Northwest Community Healthcare Paramedic Program

Lifespan development
PEDIATRIC ASSESSMENT
Peds Trauma

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Reading assignment: Aehlert Vol. 2: pp. 71-132,167-181,184-189,532-533
Companion DVD-Chapter 35
SOPs: Peds section, CPR table; Pediatric drug index
Procedure Manual : Length-based tape; Pediatric intubation; Pediatric IV insertion

KNOWLEDGE OBJECTIVES:

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

1. integrate pathophysiological principles and assessment findings to formulate a field impression and implement a treatment plan for the pediatric patient.
2. discuss the paramedic's role in the reduction of infant and childhood morbidity and mortality from acute illness and injury.
3. identify methods/mechanisms that prevent injuries to infants and children.
4. describe techniques for successful assessment of infants and children.
5. describe techniques for successful treatment of infants and children.
6. identify the common responses of families to acute illness and injury of an infant or child.
7. describe techniques for successful interaction with families of acutely ill or injured infants and children.
8. determine appropriate airway adjuncts for infants and children.
9. discuss complications of improper use of airway adjuncts in infants and children.
10. discuss appropriate ventilation devices for infants and children.
11. discuss complications of improper use of ventilation devices with infants and children.
12. discuss appropriate tracheal intubation equipment for infants and children.
13. identify complications of improper tracheal intubation procedure in infants and children.
14. list the indications and methods for gastric decompression for infants and children.
15. define respiratory distress.
16. define respiratory failure.
17. define respiratory arrest.
18. discuss the common causes of hypoperfusion in infants and children.
19. identify the major classifications of pediatric cardiac rhythms.
20. discuss the primary etiologies of cardiopulmonary arrest in infants and children.
21. discuss age-appropriate vascular access sites for infants and children.
22. discuss the appropriate equipment for vascular access in infants and children.
23. identify complications of vascular access for infants and children.
24. describe the primary etiologies of altered level of consciousness in infants and children.
25. identify common lethal mechanisms of injury in infants and children.
26. discuss anatomical features of children that predispose them or protect them from certain injuries.
27. describe aspects of infant and children airway management that are affected by potential cervical spine injury.
28. identify infant and child trauma patients who require spine motion restriction.
29. discuss fluid management and shock treatment for infant and child trauma patients.
30. determine when pain management and sedation are appropriate for infants and children.

NCH Paramedic Program Pediatric Lifespan Development/ Assessment/Trauma

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Children present a special challenge because seriously ill or injured pediatric patients are not as common as adults. Skilled EMS personnel, who competently manage adult crises, become nervous when faced with a critically ill or injured child.

Factors for successful outcomes

- EMS agencies need to be prepared through education & having proper equipment.
- Properly trained personnel must be available with predesignated responsibilities.
- Care givers must appreciate a child's responses to injury - physiologic and psychologic.
- The developmental stages/needs of children based on their physical, cognitive, and psychosocial growth and development must be understood.
- Caregivers must have knowledge of mechanisms and unique injury patterns in children.

Children are not mini-adults. There is no "average size" child as there is in adults. Assessments and interventions must be based on the individuality of each child in terms of age, size, psycho-social development and metabolic status.

Age definitions

Newborn	First mins to hrs following birth
Neonate	Birth to in first 28 days of life
Infant	1 to 12 months
Toddler	1 to 3 years
School age:	6 to 12 years
Adolescent:	Puberty to adult (18 years)

Use PEDS SOPs for children 12 years and younger

Anatomy and physiology differences – Lifespan development

Average growth and developmental milestones

Ave birth wt is 3500 gm (7 lb. 8 oz.); length 19.5 - 20"

- Weight should double by six months
- Should triple by one year: ave 22 lbs., 30"
- 3 years: 30 - 35 lbs.
- 4 years: 16 kg (40 lbs.) - ¼ of adult weight; length 40"
- 10 years: 35 kg or ½ of adult weight

Size estimation in the field: Most accurately done by measuring child's length with a **Broselow tape** (2011A edition) **to determine tube sizes, drug doses, and defibrillation joules.** Lean body size may also be estimated by using the following formula:

2 x age in years + 10 = weight in kg.

Communications guidelines

Children are unpredictable by adult standards. You must know psycho-social growth and developmental stages to communicate with them effectively. See chart.

- Be prepared: Children cry loudly!
- Younger children have limited language skills and a decreased ability to communicate. Look at their faces for clues to their well-being.
- Keep voice at even, quiet tones, don't yell. They tend to respond to our facial expressions and tone of voice more than to what we actually say.
- Use toys or penlight as distracters; make a game of assessment. Use non-medical techniques such as pacifiers, toys, or books to calm children.
- Keep a small child with their caregiver(s) if possible; do assessment on a stable child while being held. Allow parents to remain with child and offer comfort.
- Only one person should give instructions
- Get down on their eye level if possible. Speak slowly, communicate in words they understand.
- Make as many observations as possible before touching and upsetting the child or inflicting pain.

Stages of emotional maturity- don't overestimate

Psychosocial development see detailed handout chart

Neonates:

- Unconcerned about strangers
- No language but a cry – typically caused by hunger, irritation, boredom, pain; persistent crying may indicate physiological distress.
- Handle gently, supporting head and neck.
- Respond to soothing voice, gentle hands and pacifier unless hungry or in pain, then may be inconsolable.
- Not modest, may mind being undressed in a cold environment; may become frankly hypothermic if left uncovered during exam or therapy.
- Begin exam with chest and abdomen; difficult to examine if crying; progress to head (and extremities).

By 3-4 months:

- Establishes attachment to parents
- Can be quieted easily (more readily by primary caretaker
- Smiles readily

By 4-6 months:

- Is learning to treat individuals differently
- Laughs out loud and may show displeasure if facial contact is broken
- About 6 mos begins to be anxious around strangers

By 8-9 months:

- Protests when primary caregiver leaves
- Shows happy feelings when interacting with people
- Starts to experiment with independence (crawls away from parents, cries, then comes back

Infants: Implications for care

- The baby will reject the attention of strangers. Make first contact with the infant in the mother's lap until the child views you as a safe person.
- Will probably not object to being undressed but will object violently from being removed from their primary caregiver and placed on a table or cart for examination
- Distract infant with verbal stimulation and examine while sitting in mother's lap
- Crying gradually decreases throughout infancy
- Begin exam with chest and abdomen
- Foreign body airway obstruction risk begins at about 6 months and increases with age.

Toddlers: One and two year olds

- Exhibits the beginnings of autonomy (showing clothing or food preference
- Independent, strong-willed; favorite word is "NO"
- Explores the environment, using the parent or primary caretaker as a secure attachment
- May use a transitional object - a doll, blanket, or thumb to calm himself or help himself go to sleep
- Learns to soothe self verbally and deal with emotional issues with words
- Demonstrates interest and enjoyment in play
- Demonstrates a wide variety of emotions feelings, and moods, including protest, anger, pleasure, joy, assertiveness, and warmth
- Strong distrust or fear of strangers
- May understand language but unlikely to believe reassurances
- Likely to shriek and kick when touched
- At risk for emotional consequences after unpleasant experiences
- Approach kindly but firmly; reassure it's OK to cry (but not to kick or bite)
- Distract patient with interesting object (toy, penlight) during exam
- Allow patient to hold an object (blanket, stuffed animal)
- Keep parents nearby and involve in exam as possible
- Limit exam to bare essentials, begin with trunk

Pre-school (3 to 5 years)

- Continues to demonstrate curiosity and interest
- Exhibits a vigorous enjoyment of new skills
- Is imitative and imaginative (play may include an imaginary friend)
- May be even more strongly attached to a transitional object
- Begins to be curious about gender differences
- May express anger using words (sometimes includes profanity)
- Continues to show a variety of emotions
- Likely to be frightened, especially if body injured
- Needs explanations in clear and unambiguous language; avoid baby talk; provide reassurances
- Avoid frightening or misleading comments
- More cooperative, may want to participate in exam; offer choices if possible
- Toy may help with exam and any therapy
- May be modest, examine respectfully
- Exam still begins with chest and abdomen; involve caregivers whenever possible

School-age (6 to 12 years)

- Enjoys interaction with peers, make friends easily
- Recognizes the need for rules
- Shows self-esteem and self-confidence
- Feels good about accomplishments
- Has a vivid imagination, and in play often stages dramatic scenes using favorite toys
- Usually cooperative
- Still afraid of pain, separation of parents, permanent injury; more aware and afraid of death
- Usually modest; defer genital exam unless necessary
- Needs friendly reassurance, likes unambiguous explanation of procedures and equipment
- Address preoccupations about death when appropriate
- Generally examined like an adult, best in presence of parents

Adolescents (13 to 15 years)

- Enjoys close interaction with peers and develops intimate relationships, especially with friends of the same sex
- Is industrious, demonstrates a sense of mastery and progressively takes responsibility for own work (homework, chores)
- Demonstrates self-confidence and sense of pride
- May occasionally exhibit anger and rebelliousness but is generally enthusiastic, energetic, and cooperative
- Spends leisure time involved in complex games and sports teams with less need for adult supervision (by age 15, play and leisure time are part of the child's identity and may incorporate music, lounging around or experimental risk-taking, such as harmless pranks or daredevil-type sports activity Treat like adult, shares many fears of younger children; especially regarding body image
- Likely to be excessively modest; respect privacy
- Approach in adult fashion; explain things clearly and honestly; offer lots of reassurance
- Involve patient in treatment whenever possible
- Address preoccupations about death when appropriate

Ages 16-18

- Is self-confident
- Has a sense of pride, competence
- Enjoys close interaction with peers of both sexes
- Is moving toward independence
- Feels responsible for his own health and behavior
- Participates in activities outside of school
- Is generally energetic, enthusiastic, idealistic
- Is generally cooperative and considerate (although a certain amount of rebelliousness is normal)

Psychological vulnerability

~One in six injured children develops persistent stress symptoms, such as nightmares, concentration difficulties and negative thoughts, that impair functioning and development after an injury occurs. Apart from physical care, EMS providers can play a key role in supporting injured children from a psychosocial perspective (Alisic et al, 2015).

Fears

- They are placed in an unfamiliar setting surrounded by strangers, bright lights, scary machines and sounds. They are afraid of separation from their parents, permanent removal from their homes, angry parents or the possibility of punishment. Children are used to being scolded or punished for doing dangerous things. Now he knows he's done something "*really bad*", and the fear of imagined punishment blends with the pain of the injuries to create a living nightmare (Hawkins, 2002).
- They are afraid of pain, mutilation or disfigurement and the unknown.
- **Never lie to a child, be honest no matter what - even if it involves pain. Smile at the child and appear calm and in control.**
- Parents, too, may feel anger, guilt, or fear especially if they caused the injury. They may fear that the child will die, be brain damaged or experience permanent disability. They may also be injured, adding to the child's decompensation.
- Provide your name and level of licensure
- Acknowledge their fears and concerns
- Remain calm and provide reassurance
- Explain exam and procedures
- If the parent cannot cooperate, assign someone to remove them until they can remain calm.

Pain in children

- Defer the painful part of the exam to last
- Avoid having parents participate in the painful part of any exam or treatment. Ex: Don't have them hold the child down to start an IV.
- Tell them how it will feel, not what will happen. Example: cold, wet, prick like a mosquito, mushy.
- Children do not localize pain well and can only appreciate severe pain in one place at a time.

Metabolic and physiologic differences

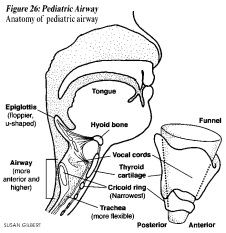
Head

The head is a proportionately larger size with a larger occipital region. The fontanelles remain open in infancy and the face is small in comparison to the size of the head.

