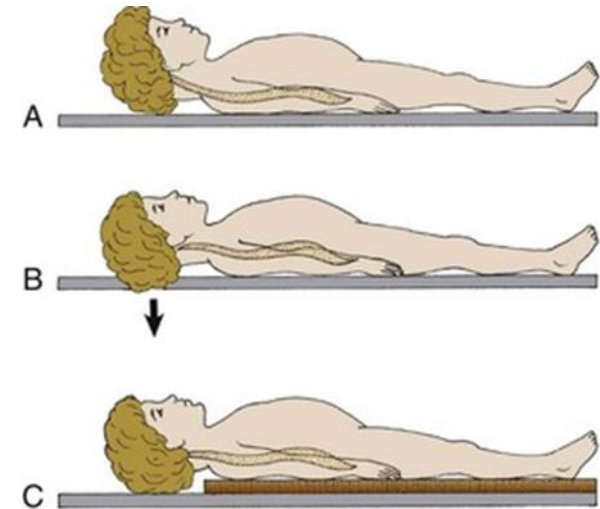


Prehospital Care

- Advances in Pediatric transport have taken place over the past 2-3 decades
- Early identification and stabilization have resulted in rapid prehospital transport during the “golden hour”
- Scene related triage and rapid delivery of patients has improved outcomes



Pediatric Equipment



MIAMI JR® CERVICAL COLLAR

- Innovative nylon designed exclusively for children 11 and under
- Free size pediatric sizes ensure optimal fit and the upper cervical spine immobilization
- Scrub according to the Ecozone Lubri Color-Colling System
- Softlites™ pads make the collar "skin-friendly" and protect skin integrity during extended wear
- The Dual Pediatric system also includes the Pro-Occ® 6-66i Estimation Collar, Occu-Net™ Air-Way PEG™ for appropriate positioning and the Collage® MRI Safe Head System

COLLAR	COLLAR SET	REPLACEMENT PADS	SIZE
MJR0	MJR-P0	MJR-P-01	0-6 months
MJR1	MJR-P1	MJR-P-02	6 months - 2 yrs
MJR2	MJR-P2	MJR-P-03	2-6 yrs
MJR3	MJR-P3	MJR-P-04	6-12 yrs

Occu-Net Air-Way Pad part MRP-T15 available
Replacement pads and collars may be ordered separately.
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	RED	PURPLE	YELLOW	
RESUSCITATION	RAPID SEQUENCE INTUBATION 0.05 mg/0.85 ml Atropine 0.17 mg Pan/Vecuronium N/A (Defasciculating Agent) N/A < 20 kg Lidocaine 10 mg 0.17 mg Fentanyl 25 mcg 8.5 mg Etomidate 2.5 mg 17 Joules Ketamine 17 mg Midazolam 2.5 mg 34 Joules Propofol 25 mg 9 Joules Succinylcholine (give atropine prior) 17 mg 8.85 mg Pancuronium 1.7 mg 1.7 mg Vecuronium 1.7 mg 42 mg Rocuronium 9 mg 170 mg Pancuronium/Vecuronium 8.9 mg 425 mg Rocuronium 8.4 mg	RESUSCITATION Epinephrine 1st Dose (1:10,000) 0.1 mg/1 ml Epinephrine High Dose/TT (1:1,000) 1 mg/1 ml Atropine 0.21 mg Pan/Vecuronium N/A < 20 kg Lidocaine 10 mg Fentanyl 32 mcg First dose 20 Joules Second dose (may repeat) 40 Joules Cardioversion 10 Joules Adenosine 1 mg 1st Dose 2.1 mg 2nd Dose if Needed 2.1 mg Amiodarone 52 mg Calcium Chloride 210 mg Magnesium Sulfate 525 mg	RAPID SEQUENCE INTUBATION PREMEDICATIONS Atropine 0.21 mg Pan/Vecuronium N/A (Defasciculating Agent) N/A < 20 kg Lidocaine 10 mg Fentanyl 32 mcg INDUCTION AGENTS Etomidate 3.2 mg Ketamine 21 mg Midazolam 3.2 mg Propofol 32 mg PARALYTIC AGENTS Succinylcholine (give atropine prior) 20 mg Pancuronium 2.1 mg Vecuronium 2.1 mg Rocuronium 10 mg MAINTENANCE Pancuronium/Vecuronium 1 mg Lorazepam 0.5 mg	RESUSCITATION Epinephrine 1st Dose (1:10,000) 0.13 mg/1.3 Epinephrine High Dose/TT (1:1,000) 1.3 mg/1.3 Atropine 0.26 mg Sodium Bicarbonate N/A < 20 kg Lidocaine 13 mg Defibrillation 32 Joules First dose 26 Joules Second dose (may repeat) 52 Joules Cardioversion 13 Joules Adenosine 1.3 mg 1st Dose 2.6 mg 2nd Dose if Needed 2.6 mg Amiodarone 65 mg Calcium Chloride 260 mg Magnesium Sulfate 650 mg
KG	9 KG	10 KG	11 KG	

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Summary

- Trauma is a leading cause of death in the pediatric population
- The anatomy and physiology of children make them vulnerable in traumatic injury
- Blunt abdominal trauma can cause serious internal injury and bleeding in children
- Signs and symptoms of shock need to be recognized and treated promptly
- Rapid transport to hospital care is vital





Questions?