Airway

Anatomic differences leading to an increased susceptibility to airway obstruction in children:

- The airway is narrower at all levels
- Infants (first 2-6 months) are obligatory nose breathers; keep nasal passages clear to avoid airway obstruction
- Because of the large occiput in infants and young children, a supine position flexes the cervical vertebrae and trachea. Large head + short neck + weak shoulder girdle = easily obstructed airway.
- The oral cavity is smaller and the tongue is large in relationship to the mouth size.
- Tonsils and adenoids are large and have a plentiful blood supply.
- Narrow nares are easily obstructed with edema or secretions like blood or mucous.
- The jaw is smaller in young infants
- The larynx is higher (C3-4) and more anterior
- The small, immature larynx collapses on inspiration. This space must deal with food and liquids as well as air which can cause a feeding problem
- The **epiglottis** is large and omega shaped. It extends at a 45° angle into the airway. The epiglottic folds have softer cartilage, therefore are more floppy and are susceptible to trauma and swelling.
- Vocal cords are short and concave and the trachea is shorter: 4-5 cm in newborn, 7-8 cm in 18 month old.
- Lack of cartilaginous supporting structures (immature tracheal rings) in the larynx and trachea and flaccidity of the esophagus allows swallowed foreign bodies in the cervical esophagus to balloon into the common wall between the esophagus and trachea and occlude the airway.



- **Narrowest part of the upper airway is at the cricoid ring**
- Speed of deterioration is mathematical. Diameter of a circle is πR^2. Since a child's airway is so small to begin with, even a mm or two of circumferential edema narrows it by a considerable percentage.
- The smaller the diameter, the more resistance there is to airflow and the more pressure needs to be exerted to ventilate. Decreasing airway diameter by ½ results in a 16 fold increase in resistance.

PULMONARY System

- There are about 70 million primitive fragile alveoli at birth, which increase to 200-600 million (ave 375 m) in an adult. Infants have an ↑ risk for pneumothorax following barotrauma and **atelectasis.**

- A newborn's chest has a cylindrical shape and a relatively horizontal orientation of softer ribs making the chest very pliant and the mediastinum is more mobile. The ribs are less likely to fracture, but pulmonary contusions are more common. Greater energy is transmitted to underlying organs following trauma, and significant internal injury can be present without external signs. Mediastinal shift is greater with a tension pneumothorax.
- Chest muscles are immature and fatigue easily. Tidal volumes (V_T) in children are 6-8 mL/kg. Horizontal ribs + soft sternum + weak intercostal muscles = poor ability to create negative intrathoracic pressure so they cannot increase V_T when in distress.
- Diaphragmatic or "**Belly breathers**" until the age of about three. Abdomen rises and falls with each breath.
- They have **poor pulmonary reserve** due to a soft sternum, large heart, large abdomen and ↓ functional reserve capacity. Hypoxia will develop rapidly.
- Children tend to hold their breath when scared and swallow air when crying (aerophagia) which predisposes them to gastric distention.
- Small thorax, thin chest walls allows for easily transmitted breath sounds throughout the chest. It is easy to miss a pneumothorax or misplaced TT due to transmitted breath sounds.

Respiratory rates

- Children hyperventilate naturally. Resting RR decreases as body size increases

Normal respiratory rates

Newborn – 3 mos	30-60/minute
3 mos – 2 years	24-40/minute
2 – 10 years:	18-30/minute
> 10 years	12-16/minute

- Basal metabolic rate is higher in infants and small children than in later years, which makes **O_2 consumption approximately 50% higher**/unit of body weight in early childhood.

CARDIOVASCULAR system

Estimating circulating blood volumes in children can simplify resuscitation. Total blood volume (TBV) is calculated on the basis of body weight. One can use the following to estimate **TBV in children**.

Neonate:	85-90 mL/kg
Infant:	75-80 mL/kg
Child:	70-75 mL/kg
Adult:	65-70 mL/kg

A 2-y/o child who weighs 12 kg would have a TBV of 960 mL (< liter of IV fluid). A loss of 240 mL (24% of CBV) is roughly equal to a typical glass of water and would result in shock. **90 mL of blood = 1 kg body wt.**

Because of their smaller total blood volume, children may lose the same amount of blood as an adult with a similar injury, but this amount represents a much larger percentage of TBV.

Hemoglobin in children: Relatively anemic compared to adults. Normal Hb in a 2 month old is 10.5 gm/100 mL. Given that it takes 5 gm of desaturated Hb for cyanosis to be exhibited, **as much as 50%** of a child's blood **must be desaturated before cyanosis** is evident.

Children are dependent on HR to maintain CO

The pediatric myocardium has less contractile mass than an adult's resulting in a limited ability to increase SV. Starling's law (increased stretch=increased contractility) does not apply until age 8.

They have vigorous but limited cardiac reserves and compensate for vascular volume loss with catecholamine release and severe vasoconstriction that shunts blood from the periphery to central structures. HR increases **while limbs are cold and mottled**. Carefully assess for shock if sustained tachycardia is present.

If HR exceeds 180-200, diastolic filling time is compromised and both SV and CO begin to fall. Bradycardia is a later response to hypoxia and causes a significant drop in CO due to the relatively small SV in child. **Bradycardia** is a HR < 100 in a neonate; < 60-80 in a child.

Their compensatory responses work almost too well. Will maintain BP until > 30% of volume is lost. A child may be in shock despite a normal BP. Shock assessment is based on clinical signs of tissue hypoperfusion.

FLUID & ELECTROLE / metabolic differences

A child's fluid requirements are higher per kg of body wt than an adult's, as insensible water losses are greater per unit of body wt and circulating blood volume is greater per kg.

Fluid and electrolyte imbalances

Dehydration is a major problem in infants. Water deprivation threatens survival. Wt ↓ of 10% = 15% loss of body H_2O. This is caused in part by the rapid ECF turnover rate -up to 3 X greater than an adult.

Preemies: ≥ 60% turnover of water/day
Infants: 15% turnover of water/day
Adults: 9% turnover of water/day

Increased potential for ECF losses due to:

- Greater body surface area per kg of body weight
  - ↑ RR
  - ↑ basal metabolic rate
  - ↑ loss with fever
- Immature kidneys that cannot conserve H_2O

Disorders of infancy predispose to ↓ water and electrolyte stores, i.e., infantile diarrhea (may loose 1 L of stool/day)

Routinely assess for volume/hydration status

- Palpate anterior fontanelle if < 15 mos of age.
- Bulging fontanelle suggests increased ICP
- A sunken fontanelle suggests dehydration
- Skin turgor: tenting on abdomen or back of head
- Dry mucous membranes, decreased tears
- Tachycardia
- Acute weight loss

Significant weight changes

Infants:	50 Gm or more in 24 hrs
Children:	200 Gm in 24 hrs
Adolescents:	500 Gm in 24 hrs

Urinary output: Normal in small children is 1-2 mL/kg/hour. Adolescents produce 0.5 mL/kg/hour. Assess for ↓ volume and ↑ concentration:

Infants:	≤ 1 mL/kg/hr
Children:	0.5 mL/kg/hr

Ask # of diapers they have changed in the last 8 hours.

Tonicity: Decreased sodium can lead to seizures and may make it difficult to determine if the child has a head injury or if S&S are due to fever or an electrolyte imbalance. Never use D_5W alone to rehydrate a child.

Changes in pH: Acidosis common in children

- Increased loss of HCO_3 through the GI tract
- Ketones released during starvation
- Lactic acids released due to poor perfusion
- Renal insufficiency causes them to retain H^+
- Immature parathyroid glands and kidneys

Higher glucose needs and low glycogen stores and Rx of hypoglycemia

Infants and children have limited glycogen and glucose stores. Stress caused by shock or respiratory distress/failure rapidly depletes glycogen stores in the liver and muscle mass. Hypoglycemia can cause seizures. If glucose is < 70 in an infant or child, it should be treated with an age-appropriate dose of dextrose 10% per SOP.

Thermoregulation

Children cannot control body temperature well and are prone to hypothermia. Their larger surface area relative to body mass allows increased heat loss through the skin. Infants have immature thermoregulatory responses and do not shiver to gain heat. They have thin skin with little sub-q tissue for heat insulation plus they have ↑ caloric use and energy requirements. The younger the child, the greater the risk for hypothermia.

Normal:	37°C or 98.6° F
Formulas:	°C = 5/9 x (°F-32)
	°F = 9/5 x °C + 32

Heat loss occurs easily. Children become cold quickly when exposed or wet. Estimating temp by touching the skin may grossly underestimate core temperature when exposed or when CO is low.

Each 1 degree ↑ or ↓ in temp = 7% ↑ in O_2 requirement

Cold stress results in hypoxia, bradycardia, acidosis, & hypoglycemia

Hyperpyrexia (fever) in children: Reducing a child's fever with drugs may not be necessary if T < 102° F (38.9° C). Always assess clinical status first. If comfortable, eating, drinking, and playing, they probably won't benefit much from antipyretic therapy. Temps above 102° F require more aggressive therapy. Fevers above 105° F (40.6° C) need very aggressive antipyretics at the hospital to prevent neuro damage.

Drug of choice is acetaminophen (Tylenol) 10-15 mg/kg q. 4 hours. Ibuprofen is an alternative but children's dosages and forms are available by prescription only. Not usually given by EMS personnel.

In general, **children shouldn't receive ASA** following viral illnesses, such as chicken pox, due to its association with Reye's syndrome.

Alcohol baths/rubs are contraindicated due to the risk of isopropyl alcohol poisoning from skin absorption and inhalation.

Immune System

Immature in first 3-6 mos
More susceptible to severe infections
Limited to passive immunity from mom

Nervous System

Newborn babies, whether born prematurely or at term, have a very different brain than a mature child. The brain is very small, the connections have not been fully established or matured, and the axons, the long processes that connect the nerve cells and allow intercommunication among them, have not yet been covered with myelin, a substance that increases the speed of transmission of communication. In addition, the immature brain is at significant risk for injury, in part because other body systems, including the heart, lungs, blood vessels, and immune system, are still immature.

The immaturity of the nervous system makes neurological examination very challenging, even for experts. Therefore, **brain imaging at the hospital** is a crucial test to evaluate newborns who are suspected of having suffered any sort of injury.

Brain development in toddlers

- Increase from 70% to 90% of adult brain weight between age of 2 to 5 years
- Cerebral cortex thickens as myelination occurs – rapid growth in frontal lobe/cortex
- Improvement in physical coordination, perception, attention, memory, language, thinking and imagination linked to myelination

Brain plasticity in early childhood

- Connections are made permanent from infancy to early childhood
- Brain physically changes due to outside experiences
- First 3 yrs see most rapid changes (everything new)
- Brain is most flexible and prepared to learn (plasticity)

Pruning

- Connections not used are removed by "pruning"
- After 12 mos, pruning occurs more rapidly
- 3 year-old has 2 X as many connections as an adult
- By 10, child has nearly 500 trillion synapses, same as average adult

Experience builds connections

- Early experiences determine how brain is wired
- Early sensory experiences create new synapses
- Repetition strengthens them
- Synapses can go up or down by 25% due to enrichment of the environment
- Synapses not used are pruned

Window of opportunity

- About age 10, brain begins to rapidly prune to make order of tangled circuitry of brain
- Continues to prune for ~12 years, but maintains flexibility for new learning
- New synapses grow all through life
- Adults continue to learn, but do not master new skills so quickly – ex. Learning a new language

Importance of sensory stimulation

- Touch, sound, sight, taste, smell, all build neural connections
- Number of words an infant hears/day is a critical predictor of later intelligence, school success, social competence
- Touch is key to brain development; massage of premies stimulates faster growth & development

Security

- An infant must learn how to meet his needs
- If adult responds predictably to cries and provides for needs, infant feels secure
- Able to then focus on exploring & allowing brain to develop
- If needs are not met, infant will focus energies on meeting needs
- Will have more difficulty interacting with people and objects in the environment
- Brain will shut out stimulation it needs to develop healthy cognitive and social skills

Magical thinking until age 7 – be very careful what you say to them

Infant neuro status assessed through reflexes

- Automatic body response
- Sole physical ability in young infants
- Presence indicates normal brain and nerve development

Rooting/sucking

Head turns toward anything touching face, If an object is near the lips, an infant starts sucking. This reflex is needed for survival and usually disappears by 3 wks
Read more at
http://www.newbornbabyzone.com/newborn/newborn-baby-reflexes-you-should-know-about/comment-page-1/#rR0R5tsjfDqRxIUX.99

Moro/startle reflex

- Appears at birth and disappears at 3 months
- Occurs if startled by loud noise or sudden movement
- Arms and legs flail outward

Grasp reflex

- Infant grasps tightly anything put into palm of hand
- Disappears by 3-6 mos

Plantar reflex

Prior to walking, infants toes will fan out and curl, foot twists inward when sole of foot is stroked on the outside from heel to toe across

Stepping or walking reflex

- If infant held upright so feet are on a flat surface, will make a stepping motion
- Disappears after 2 months
- Returns later as a learned voluntary behavior

MOTOR DEVELOPMENT - sequence

- Lifts head, tracks objects
- 3 mos: Moves objects to mouth w/ hands
- 4-5 mos: Reaches out to people; rolls over
- 4-6 mos: Sits upright if supported
- 7-9 mos: Sits unassisted
- Belly crawl using legs or arms to push
- Hitch crawl on buttocks
- Crawl hands and knees: By 9 months, most babies crawl using both hands and feet, though some babies never crawl, preferring to creep or wriggle instead. Crawling is not an essential baby milestone, and infants who choose to scoot or creep still tend to reach other milestones on schedule.
- Stands with assistance, then

- 9 mos: Pulls self to standing position; holds onto furniture or wall & cruises
- Walk with support
- Stands without help
- Walk without support
- Run

Curiosity can become dangerous as they grow and develop motor skills

Fontanelles: Anterior and posterior

- Allow rapid growth of brain
- Permit skull to change shape
- Posterior closes: 3 mos
- Anterior closes 9-18 mos
- Pulsations reflect HR
- Bulge: cry, cough, vomiting, ↑ ICP
- Depressed: dehydration, malnourished

Sleep needs

- Infants: Sleep 16-18 hrs/day in short segments d/t frequent feeding
- 4-6 mos: Sleep 14-16 hrs/day with 9-10 hours at night
- Easily wakened
- Strong correlation between sleep and normal brain development
- Brain needs deep, uninterrupted, physiological rest
- Children between birth and 12 years that do not get enough sleep do poorly on performance testing, creativity, and higher level problem solving
- May relate to cortisol (stress hormone) levels

Musculoskeletal System

- Bones grow in length at epiphyseal plate
- Influenced by growth hormone, thyroid hormones, genetic factors, general health & nutrition

Tooth eruption

- Generally begins with front teeth at 5-7 mos
- Some born with teeth
- Some have none until 1 year

Magnitude of pediatric trauma

- Child mortality rates in U.S. exceed any other industrialized country.
- Trauma is the leading cause of morbidity and mortality in children; 50% or more of total deaths in children 1-14 years of age.
- Injury every 4 seconds, death every 6 minutes in US. More than 20,000 trauma deaths/yr: for every 1 that dies, 4 survivors are permanently disabled.
- Approximately 1 million hospitalizations/year; 25 million ED visits/year.
- 33% of trauma deaths are due to head injuries; 80% of all trauma deaths have head trauma.
- Blunt trauma most common producing subtle S&S

Age plays a role in mechanism of injury (MOI)

0-12 mos: Child abuse, falls, inhalation or ingestion of F/B/poisons, burns, drowning, MVCs

1-4 years: Falls, drowning, MVCs, poisonings, burns

5-9 years: MVCs, bicycle accidents, submersion, burns, firearms, sports, pedestrian vs. car

10-14 years: MVCs, submersion, burns, firearms, falls, bicycle accidents, sports accidents

GENERAL APPROACH to a pediatric patient

Action strategy overview

Assess for causative factors of distress and initiate resuscitative measures as found.

Causes of acute deterioration in an infant or child include the H's and T's

- **H**ypoxemia
- **H**ypovolemia
- **H**ypothermia
- **H**yperkalemia, hypokalemia
- **H**ypoglycemia and other metabolic disorders
- **T**amponade
- **T**ension pneumothorax
- **T**oxins, poisons or drugs
- **T**hromboembolism

The 4 C's are additional potential causes of acute deterioration in a peds trauma victim

- **C**entral neurologic injury or cervical spinal cord transection
- **C**ardiovascular injury, particularly direct injury to cardiovascular structures such as the heart, aorta or pulmonary arteries
- **C**hest wall disruption (ruptured diaphragm uncommon: open pneumothorax is possible)
- **C**o-morbid conditions that may contribute to the injury (e.g., diving causing head injury and secondary submersion, seizure leading to a fall, or electric shock resulting in a fall).

Also consider poisoning/ingestion, or severe infection;

Regardless of the complaint, follow a systematic approach in assessing all patients. While prioritized steps are sequenced in their order of importance for clarity, some are frequently accomplished simultaneously such as airway and breathing.

Assume that all have a life-threatening event until it is ruled out.

Scene size up

- Observe the scene for hazards or potential hazards
- Observe mechanism of injury (MOI)/nature of illness
- Ingestion: Pills, medicine bottles, household chemicals
- Abuse: Assess any discrepancies between the history and the patient presentation

- If an infant is a possible victim of SIDS; inspect the environment in which the baby was found
- Observe the parent/guardian/child interaction
  - Do they act appropriately?
  - Is the parent concerned for the child's welfare?
  - Are they angry or indifferent?

PRIMARY assessment

Purpose: Detect and resuscitate all clinically evident, immediate life threats.

O**bserve before touching, especially if conscious**

- Preferred position
- Unusual/significant odors
- Movement: spontaneous, purposeful, symmetrical
- Obvious injuries, bleeding, bruising, impaled objects, gross deformities

General impression: While walking up to the child, do a quick look to determine the severity and urgency of the situation using the **pediatric assessment triangle (PAT)**

The PAT focuses on three independent aspects of the physical assessment that are used to determine the physiologic stability of a child by just looking at them.

In other words, ***"How sick?" "How quick?"***

- **Appearance:** The child's overall appearance reflects the adequacy of oxygenation, ventilation, and perfusion. Appearance is the single most important factor in assessment. There are very few false negatives (very few really sick or injured children have a normal appearance). However, a child can have a chronic illness with visible abnormalities, but not be physiologically sick. **A sick child will look sick**.
  - **Alertness, mental status and child's response to environment:** Observe for age-appropriate behavior, level of consciousness; affect, or restlessness. Is the child looking around, making eye contact; distractible, responding with curiosity or fear, playing, or quiet, eyes open but not moving much or uninterested in environment? Do they recognize parents/favorite toy? Are they uncooperative and clinging to parent vs. unconcerned and allowing invasive procedures? Are they irritable and unresponsive to comforting measures yet they stop crying and fall asleep when left alone? Paradoxic irritability is a sign of meningeal irritation.
  - Muscle tone: good or limp; sucking on a pacifier or bottle; hands of an infant should be in fists.
  - Cry or speech
- **Work of breathing**
  - General respiratory rate while child is quiet
  - Respiratory effort: Obvious respiratory distress or extreme pain; *retractions, nasal flaring*
  - *Abnormal audible breath sounds* – stridor, wheezing, grunting.

    A normal appearance with increased work of breathing means **respiratory distress**.

    An abnormal appearance with increased or decreased work of breathing means **respiratory failure.**
- **Circulation to skin:** Inadequate perfusion of vital organs leads to compensatory vasoconstriction in non-essential areas, especially the skin. Circulation to the skin reflects overall adequacy of perfusion.
  - Skin signs: Obvious bleeding
  - Skin color: pink, pale, flushed, cyanotic, mottled
  - Skin temperature
  - Pulse strength
  - Capillary refill time (CRT)

  Normal appearance + poor circulation to skin = observe carefully

  Abnormal appearance + poor circulation to skin= shock

  Other causes for vasoconstriction (mottling and/or prolonged capillary refill time (CRT): fever, hypothermia, medications, and normal vasomotor lability in infants.

The PAT can also help identify a child with CNS or systemic problems who has normal oxygenation, ventilation & perfusion.

Abnormal appearance + normal WOB and normal circulation to skin may mean brain/CNS dysfunction.

After completing the PAT, begin a more complete Primary assessment.

- **Determine level of consciousness**: Brief evaluation of responsiveness. Some parameters are not easily measured; Ex: assessing the level of consciousness in a baby at nap time.
  - **A:** Alert
  - **V**: Responds to verbal stimulus
  - **P**: Responds to painful stimulus
  - **U**: Unresponsive

It is important to note if the child arouses easily then stays awake and alert, arouses to repeated gentle or aggressive/irritating stimulation and falls back to sleep when stimulus stops, or does not arouse at all.

Airway assessment – determine patency

Airway obstruction may be acute, insidious, progressive or recurrent. Maintain high index of suspicion.

Possible causes of airway impairment

- Tongue; improper positioning
- *F/B aspiration, secretions, trauma
- Supra or subglottic allergic edema/anaphylactic shock
- Reactive airway disease
- Ingestion of caustic agent
- Unique airway infections: croup, epiglottitis, infectious mononucleosis, peri-tonsilar abscess, retropharyngeal abscess, bacterial tracheitis, diphtheria
- Pneumonia, pneumothorax, Reye's Syndrome, metabolic acidosis
- Congenital disorder: laryngomalacia, webs or polyps; Beckwith-Wiedemann syndrome (large tongue), Pierre Robin syndrome (relatively large tongue-to-chin ratio)

* Most deaths occur when fragments from popped balloons occlude a child's airway or food is aspirated, i.e., hot dogs, peanuts, bread with peanut butter, beans.

If a F/B passes the glottis, it can lodge in a lower-airway (suspect in child with recurrent pneumonia always in same place). Aspiration episodes are rarely witnessed. Ask about choking history or coughing spell that went away.

May present with unilateral "new-onset asthma". Clues: unilateral wheezing, coughing, and decreased or absent breath sounds.

Inspect: Look/listen for signs of airway obstruction

- If patient is responsive: are they crying or talking without difficulty?

  YES → assess breathing, quality of voice (hoarse or raspy?)
  NO → feel for air movement
- If unresponsive: look, listen, feel for air movement
- Position
- Face and neck: symmetry, wounds, edema, F/B, Secretions in mouth
- Symmetry of chest expansion and depth
- Listen for audible sounds

S&S of partial airway obstruction

- Stridor
- Choking
- Drooling
- Hoarseness
- Tripod position
- Accessory muscle use: nasal flaring, head bobbing
- Diminished breath sounds
- Wheezing
- Grunting
- Tachypnea
- Retractions
- Tachycardia/bradycardia
- Altered level of consciousness

Airway access maneuvers

Position child appropriately

- If child is conscious, but struggling to breathe, allow children with medical conditions to assume a position that is most comfortable for them. Children will find the best position in which to keep the airway open.
- **Infants**: Place a towel under the shoulders to open airway. Avoid pillows in small infants and children.
- Children younger than 3 years with possible c-spine trauma must be supported under the torso in neutral, axial alignment with spine motion restriction, **not traction.** The spine must not be distracted or otherwise manipulated in any way that could worsen existing injury or convert a stable injury to unstable and result in permanent spinal cord injury

Reposition mandible. Use **chin lift** or **modified jaw thrust** on a less responsive child as a first step in securing an airway.

- Manually remove visible gross debris
- **Peds Foreign Body Airway Obstruction**: If a conscious child between the ages of 1-12 years cannot speak, cough, or cry, perform **abdominal thrusts** for witnessed or strongly suspected aspiration of F/B. For a child < 1 yr, perform up to 5 back slaps and up to 5 chest thrusts. If the child is unconscious with an obstructed airway, begin CPR.
- ALS personnel are authorized to perform direct laryngoscopy w/ Magill forceps if BLS maneuvers are unsuccessful.
- If obstruction remains: intubate and attempt to push the PB into the right mainstem bronchus, pull ET back and ventilate left lung. If ≤ 12 years contact OLMC for authorization to intubate.
- Perform a needle cric as a last resort if complete upper airway obstruction is present and you cannot ventilate the child.
- **Suction using a size-appropriate catheter** (usually no smaller than 8 Fr) to maintain patency. Children tend to have a profound vagal response to tracheal suctioning so monitor the ECG for bradycardia during the procedure. Limit suction application time to 5 seconds. Decrease suction negative pressure (≤ 100 mmHg) in infants.
- **Vomiting/seizure precautions** prn

Airway adjuncts: size appropriate

Nasopharyngeal airways (NPA): 26-34 Fr. for children older than 4 years. NPAs are generally contraindicated for younger children due to the small size of the nasal passageways and larger adenoids that make insertion difficult or impossible.

Oropharyngeal airways (OPA): Sized for children of all ages; particularly helpful w/ BVM ventilations. Measure from the front of the lips to the angle of the jaw. If too long, distal tip will irritate epiglottitis and cause it to swell. Insert along curvature of tongue to prevent oral trauma.

See Peds Airway Adjuncts SOP - p. 70

Possible indications for peds intubation

- Actual or potential airway impairment/aspiration risk
- Actual or impending ventilatory failure (apnea, RR < 10 or > 40; shallow/labored effort; or $SpO_2 \leq 92$)
- Excessive work of breathing (retractions, nasal flaring, grunting) → fatigue
- **DAI:** GCS 8 or less due to an acute condition w/ retained airway reflexes unlikely to be self-limited (Ex. seizures, hypoglycemia, postictal state, certain ODs)
- Inability to ventilate/oxygenate adequately after insertion of OP/NP airway and/or via BVM
- Need for ↑ inspiratory or positive end expiratory pressures to maintain gas exchange
- Need for sedation to control ventilations
- **Contraindications/restrictions for DAI:** Coma with absent airway reflexes or known hypersensitivity to drugs

Preoxygenate with 12-15 L O_2/appropriate sized peds NRM or ventilate with a peds BVM every 3 to 5 seconds for 3 minutes just to see the chest rise and hear midaxillary breath sounds. Children have a profound vagal response to hypoxia.

Prepare equipment per usual procedure

Assess child for difficult intubation, i.e., mobility of the mandible, lose teeth or F/B.

Monitor ECG for bradycardia & dysrhythmias during procedure

DAI premedications prior to intubating a responsive child

- Gag reflex present: **BENZOCAINE** 1-2 second spray, 30 seconds apart X 2 to posterior pharynx
- **2015 (Updated AHA guidelines):** There is no evidence to support the *routine* use of atropine as a premedication to prevent bradycardia in emergency pediatric intubations. It may be considered in situations where there is an increased risk of bradycardia. There is no evidence to support a minimum dose of atropine when used as a premedication for emergency intubation.
- **Pain: FENTANYL**: 1 mcg/kg (round to closest 5 mcg - max 100 mcg) IVP/IN/IM/IO. May repeat X1 at 0.5 mcg/kg (max 50 mcg) in 5 min to a max of 1.5 mcg/kg/SOP
- **DAI Sedation: KETAMINE 2 mg/kg slow IVP (over 1 min) or 4 mg/kg IN/IM.** Allow for clinical response before DAI (if possible); See notes on peds sedation in PEDs IMC p. 67 and after pain mgt. in this outline.
- Monitor VS, ECG, level of consciousness, skin color and SpO_2 q. 5 min. during procedure. Interrupt DAI if HR drops < 60 or SpO_2 < 94%. Ventilate w/ O_2 15 L//Peds BVM at 12 BPM until condition improves.

Special considerations when intubating children

- Vocal cords may be difficult to visualize
- Glottis is higher, more anterior, and more flexible
- May have difficulty passing the tube below the cords through a narrow cricoid ring.

Pass the tube

- **Introduce laryngoscope** (straight blade may work better) and gently elevate the epiglottis. Do not pull back along glottic tissues if the cords are not immediately visualized - will harm delicate tissue. **Apply anterior laryngeal pressure to drop cords into view**.
- **Visualize cords**; may only see pink-rimmed hole
- **Insert tube**. Do not advance more than 2 cm below the cords. **Align distal tube markings** with the vocal cords and note the markings on the proximal end of the tube that correspond to the gums/teeth or lips.
- **Depth of insertion**:
  - Internal tube diameter (in mm) X 3
  - If > 2 years: (Age in years ÷ 2) + 12
- **Confirm tracheal placement**
  - Visualize ET tube going through cords
  - Attach peds capnography monitor plus exam.
  - Auscultate breath sounds over epigastrium (should be no sounds), bilateral midaxillary lines and anterior chest for symmetric sounds. If in stomach, withdraw tube, start again. Do not allow a tube to remain in the right or left mainstem bronchus. Pull back slightly until breath sounds are equal bilaterally.
  - Monitor $EtCO_2$ to determine ongoing tracheal placement. If EtCO2 not detected, confirm placement with direct laryngoscopy. Reconfirm tube placement every time the child is moved.
- **Inflate cuff** (if one is present)
- **If correctly placed,** ventilate every 3 to 5 sec just to see the chest rise. **Secure the tube** with tape or commercial tube stabilizer if size-appropriate device for a peds tube is available. An ET tube is easily displaced with head and neck movement. Immobilize the head, neck, and shoulders.
- If intubated: Max suction force of -80 to -120 mmHg; higher suction pressures OK for mouth/pharynx
- **Post-intubation sedation** If SBP > 70 + 2X age or ≥ 90 if 10-12 years: **MIDAZOLAM 0.1 mg/kg slow IVP (0.2 mg/kg IN/IM)** (max single dose 5 mg). May repeat to total of 10 mg based on size and BP.

If unsuccessful and good air exchange w/ peds BVM: Continue ventilations/BVM

If unable to intubate or adequately ventilate, consider need for a **cricothyrotomy**. This can be done by needle jet-insufflation on children of any age or using a surgical method in children 12 or older. Surgical crics are contraindicated in younger children due to their small cricothyroid membrane, risk of tracheal stenosis and procedural complications.

Never leave an intubated child unattended. You may need to restrain the child's hands if they begin to regain consciousness. Use post-intubation sedation guidelines.

Carefully monitor for rhythm and SpO_2 changes during and after procedure. If condition of an intubated patient deteriorates, consider the following causes:

- **D**isplacement of the tube from the trachea,
- **O**bstruction of the tube,
- **P**neumothorax, and
- **E**quipment failure.

Breathing/ventilatory status/gas exchange

Inspect

Ventilatory attempts: Spontaneous? Generally fast or slow?

Tachypnea may be due to metabolic acidosis secondary to ↓ perfusion with ↑ lactic acid production.

Bradypnea may indicate impending respiratory arrest.

Mechanics: Symmetry of chest expansion; retractions, tracheal tugging, accessory muscle use(head bobbing, expiratory grunting), work of breathing (repeated from PAT)

Abdominal contour: Distended?

Adequacy of gas exchange

- **Skin color**: Mottling of extremities?
- **SpO_2:** Children should easily maintain an SpO_2 well over 96% on room air (higher than normal adult values). SpO_2 of ≤ 94 is a clue that pulmonary function is impaired. If nonperfusing rhythm, monitor SpO_2 as clinical recognition of hypoxia is not reliable. (SpO_2 unreliable in pts w/ poor peripheral perfusion, CO poisoning or methemoglobinemia.)

  Use a pediatric sensor.

Palpation

- Amount of air movement
- Tracheal position in neck
- Chest wall expansion
- Skin temperature/moisture

Auscultate immediately if pt appears to be in ventilatory distress. Assess if breath sounds are present, diminished, or absent; compare equality; note adventitious sounds.

Signs of inadequate ventilations/gas exchange

- ↑ work of breathing
- Increased use of accessory muscles: **Head bobbing** in infants 6-12 months. Head bobs with each breath to ↑ the effectiveness of the accessory muscles
- Presence of **retractions**
- RR: Increase then decrease
- Depth: decreased
- **Nasal flaring**
- Expiratory grunting
- I/E Ratio: Prolonged expiration
- Frequent coughing
- Mottling/cyanosis of extremities
- Anxiety, irritability,
- AMS; lethargy
- Tachycardia → bradycardia; ↓ BP
- Irregular respiratory pattern
- Breath sounds: wheezes, crackles, stridor or absent
- Central cyanosis: **late** sign of hypoxia

Anticipate deterioration or imminent respiratory arrest if: ↑ RR esp. if accompanied by S&S of distress & ↑ effort; inadequate RR, effort, or chest excursion; diminished peripheral breath sounds; gasping or grunting respirations; decreased LOC or response to pain; poor skeletal muscle tone; or cyanosis.

Oxygen/ventilatory therapy

Oxygen 1-6 L/NC: Adequate rate/depth; minimal distress and SpO_2 92- 94%

Oxygen 12-15 L/peds NRM: Adequate rate/depth; mod/ severe distress; S&S hypoxia (SpO2 <92%) or as specified in protocol

Oxygen 15 L/ BVM: Inadequate rate/depth: mod/ severe distress; unstable. Ventilate at 1 breath every 3 to 5 sec. Avoid hyperventilation; volume should just cause the chest to rise. BVMs require a high degree of skill to operate effectively, particularly in the peds patient. Insert an oral or nasal airway; may apply Sellick's maneuver to diminish gastric distension.

BVM Sizes

0 - 1 Month - Neonatal bag
>1 month - 8 Years - Peds bag
Over 8 Years Adult bag

Key points

- Over-ventilation can fill the stomach with air, prevent adequate ventilations, and cause a pneumothorax.
- A child may be difficult to ventilate if they are struggling, have a laryngeal injury, if the upper airway is filled with vomitus, in the presence of a pneumothorax with ↑ airway resistance, or there is massive airway obstruction. Anticipate tension pneumothorax and prepare for needle decompression whenever BVM ventilations are given.

Circulation: CO/ECG/fluid status/perfusion

Rapidly recognize hypovolemia with inadequate perfusion and/or shock. **Hypotension is a late sign of shock in children**. Assess for other signs of perfusion deficit. Often, seemingly subtle clues such as sustained tachycardia, listlessness, or mottled skin signify impending cardiovascular collapse.

- **Palpate** presence, location**, general rate,** volume/ strength, and rhythmicity **of pulses** in all extremities. Compare to central pulses (brachial, femoral, carotid).
- **Pulse assessment sites**
  - Umbilical cord/brachial artery in newborn

- Brachial artery in infants, young children
- Radial/carotid arteries in older children
- Femoral artery in undressed child of any age

- Interpret the significance of your findings by taking into consideration age-appropriate norms and whether the child is crying, is fearful and in need of family presence, has a fever or is in pain.
- **Sustained tachycardia**: In the quiet or unconscious, non-febrile child, HR ↑ long before the BP falls, and is an indicator of ↓ CO. Even more alarming is **bradycardia**, which often signals severe hypoxia and extreme distress.
- If no central pulse & unresponsive: Start CPR at 100-120 compressions/min. (No ResQPod use in children)
- **Skin**
  - **Color**: Pink, pale, flushed, mottled. Decreased peripheral perfusion triggers ↑ peripheral vasoconstriction resulting in cold, mottled extremities - ***look at the knee caps*!**
  - **Temperature**: Hot, warm, cool, cold
  - **Moisture**: Dry, moist, diaphoretic
- Delayed **capillary refill** (normal < 2 sec in warm ambient environment in child < 6 years)
- **Altered LOC** with agitation, restlessness, confusion, listlessness, or stupor.
- **Decreased muscle tone** = poor central perfusion
- Inspect for uncontrolled **external bleeding**; note type and amount. Suspect **concealed internal bleeding** if shock is apparent without external hemorrhage.
- **Hemorrhage control:** Apply direct pressure to any bleeding wounds. Pay close attention to scalp lacerations as they bleed profusely and can decrease BP and cerebral perfusion. Apply hemostatic dressings and tourniquets as needed.

Cardiac rhythm/ECG monitoring

- Apply ECG monitor (defib/pacing pads) if actual or potential cardiorespiratory compromise.
- Use standard size pads in children > 10 kg (use largest size that fits on the chest wall without touching with 3 cm between them). Prepare peds defib paddles if no pads.
- ALS patients do not necessarily require ongoing ECG monitoring or transmission of a strip to OLMC. If ECG is run, attach/append to PCR/EHR left at, faxed to, or downloaded to, the receiving facility.
- **Consider need for peds 12 L ECG**; based on chief complaint or PMH: same criteria as adults.

  Peds ECG changes: PR & QRS intervals are shorter Be alert for conduction abnormalities in what looks like "normal" intervals or complex durations in young children. T waves normally inverted V1-V3 up to 8 yrs.

Treat dysrhythmias per appropriate SOP: **Most peds arrhythmias caused by hypoxemia, acidosis, or hypotension. At risk children for cardiac arrest:**

- Respiratory compromise/hypoxia
- Hypotension/shock due to trauma/acute blood loss/ cardiac tamponade
- Dehydrated
- Sepsis
- Congenital heart disease
- Altered mental status/lethargy

- **The most common cause of pediatric cardiac arrest is respiratory compromise/arrest**. Asystole and brady-arrhythmias are responsible for 90% of the rhythms seen in peds arrests. Ventricular dysrhythmias are responsible for the remaining 10%.

Hydration status: Anterior fontanel in infants, mucous membranes, skin turgor, presence or absence of tears when crying, urine output.

Carefully assess signs of fluid imbalances to recognize subtle as well and obvious signs and appropriately intervene before the child is in trouble.

Vascular access

Consider patient's condition and hemodynamic stability. Vascular access is indicated for fluid and electrolyte replacement or as a route for drug administration. IVs are most urgently needed in hypovolemia, hemorrhage, or prolonged cardiac dysfunction with acidosis. Limit time spent establishing peripheral venous access in critically ill or injured child.

Prepare the patient/significant others

Use age-appropriate techniques to prepare the child. Inform them about what you are going to do and explain in terms they can understand what they will experience and feel. Children are often very fearful of needles (pain) and may be afraid that they are about to be poisoned or that the needle will never be removed.

Select the site

The equipment and site selected will depend in part on the purpose and duration of the infusion plus the patient's clinical status, age, and health history.

Peripheral veins are generally selected based on their location, condition, relation to other anatomical structures, physical path along the extremity, and size. The best choice is a vein that is pliable, appears long enough to accommodate the catheter length without traversing a joint, and large enough to allow blood flow around the catheter.

Commonly selected vessels include the metacarpal veins on the dorsum of the hand, accessory cephalic, cephalic, and antecubital veins. In non-emergent situations, attempt distal sites first.

The antecubitals are often visible or palpable in children when other veins won't dilate, as in shock or severe dehydration, and can be best accessed by placing a small roll of gauze behind the elbow to aid in hyperextension. During CPR, the preferred site is the largest, most

accessible vein that does not require interruption of resuscitation (IO often used). If able, select a site in the non-dominant hand or arm.

Avoid veins in the inner wrist or arm as they are small and uncomfortable for the patient. Equally, avoid sites where there is a circumferential burn, infection, or marked edema in an extremity from a suspected fracture.

Sites of venous access in priority are:

- Percutaneous peripheral (two attempts max)
- Intraosseous: During insertion, **prior to activating trigger, insert needle through skin/fat/muscle and rest tip needle on bone; at least the 5 mm mark on needle should be visible**. This tells you the needle is long enough. If no markings are visible, remove the needle and use a longer needle or alternate site.
- Peripheral access may be attempted enroute; IO should be attained while stationary

IV catheters

The type of venipuncture device will depend on the child's age, activity level, type of therapy, available veins, and site selected. Generally, the largest gauge needle (catheter) with the shortest length is preferred to allow rapid fluid infusion when volume resuscitation is necessary.

Fluid flow rate is directly proportional to the diameter of the catheter and inversely proportional to the length of the catheter.
Gauge selection for peripheral catheters: 24-26 for neonates, 22-24 for infants, 20-22 for children, and 16-18 for adolescents who need large amounts of fluids.

Administration sets

If child needs IVF volume challenges, use regular drip tubing, a large volume syringe and 3-way stop-cock to bolus in the fluid.

If IO infusion: put a pressure infuser around IV bag and inflate to 300mmHg.
Volume of fluid to be infused

Rapidly infuse a **precalculated** amount of fluid based on child's weight delivered in a fluid bolus or challenge.

Give **20 mL/kg** as the initial bolus **even if BP is normal** if **other S&S of hypoperfusion are present**. Draw fluid into a 50-60 mL syringe using a 3-way stopcock and push it as rapidly as possible (over 5 minutes) while preserving the integrity of the IV. If IVF is given too fast or too slowly, the child may experience phlebitis, infiltration, circulatory overload, or insufficient resuscitation.

Response to initial fluid bolus should be an improvement in capillary refill, mental status, skin color and temperature of the extremities, ↓ HR, and elevation of an initially low BP.

If reassessment reveals **on-going hemodynamic instability** additional boluses of 20 mL/kg should be repeated X 2.

Avoid excess volume replacement in children with possible ↑ ICP, such as meningitis, prolonged seizures, or severe head trauma.

When using a roller or screw clamp for **flow regulation**, the rate must be monitored closely as vein spasm, vein pressure changes, patient movement, bent or kinked tubing, and the gravity drop height may cause the flow rate to vary markedly.

Protect the site: Children benefit from having limb immobilized on an arm board. Position board so fingers curve over the end rather than being fully outstretched on a flat plane. Protect site by covering it with a paper or Styrofoam cup sliced in half or a commercially available product secured over the IV insertion area.

Conditions requiring rapid cardiopulmonary assessment and/or potential cardiopulmonary support

- Respiratory rate > 60 breaths/min
- Cyanosis or a decreased SpO_2 despite administration of O_2
- Increased work of breathing (retractions, nasal flaring, grunting), respiratory fatigue and/or failure
- Heart rates: (Weak, thready, or absent peripheral pulses)
  Child ≤ 8 years: < 80 BPM or > 180 BPM
  Child > 8 years: < 60 BPM or > 160 BPM
- Poor perfusion, dysrhythmias; chest pain
- Altered LOC (syncope, unusual irritability or lethargy or failure to respond to parents or painful procedures)
- Seizures
- Trauma; Post-ingestion of toxic substance
- Fever with petechiae
- Burns involving > 10% BSA
- Hypoglycemia

Disability

AMS: Assess capillary glucose. Briefly assess pupils for size, shape, equality, and reactivity to light. Posturing?

Resuscitative interventions

If hypoglycemic: (SOP p.82)

BLS: If GCS is 14-15 and patient is able to swallow: oral glucose in the form of paste, gel, or liquid if available

ALS: If borderline glucose level (60-70) & symptomatic: give ½ Dextrose dose (see below)

Children (up to 50 kg or 110 lbs) if bG < 60:

- **DEXTROSE 10%** (25 g/250 mL) **0.5g/kg up to 25 g** (5mL/kg) IVPB. Ensure patent IV prior to infusing. See dosing chart on SOP page 100.
  For smaller children, draw up desired volume into a syringe and administer slow IVP.
  Observe pt for improvement while dose is given.
- If S&S of hypoglycemia fully reverse and pt becomes decisional after a partial dose, reassess bG.
  If >70; close clamp to D10% IV and open 0.9 NS TKO.

If no IV/IO: **GLUCAGON 0.03 mg/kg IM/IN**. Maximum dose 1 mg. EMT may give per System policy.

Observe and record response to treatment; recheck glucose level

- **If 70 or greater**: Ongoing assessment
- If no improvement after first D10% dose **and** bG remains <70: give additional D10% 0.5 g/kg (5 mL/kg) up to 25 g IVPB 5 minutes after initial dose followed by reassessment.

<u>If generalized tonic/clonic seizure activity:</u>

MIDAZOLAM 0.1 mg/kg IV/IO (0.2 mg/kg IN/IM) (max single dose 5 mg). May repeat to a total of 10 mg to stop seizure activity. If seizures persist: Contact OLMC for additional orders.

Valium (diazepam) 0.5 mg/kg may be given rectally in the form of **Diastat** if found on scene. Midazolam is preferred for the IN and IM routes if no vascular access.

If AMS: calculate PEDS GCS (see SOP p. 66)

EXPOSE to examine as indicated

Cut away clothing if necessary but preserve evidence and patient modesty whenever possible. Assess front, back, and sides of patient for signs of injury, heat/ chemical exposure and need for irrigation.

Keep child warm! Use blankets, head coverings, well protected hot packs to prevent heat loss; warm IV fluids.

Identify priority patients - Rapid transport decision

- Poor general impression, look ill or severely injured: apnea, pulseless, obvious severe distress
- Immediate life threats where the ABCs have not successfully reversed or definitively altered during resuscitative efforts
- Altered mental status (AMS)
- Airway/ventilatory impairment or those who are intubated or require ventilatory assistance with a BVM
- Hemodynamically unstable and have received temporizing measures (pleural decompression)
- Poisoning/overdose of unknown substance or a caustic substance; serious or multiple injuries.

Secondary assessment

Obtain MOI, history, vital signs, and complete a rapid trauma assessment using DCAP BLS TIC.

Obtain baseline vital signs

Normal, age-appropriate pediatric VS are rarely remembered in an emergency. Use memory joggers like laminated charts or cards. See VS table in SOP p. 68 and back of this handout.

Respiratory rate, pattern, depth: know age-appropriate norms

Pulse rates: Count rate for 30-60 seconds

Blood pressure

- **Children compensate well to early volume losses** by vasoconstricting so there is a stable BP until sudden decompensation leads to cardiac arrest and irreversible asystole.
- **Hypotension** does not occur until the blood volume is decreased by 25%-30%, so **is an ominous sign**.
- BP is age and weight dependent and should be taken in each arm at least once.
- **Systolic BP estimations in children 1-10**

  Typical systolic BP = 90 + (2 X age in years)
  Lower limits of nml = 70 + (2 X age in years)

Essential to use appropriate size cuff

Too large (≥ 2/3 length of upper arm) = false low reading
Too small (≤ ½ length of upper arm) = false high reading

Flush method if BP cannot be heard/palpated:

- Elevate extremity to drain blood
- Inflate cuff to above expected SBP
- Lower arm and slowly deflate
- Point at which color returns is approximate SBP

Patient HISTORY (Acquire during/incorporate into PE)

Obtaining patient and event histories may account for 90% of the initial impression. Obtain from patient, family, significant others, bystanders, medic-alert tags, or personal belongings. Ask verbal child simple questions: age, what happened, do they have pain and where? Adolescents may need to be interviewed without their caregivers present if accurate information is to be obtained regarding sexual behavior, pregnancy, drug use, alcohol use, or child abuse.

Signs & symptoms as they relate to chief complaint.

- Onset: fast, slow
- Precipitating factors; palliation attempts
- Quality
- Recurrence/region/radiation
- Severity
- Time/Duration of this event

To accurately assess pain requires careful observation of key behaviors appropriate for their age.

Quantify pain using a pain scale that is consistent with the pt's age, condition, and ability to understand.

- Age <4 yrs: Observational scale such as FLACC (see SOP appendix)
- Age 4-12 yrs: Self-report scale such as Wong-Baker Faces, numeric or verbal scales

Additional pain assessments

- Patient's rate of breathing
- Negative vocalizations
- Facial expressions
- Body language
- Consolability
- Note social, cultural and spiritual influences that may affect pain experience

- Infant: Intense crying, unable to be consoled, tremors, unable to suck without crying
- 1-2 y/o: Intense reaction to painless procedures, aggression, regression, physical resistance. May shriek NO over and over again.
- 3-5 y/o: Perceive pain as punishment; aggressive with verbal attacks, such as "I hate you!"
- 6–10: Past experience influences reaction to pain, exaggerated by fear of bodily injury and death. This age can localize and describe pain.

Allergies: Medications, foods, environmental

Medications: Prescribed, over-the-counter, compliance with prescribed doses, time/amount of last dose.

Pertinent past medical history

- Pertinent medical or surgical problems
- Co-morbid conditions/preexisting diseases
- Are they being seen by a doctor?

Last oral intake; adolescent females: LMP

Events surrounding current problem

- Associated factors such as toxic inhalants, drugs, alcohol
- **MOI:** Clinical course following injury

Obtain a detailed history of a traumatic event. Ask about child's mental status before and after injury. Any change between incident and the present time?

Nausea mgt: ONDANSETRON 0.15 mg/kg (max **4 mg)** oral dissolve tablet (ODT) or slow IVP (over no less than 30 sec.) May repeat X 1 in 10 min to a total of 8 mg.

Pain management

Pharmacologic and non–pharmacologic (parental presence, distraction, topical use of cold packs) options should reflect a pt–centered approach based on specific needs. Consider pt. status, responder scope of practice, risks/benefits of each strategy. Provide individualized pain mgt. regardless of transport interval.

If SBP ≥ minimum for age: **PEDS STANDARD DOSE:**

FENTANYL: If > 2 yrs: 1 mcg/kg (round to closest 5 mcg -max single dose 100 mcg) IVP/IN/IM/IO.
May repeat once in 5 min: 0.5 mcg/kg (max 50 mcg). Max total dose per SOP: 150 mcg (1.5 mcg/kg)
Additional doses require OLMC: 0.5 mcg/kg q. 5 min up to a total of 3 mcg/kg (300 mcg) if indicated & available.

The safety of FENTANYL in children <2 years has not been established. Call OLMC.

Peds -sedation: Children <6 yrs (esp. those < 6 mos) may be at greater risk for an adverse event from sedation and/or opiate pain medication. They are particularly vulnerable to the medication's effects on ventilatory drive, airway patency and protective airway reflexes.

Safe sedation of children requires a systematic approach that includes the following:

- Close supervision by qualified EMS practitioner(s)
- Pre-sedation evaluation for underlying medical conditions that would place child at risk from sedating medications
- Airway exam for large (kissing) tonsils or anatomic airway abnormalities that might increase risk from sedating meds
- Clear understanding of medication actions, side effects, and drug interactions
- Appropriate training and skills in pediatric sedation and airway/ventilator management to allow rescue of the pt
- Age and size appropriate equipment for airway management and vascular access
- Appropriate medications and reversal agents (per local policy/procedures)
- Sufficient staff to provide medication and monitor patient
- Appropriate physiologic monitoring and continuous observation before, during, and after the procedure
- Practitioners must have the skills and age and size-appropriate equipment based on their scope of practice to rescue a child from a level of sedation that is deeper than desired, apnea, laryngospasm, and/or airway obstruction. This includes the ability to open the airway, suction secretions, perform successful bag-mask ventilations, insert an oral airway, a nasopharyngeal airway, an extraglottic airway, and rarely perform tracheal intubation per local policy/procedures. (Am Acad of Pediatrics, 2016)

Review of Systems: trauma assessment

Detect non-life-threatening conditions and to provide definitive care for those conditions/injuries. **Inspect & palpate** each of the major body systems for the following:

- **D**eformities
- **C**ontusions
- **A**brasions
- **P**enetrations/punctures
- **B**urns
- **L**acerations
- **S**welling/edema
- **T**enderness
- **I**nstability
- **C**repitus

Head trauma

Children are more prone to traumatic brain injury.

Head injury results in about 300,000 hospitalizations annually in the U.S. About 90% of all trauma-related deaths among children are associated with head trauma.

In children < 2 years, the most common cause of head injury is falls. Child abuse is a common cause in children < 1 year. Traumatic brain injury from child abuse has

become more recognizable due to the availability of CT scanning. Cerebral injuries and retinal hemorrhages without external signs of trauma are highly suggestive of "shaken baby syndrome". In older children, the most frequent causes of head injuries are falls, MVCs, and bicycle injuries.

Unique considerations

Infants and young children have larger and heavier heads with a higher center of gravity in proportion to their bodies. The head of an infant or small child accounts for approximately ¼ of the body size as compared with an adult's head which is 1/8th of the body mass. Children tend to "lead with their head" in falls and deceleration injuries. This, combined with their weak neck muscles, leads to high frequency of head injuries. In a front-end crash at 30 mph, the unrestrained child will strike the dashboard at a force similar to falling from a 3-story building.

Mass lesions following head injury are less common, but intracranial hypertension and cerebral hypoxia are more common – children are more susceptible to secondary brain injury.

Children have better outcome and survival than adults with head injury. Data from a pediatric trauma registry showed that children have an overall mortality rate from head injuries of 6% compared to adults who have an 18% overall mortality rate.

Infants and very young children do not typically become hypotensive from blood loss in head injury. If signs of shock are present, investigate other sources. However, small children can lose a significant percentage of blood volume into subgaleal or epidural space. Child's scalp is very vascular - can bleed to death from scalp lacerations.

Rapid changes in all areas of development necessitate age-specific neurologic assessment. Need to know normal activities of children at various ages to provide context for exam. Question parents about any changes in child's behavior, activities, etc.

Are they irritable and consolable or irritable and inconsolable?

Are they quiet or crying? Note type of crying: whimpers, sobs, or whines vs. high pitched and screeching or weak and moaning.

Fontanelles and cranial sutures: The protection afforded by the cranium differs as bones are thinner, less developed, may not be fused, and the fontanelles and may still be open. Sutures remain open during early infancy and the anterior fontanel remains open for first 10-18 months. This allows for some limited swelling of brain. Cushing's response to ↑ ICP seen in adults may not be evident in an infant. First clue of **significant ↑ ICP** may be rapid, unexpected, neurologic decompensation. Maintain a high index of suspicion based on history and early subtle changes in mental status.

Nervous system development continues throughout childhood. Developing neural tissue is more fragile. Particularly in infancy and early childhood, the **brain is less myelinated** and is much more easily injured.

Blood loss: Children do not typically become hypotensive from blood loss inside the skull. If signs of shock are present, investigate other sources. However, small children (< 18 mos) can lose enough blood into the epidural space to cause shock or death. Child's scalp very vascular - can bleed to death from scalp lacerations.

Outcomes: Determined by damage sustained at moment of impact (**primary injury**) such as skull fractures, concussions, contusions, lacerations, axon-shearing injuries and initial neuronal and vascular damage.

Secondary injuries result from events resulting from the primary injury or failure to resuscitate appropriately. Damages vulnerable but potentially viable cells resulting in additional cell death during the first few hours to days. Secondary injury is associated with cerebral ischemia, edema and ↑ ICP resulting from hypoxia, hypercarbia, and ↓ CPP. Untreated, potentially reversible lesions can become permanent and new lesions may result from anoxic damage.

Children are at **greater risk for secondary brain injury** due to intracranial HTN and cerebral hyperemia.

Mass lesions (epidural/subdural hematomas) following head injury are less common, but elevation of ICP is more common in children (80%) than in adults (50%). Small changes in cerebral blood volume or cerebral tissue volume can result in significant insult to the brain.

Major goal of early management: maintain cerebral perfusion pressure (CPP) and prevent secondary injuries

History - key points

- Loss of consciousness; how long
- Amnesia
- Decreased activity level
- Inability to recognize caregiver
- Nausea or emesis
- Abnormal behavior
- Seizure following injury

HEENT: Inspect medial to lateral; superior to inferior

Head: Note size, shape, contour of skull and face; fontanelles (soft and flat or tense and bulging?). Look for DCAP, BLS, ecchymoses, depressions, and old scars. Is there blood in the hair? Skin color of face and neck.

Eyes: Trauma to orbits. Assess for telecanthus (wide eyes). Check obvious injury to the globe; anterior vs. posterior chamber; sclera, conjunctiva, cornea, lids; discoloration, hemorrhage, hyphema, ptosis, foreign bodies, penetrating trauma, contusions, lacerations and contact lenses.

Pupils: Pupil changes occur later in most children than in adults. A dilated, nonreactive pupil strongly suggests ↑ ICP due to cerebral edema, an intracranial lesion, or herniation and requires immediate intervention.

A brief period of **controlled hyperventilation** may be ordered only if signs of herniation and neurological deterioration present that have not responded to alternative methods to reduce the pressure. Clinical indicators of brain shift include, but may not be limited to, unilateral or bilaterally dilated and nonreactive pupils, absence of movement on one side or posturing.

Close eyes in unconscious patient to protect corneas from drying and injury.

Face: Facial symmetry; assess for mobile mid-face segments, check for epistaxis, rhinorrhea.

Oral cavity: Inspect mouth for broken, malaligned, missing teeth, deformities of dental occlusion, trismus, bleeding gums, and trauma to tongue or oral cavity.

Look for fluid/secretions: Blood (hemoptysis or hematemesis) sputum/mucous, carbonaceous (respiratory burn), CSF, saliva from laceration through parotid duct

Ears: Assess for external trauma, Battle's sign, otorrhea, hearing deficit

Palpate: Skull, orbital rims, nasal bones, zygoma, maxilla, mandible for TIC, deformity, hematoma, neuro-vascular impairment, muscle spasm, false motion or motor impairment.

↓ BP is rarely caused by bleeding inside the head.

Anticipate hypotension with

- Large scalp lacerations
- Open skull fracture
- Epidural in an infant: Infants with a large epidural bleed can lose a significant amount of blood into their skull and can become hypotensive. Assessment will be consistent with ↑ ICP.

If children with closed head trauma initially show S&S of hypovolemia, look elsewhere for blood loss.

Babinski sign: While a Babinski reflex indicates abnormalities of the pyramidal tract in children older than 2 (after child begins to walk), it is unreliable in younger children and is believed to be normal in a newborn. No need to assess in the field.

Assess neurologic status frequently using the **GCS modified for children.**

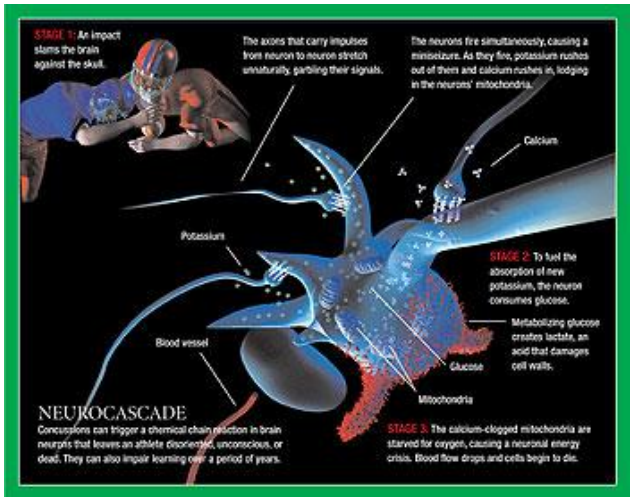
Drop of 2-3 points = significant deterioration
Score of 8 or less = coma, very serious sign

Abnormal extensor posturing in a child is rarely associated with isolated brain stem injury as in an adult. It is more commonly associated with diffuse cerebral swelling and hyperemia (too much blood flow to brain).

<u>Specific neurological injuries</u>

Closed-head injury: No loss of consciousness. Becomes irritable, sleepy and less responsive; may vomit several times. Self-limited, child is usually normal within 6-8 h after impact.

Concussion: Up to 25% of children with minor head trauma develop a concussion (or mild traumatic brain injury [MTBI]), which is defined as a diffuse injury resulting from transient alteration in neuronal function. Patients do not have to lose consciousness, but if they do, it lasts < 6 hours.



The disturbance of brain function is primarily a symptom of metabolism rather than structural damage. Neuronal dysfunction involves a cascade of ionic, metabolic & physiologic events. Therefore we rely more on the clinical presentation including:

Memory disturbance
Delayed processing speed related to brain function
Ataxia and incoordination
Fatigue and dizziness that result from brain stress

Symptoms of MTBI usually fall into 1 of 4 categories:

Physical	Cognitive	Emotional	Sleep
• Headache • Nausea • Vomiting • Balance problems • Dizziness • Visual problems • Fatigue • Sensitivity to light • Sensitivity to noise • Numbness/ Tingling • Dazed or stunned	• Feeling mentally "foggy" • Feeling slowed down • Difficulty concentrating • Difficulty remembering • Forgetful of recent information or conversations • Confused about recent events • Answers questions slowly • Repeats questions	• Irritability • Sadness • More emotional • Nervousness	• Drowsiness • Sleeping less than usual • Sleeping more than usual • Trouble falling asleep

While EMS is not responsible for diagnosing MTBI, it is imperative to transport these pts so they can be evaluated by a licensed medical professional to ensure proper diagnosis and follow up. Coaches & trainers have been instructed, according to guidelines, to take the athlete out of play & the decision to return to practice or play is a medical decision. This change in practice may invoke greater EMS involvement in an athlete's care & best practice dictates transport to the ED for further

evaluation. Clinical management can include initial monitoring of the pt (either in the ED or physician's office), referral to a MTBI specialist if symptoms have not diminished within 3-5 days post injury, diagnostic testing, (including a CT or MRI scan), and if persisting symptoms, more extensive neuropsychological tests.

Skull fractures: Children with head trauma may present with linear, basilar, comminuted, depressed, ping-pong, or growing skull fractures.

- **0 to 12 months:** Develops cephalohematoma. Presents as a soft boggy mass under the scalp. This may develop 1-2 days after injury and is associated with a parietal fracture. A depressed skull fracture can have a **ping-pong indentation** and cannot be clearly defined clinically unless it is open. Common to have post-traumatic seizures.
- **Growing fractures:** Seen with linear fractures across suture lines in children whose sutures have not fused. The brain is under 10 torr pressure. May push outward through linear fracture line.

Epidural hematoma: Frequently associated with temporal/parietal fractures across middle meningeal artery. Uncommon in children < 2 as the artery is not yet embedded into temporal bone, so is able to rotate and avoid injury. Hallmark signs are AMS with headache/ vomiting and ipsilateral (same side) dilated and fixed pupil with contralateral (opposite side) motor deficit. Early diagnosis and Rx = good prognosis; delayed Rx = poor prognosis. Bilateral 20% of the time.

While often dramatic in presentation, epidural hematomas may occur after minor trauma and in alert children with non-focal neurologic exams.

Subdural hematoma: Small children at particular risk due to the relatively smaller size of their brain in relation to the size of the skull with resulting tension on the bridging veins. Usually venous due to shear injury of bridging veins; 75% are bilateral; more common than epidurals. Almost always associated with a bruise of the brain and produces similar symptoms as an epidural.

COMPARISON IN CHILDREN		
	EPIDURAL	**SUBDURAL**
Frequency	Uncommon	Common
Skull fracture	75%	30%
Source of hemorrhage	Usually arterial	Usually venous
Age	Usually >2 years	Usually <1 year
Laterality	Usually unilateral	Usually bilateral
Seizures	<25%	75%
(Retinal hemorrhages)	<25%	75%
Mortality	25%	<25%
Morbidity	Low	High

Chest/thorax/pulmonary system assessment

Suspect/treat thoracic injuries if the child has a history of thoracic trauma, upper abdominal trauma or arrhythmias or if you have difficulty providing effective ventilation.

Ask about pain, dyspnea. **Re-inspect** for any changes from primary assessment. Assess for ventilatory difficulty, change in the LOC, agitation, tachypnea, retractions, & nasal flaring.

Contour and integrity of chest wall: Should be symmetrical and move equally with each inspiration or assisted breath. If asymmetrical, suspect pneumothorax, flail chest or F/B aspiration. Abnormalities to note: hyperinflated hemithorax.

Ratio of inspiration to expiration: Prolonged expiration indicates distress.

Coughing: May be due to hyperreactive airways, aspiration, smoke, secretions, irritation, or bronchospasm. Determine if productive or non-productive cough.

Palpate: Ribs, clavicles, sternum, and scapulae for sub-q emphysema, deformity, and crepitus.

Cyanosis is **not** a reliable indicator of respiratory failure or perfusion in children. In the presence of hypovolemia, the Hb level may be too low (6 gm) to carry desaturated Hb. It is this desaturated Hb that gives skin its characteristic dusky color. Re-assess SpO_2.

Re-auscultate

- Presence/equality of breath sounds
- Heart sounds; muffled or clear

Specific thoracic injuries: life-threats should have been found and resuscitated during primary assessment

Mortality risk in child with thoracic injury is nearly 20 times that in children w/o thoracic involvement. Mortality rate much higher in children < 5 years.

Ribs and sternum: Ribs are more flexible, reducing incidence of fractures but allowing direct transfer of energy from external forces to internal viscera. Rib fractures are an ominous sign because more force is required to cause the injury. Over ½ of rib fractures in those younger than 3 years of age may be due to abuse.

Trauma above T3 is serious due to the likelihood of injuries to the subclavian arteries. Below T10, check underlying soft tissue lacerations.

3 types of pneumothorax: Simple, open, tension

- **Simple/closed pneumothorax**: S&S similar to an adult; however, with ventilatory support can rapidly develop into a tension pneumothorax.
- **Tension pneumothorax**

  Same mechanism as adult. **S&S:**

  - Severe respiratory distress
  - Unilateral absence of breath sounds
  - Decreased peripheral pulses

- Hypotension; narrowed pulse pressure; JVD
- Bradycardia
- Decreased level of consciousness

Treatment: Immediate needle decompression

Open pneumothorax: Relatively uncommon in children except in those areas with a prevalence of penetrating trauma. Treat like an adult by converting to a closed pneumothorax with an occlusive dressing.

Flail chest (pulmonary contusion): Uncommon in children due to cartilaginous and flexible ribs. Multiple double fractures of adjacent ribs leave a free-floating section. Paradoxical chest movement present with S&S of respiratory distress, often from pulmonary contusion. Positive pressure ventilation and supplemental oxygen is definitive treatment, especially if severe hypoxia and/or hypercarbia is present.

Pulmonary contusion: Most common and serious injury to child's thorax in non-penetrating chest trauma. Causes bruising of lung tissue with alveolar-capillary hemorrhage and edema. Anticipate in child with chest wall injury. Initially, the child may be asymptomatic, but after 6-12 hours can develop ↑ RR, hypoxia, hemoptysis, dyspnea, decreased lung compliance, increased WOB, diminished breath sounds, wheezes, crackles, respiratory failure, and transient temp elevation.

Treat with 15 L O_2/NRM. May need to ventilate with a peds BVM if severe.

Hemothorax

Thirty to forty percent of the total blood volume (TBV) may be rapidly lost into the pleural space. (Need 200 mL of blood to visualize a hemothorax on a routine chest film. In a 2 y/o child, this could constitute 30% of his TBV. By the time you see it the patient could be in profound shock).

S&S of a major hemothorax

- Dyspnea, tachycardia
- Diminished/absent breath sounds on affected side
- Shock, poor perfusion
- Flat neck veins
- Mediastinal shift to opposite side

Treatment: Ventilate w/ 15 L O_2, IV fluid boluses.

Traumatic asphyxia: Chest is compressed, as when a car backs over a toddler. Symptoms are made worse by the child's flexible thorax and absence of valves in the venous system.

Sudden thoracic compression when the lungs are full of air and the glottis is closed causes a sudden increase in intrapleural and intra-abdominal pressure which ↑ pressure in the superior vena cava. Blood in the large veins of the thorax and neck is forced into the chest, lungs, neck, head, and brain. Increased venous pressures rupture the capillaries resulting in hemorrhages in the upper body, especially the face, sclera, retina and brain.

The child presents with cyanosis of the face and neck and petechiae (small bruises) on the head, neck and chest. Other S&S: tachypnea, disorientation, hemoptysis, epistaxis, and respiratory insufficiency. Provide supportive care based on S&S. Co-existing injuries include pulmonary contusion and traumatic brain injury, each requiring aggressive management.

Cardiac tamponade: Rare because of infrequency of penetrating trauma (although increasing in some populations). Can occur from blunt trauma but not as likely. Blood or fluid collects in the pericardial sac and interferes with diastolic filling and systolic output. S&S: hypotension with narrowed pulse pressure, muffled heart tones, JVD (Beck's triad), tachycardia, pulsus paradoxus, electrical alternans, and poor peripheral perfusion.

Provide fluid challenges to try to fill ventricles until pericardial decompression is done at the hospital.

Abdomen

Abdominal trauma can be lethal as there are often no visible signs of injury. Second leading cause of trauma-related deaths in children.

Unique considerations

- Immature abdominal muscles offer less protection
- Abdominal organs are closer together
- Liver and spleen are proportionately larger and more vascular and thus more frequently injured
- Less protection of internal structures by abdominal wall; thinner, weaker, less muscle, and sub-q tissue.
- Increased pliability of abdominal wall allows for deeper penetration of forces into peritoneal cavity, often with no sign of surface trauma.
- Rib cage pliable, does not fully protect liver and spleen; lower abdomen and organs less well protected by pelvic bones.
- Organs proportionately larger and closer together; multiple organs may be injured by a single blunt force.
- Kidneys more anterior, surrounded with less protective fat.
- Duodenum has an ↑ vascular supply, resulting in larger amounts of blood lost if traumatized.

It is important to know the **mechanism of injury**. Hemorrhage is the most immediate life-threat, but the presentation may be very subtle. Approx. 70% of MVC victims with blunt abdominal trauma have associated injuries to the head, chest, or an extremity. A reliable exam is difficult to obtain due to guarding, neurologic impairment, severe pain, and/or nervousness.

Ask about **pain, cramping, nausea, vomiting**. The key to early recognition is systematic, repeated assessments.

Inspect all four quadrants for

- DCAP-BLS including ecchymoses, tire tracks, seat-belt marks, or other evidence of blunt or penetrating trauma; bruising around navel (Cullen's sign) or over flank (Gray-Turner's sign) characteristic of retroperitoneal hemorrhage.

- **Contour/symmetry**: **Inspect for gastric distention**. Common in infants and children since they swallow large amounts of air while crying - even with minor trauma. Measure and record abdominal girth from stretcher to stretcher across navel. This allows for early detection of distention caused by bleeding or an accumulation of air. An adynamic ileus, resulting in an expanding abdominal girth can be present even with minor injuries.
- **Assess respiratory status:** In children, 60-80% of normal ventilation depends on good diaphragm function. Irritation of the upper abdomen by blood or intestinal contents can cause severe pain and dramatically alter the child's breathing pattern. The "belly breather" will avoid deep breaths and will use his chest. They usually do not cry and will hold their breath. These are **early, subtle clues** of a potentially acute abdominal injury.

Palpation of the abdomen

- **S&S of intraperitoneal bleeding**/spillage of gastric contents: Tenderness, guarding, rigidity and/or rebound tenderness to palpation.
- Lightly palpate the abdomen with the side of the hand in a clockwise rotation in each quadrant starting in the quadrant away from the pain. You should not feel any masses, pulsations, etc.

Specific abdominal organ injuries

Spleen: Most commonly injured intraabdominal organ from blunt abdominal trauma. The spleen is the largest lymphoid organ in the body and acts as a filter for the vascular circulation. It clears particulate matter from the circulation. Storehouse for platelets. Rupture may present with Kehr's sign (LUQ pain referred to the left shoulder).

Liver: Second only to child abuse as a cause of death following trauma due to hemorrhage. Up to 40% with major liver injuries die in the field. Its large size and fragile nature make it vulnerable to crush or compression injury in children. In the case of child abuse, the MOI is usually cross kicking, cross hitting, or a direct blow to the abdomen that results in severe trauma.

Pelvic fractures

Associated with bowel/bladder injuries and lower spinal fractures. Can cause massive hypovolemia. Apply upside down KED, wrap snugly in a sheet, or apply a pelvic binder.

GU/Pelvis/Reproductive systems

Unique characteristics

- Bladder is an intraperitoneal organ in children and injured more readily than in adults.
- Kidneys are mobile, not as well protected by muscle and fat as in adults, not shielded by rib cage; more vulnerable to injury.

Ask about pain, urge to void, possibility of pregnancy in females after puberty.

Inspect

- Abdominal contusion, flank pain, scrotal edema, discoloration; priapism.
- Blood at urinary meatus, vaginal outlet
- Perineal swelling; "butterfly" hematoma
- Integrity of soft tissues/surface trauma

Palpate

- Gently push downward and outward over iliac crests
- Gently depress symphysis pubis
- Detect TIC, suprapubic mass (bladder)

Suspect GU injury in any child with abdominal tenderness, pelvic fractures, perineal swelling, flank tenderness or lower rib fractures. The retroperitoneal space can accommodate a large amount of occult bleeding resulting in a shock state. Closely assess the child for signs of blood loss.

Musculoskeletal injuries

Unique considerations

- Children have increased curiosity, limited appreciation of risk and danger and higher activity levels.
- **Fractures more common** (cortices of bones thinner) but **torn ligaments and dislocations less common** due to tissue elasticity.
- Proportionately greater blood loss with long bone and pelvic fractures in children than adults. Single femur fracture has potential for 1500 mL of loss and pelvic fractures can exceed 3000 mL loss.
- May be limb threatening. Major joint dislocations, amputations, open fractures, compartment syndromes can result in deformity, nerve damage and limb inequality if not properly treated.
- Children usually have excellent healing qualities

Inspect legs then arms

- Symmetry of limbs; compare for length/position
- Surface trauma, DCAP, BLS, protruding bone, avulsions, amputations, or hematomas
- Skin color; pallor, mottling, and/or cyanosis

Palpate legs then arms

- Bones: TIC
- Pulses (dorsalis pedis/radial), capillary refill, skin
- Moisture/temperature (warmth)
- Motor exam: passive ROM; muscle strength/spasm
- Sensory exam: ability to detect stimuli

Assess all extremities for 6 "P's"

- **P**ain: Quantify using pain scales, faces or other instruments appropriate for child's age, verbal skills, and development.
- **P**aralysis
- **P**aresthesia
- **P**allor
- **P**ulselessness
- **P**ressure

Assume injury if child will not move or bear weight on extremity.

Types of fractures in children: Greenstick, spiral, transverse, impacted, buckle.

Epiphyseal plate (Salter-Harris) fractures: 15% result in premature cessation of bone growth due to interruption to the vascularity of the epiphysis.

Anticipate: Application of appropriate splinting/ immobilization devices; ice/elevation; pharmacologic pain management; development of compartment syndrome.

Splinting will decrease incidence of neurovascular trauma to site, bleeding, fat emboli and pain. Splint the joint above and the joint below all fractures.

Back/posterior body

Inspect: May sit up, log roll, or rotate shoulder forward to inspect back depending on nature of suspected injuries.

Palpate: Palpate all posterior spinous processes and posterior ribs for TIC, deformity, blood.

Spinal cord injury (SCI)

Incidence: Although SCI is relatively rare in children, it is a catastrophic injury.

Unique characteristics in children

Decreased neck muscle mass and inability to restrict or prevent rapid motion produces **more ligamentous injuries** in children < 8 yrs (70%). Bony injury is more common in children > 8. Injuries to spine tend to be at higher levels, usually c-spine region.

Common injuries: C1-C2 (< 8-12 years); C5, C6 (older children), T12, and L1.

Facets are flatter and more horizontal with ↑ flexibility of interspace ligaments and joint capsule. Vertebral bodies are wedged anteriorly and slide forward with flexion.

Elasticity of child's cartilaginous spine and supporting ligaments may allow movement of vertebrae resulting in cord damage without evidence of fracture or dislocation on x-ray known as **"SCIWORA"** (**s**pinal **c**ord **i**njuries **w**ithout **r**adiographic **a**bnormalities). Occurs exclusively in young children, caused by forces of hyperextension, flexion, and traction. Associated with high speed MVCs, may cause C1-C2 distractions. Functional recovery is poor.

A nonresponsive child is assumed to have SCI until proven otherwise. Alert, responsive child without neck pain or neurologic deficits makes SCIWORA unlikely.
A detailed physical exam is critical - Deficits of motor and sensory function may mask fractures, abdominal and chest trauma. Look for same clinical findings as adults.

Respiratory function may progressively deteriorate in a child with c-spine injury. Adequate ventilations on arrival do not guarantee continuation of respiratory function so constant assessment is necessary.

Hypothermia is common secondary to the loss of vascular tone and neurogenic shock (poikilothermia).

Treatment

- Support ABCs; prevent hypoxia/ hypercarbia
- Maintain normal BP w/ IV fluids; vasopressors
- Maintain body warmth
- Protect extremities and skin
- **Spine precautions if indicated:** Place/monitor appropriately sized c-collar and place on backboard, scoop stretcher or directly on stretcher per System protocol until cleared by hospital**.**
- Never apply traction due to risk of distraction injury from torn or stretched ligaments. Use tape, blanket roll, car seat, commercial device, or KED to provide lateral immobilization.
- Anticipate/Rx neurogenic shock

Skin & soft tissue

Inspect: DCAP, BLS, color; impaled objects; frostbite; gooseflesh, diaphoresis, anhydrosis (lack of sweating)

If burned: Differentiate partial from full thickness; calculate TBSA % burned. Rule of 9's altered for children or rule of palms.

Palpate: Temperature, moisture, turgor, edema, deformities, hematomas and crepitus.

Anticipate: Application of dressings/bandages; appropriate cooling/rewarming techniques; appropriate pharmacologic pain management.

Provide adequate analgesia/sedation as soon as possible. Combination therapy most effective: rest, ice, compression and elevation (RICE), opiates, anxiolytics/ sedatives, muscle relaxants; and distraction therapy.

ON-GOING ASSESSMENT

Usually performed after the primary and secondary assessments. Every transported patient should have at least 2 sets of VS.

Stable: At least q. 15 min & after each drug/cardiorespiratory intervention; last set should be taken shortly before arrival at receiving facility

Unstable: More frequent reassessments; continue to reassess all abnormal VS & physical findings

The following should be performed and documented at least **every 15 minutes**.

Standard cardio-vascular monitoring

- Peripheral pulses
- BP; pulse pressure
- Skin color/temperature/moisture
- Temperature (if extremely hot or cold)
- ECG: rhythm, intervals
- Heart sounds (if chest trauma)
- Fluid volumes administered by type and amount
- Type and amount of drainage through dressings

Standard neurological monitoring:

- Mental status (GCS); pupils
- Motor/sensory exam changes
- Continued security of spinal immobilization
- Seizure precautions in head injury patients

Standard respiratory monitoring

- Ventilatory rate, pattern, depth; (SpO_2)
- Integrity of oxygen delivery system
- ET tube placement
- Airway compliance if being bagged
- Breath sounds

Few facts regarding abuse and neglect: According to *Child Maltreatment 2015*, a report from the U.S. Department of Health & Human Services:

- Approximately 683,000 children were reported victims of abuse or neglect in 2015 — an estimated 3.8% increase from 2011.
- Approximately 3,358,000 children received a child protective services investigation response or alternative response in 2015 — up 9.0% from 2011.
- Three-quarters (75.3%) of victims were neglected, 17.2% were physically abused and 8.4% were sexually abused.
- An estimated 1,670 children died of abuse or neglect in 2015 — a rate of 2.25 per 100,000 children in the national population.
- Nearly three-quarters (74.8%) of all child fatalities were younger than 3 years old, and four-fifths (77.7%) of child fatalities involved at least one parent.

Pediatric transport guidelines: Transport all children in an appropriate child restraint system, per the Illinois Child Passenger Protection Act (P.A. 83-8) eff. Jan. 1, 2004. This may include a car seat or Pediamate secured to the stretcher if larger than 10 kg.

Do not allow children to be held in anyone's arms or lap during transport.

Selection of receiving hospital: Transport children to the closest ED approved for Pediatrics (EDAP).

Stable pts may be transported to an alternate or more distant requested facility per local policy/procedure and/or with prior OLMC authorization.

Refusal of service: All peds refusals must have OLMC contact from the scene per System policy even if parent /guardian consents to release and/or is present

Upon arrival at the hospital, there should be an EMS "time-out" to allow for an **uninterrupted handover report** to ensure continuity of care - especially if written or electronic ePCRs/EHRs are not left/downloaded at the time of pt handoff (ACS, 2014).

Summary

- Children of different ages are very different patients.
- The margin of error with children is much slimmer than with adults.
- Children compensate very well for a long time then decompensate rapidly.
- Anticipation and good ventilation are the central elements of good pediatric trauma care. New ABCs: **A**nticipate **B**efore **C**omplications!

Educational programs/resources for EMS personnel

- Prehospital Advanced Life Support (PALS)
- Pediatric Basic Trauma Life Support (PBTLS)
- Advanced Pediatric Life Support (APLS)
- Pediatric Emergencies for Paramedics (PEPP)
- Regional Conferences and seminars)
- Textbooks and journals
- Teaching Resource for Instructors of Prehospital Pediatrics (TRIPP)

Emergency Medical Services for Children (EMSC)

Coordinated national effort to improve the health of pediatric patients who suffer potentially life-threatening illness or injury.

"We have the greatest trust ever given.
We minister, we love, we hold and help to heal
Other people's children."

Kate Reeves, RN, MA, CNA, CEN

SIGN	UPPER AIRWAY	LOWER AIRWAY
Stridor	Inspiratory - high-pitched	Expiratory grunt or wheeze, ↑ intrathoracic pressure to pop open alveoli
RR	40-50 maximum; prolonged inspiration	100 - 110+; prolonged expiration
Pulse	150-160	180 - 200
Associated Findings	Hoarseness, barking cough, dysphagia	Nasal flaring, moist crackles
Retractions	Sternal and subcostal	Intercostal
Age	6 months-4 years (croup)	≤ 18 months (bronchiolitis)

Age averages	0-12 mos	1-2 yrs	3-4 yrs	5 yrs	6-7 yrs	8-11 yrs
Wt. in kg	3-9 kg	10-13 kg	14-16 kg	16-20 kg	18-25	24-32 kg
Blade size	0-1 str	1 str	2 str	2 str	2 str	2 str or c
Tracheal tube	3.5-4.0 No cuff	4.0 No cuff	4.5 No cuff	5.0 No cuff	5.5 No cuff	6.0 Cuffed
Distance to upper lip	7-10.5	11-12	12.5-13.5	14-15	15.5-16.5	17-18

GCS for Children			
	Infant < 1 yr	Child 1-4 years	Age 4 to adult
EYES			
4	Open	Open	Open
3	To voice	To voice	To voice
2	To pain	To pain	To pain
1	No response	No response	No response
VERBAL			
5	Coos, babbles	Oriented, speaks, interacts, social	Oriented & alert
4	Irritable cry, consolable	Confused speech, disoriented, consolable	Confused speech, disoriented
3	Cries persistently to pain	Inappropriate words, inconsolable	Inappropriate wds; nonsensical speech
2	Moans to pain	Incomprehensible, agitated	Moans, unintelligible
1	No response	No response	No response
MOTOR			
6	Normal spont mvmt	Normal spontaneous movement	Normal spontaneous movement
5	Withdraws to touch	Withdraws to touch	Withdraws to touch
4	Withdraws to pain	Withdraws to pain	Withdraws to pain
3	Abnormal flexion	Abnormal flexion	Abnormal flexion
2	Abnormal extension	Abnormal extension	Abnormal extension
1	No response	No response	No response

PEDIATRIC TRAUMA SCORE: Age 12 and under			
Component	**+2**	**+1**	**-1**
Size	> 20 kg (40#) (> 5 yrs)	10 - 20 kg (22-40#) (1-5 yrs)	< 10 kg (22#) (≤ 1 year)
Airway	Normal	Maintainable using sniff position/chin lift	Unmaintainable/intubated
Systolic BP *or* Pulse palpable	> 90 at wrist	50-90 at groin	< 50 no pulse palpable
CNS	Awake	AMS / Obtunded	Comatose (GCS ≤ 8)
Skeletal injury	None	Closed fracture	Open/multiple fractures
Open wounds	None	Minor	Major or penetrating

Scores range from -6 to +12.
A PTS of < 8 usually indicates the need for evaluation at a (peds) Trauma Center.

Age	Weight kg	Normal Systolic BP Ages 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	>60 mmHg	>60 mmHg	100-180	30-60
Infant 1-12 mos	4-10	> 90 mmHg	>70	110-160	30-60
2 yr	12	>94	>70	90-150	24-40
4 yr	16	>98	>75	90-150	22-34
6 yr	20	>102	>80	70-120	18-30
8 yr	26	>106	>80	70-120	18-30
10 yr	32	>110	>90	70-120	18-30
12 yr	41	>110	>90	60-110	12-16

QUICK NEURO EXAM in children

Level of consciousness

A ↓ LOC cannot be fully evaluated until hypotension is reversed and the child is normothermic. All children should be alert, arousable, and respond to familiar faces/objects.

The **Glasgow Coma Scale** (GCS) is used as a guide to neurologic evaluation of consciousness but does not work well in children less than 3 years of age. An infant will be unable to understand and respond to questions, so evaluation of the infant's LOC will be based on observations. A modified coma score for infants has been developed for the younger population which may aid in a communication between care givers. See chart.

A **drop of 2-3 points signals significant deterioration**. A score of 8 or less is very serious, confirms coma, and signals a probable ↑ ICP. Abnormal extensor posturing in child is rarely associated with isolated brain stem injury as in an adult; more commonly associated with diffuse cerebral swelling and hyperemia.

Level of activity in an infant
- Is the infant alert the appropriate amount of time?
- Does the infant sleep normal periods for age?
- Is the infant lethargic or irritable without cause?
- Does the infant move all extremities actively and spontaneously?
- Does the infant demonstrate abnormal posturing (i.e., persistent tight flexion, scissoring, or hypotonia)?
- Is his cry normal (loud, angry) or weak, shrill, cat-like, or high-pitched?

Cranial nerves

II (Optic), III (Oculomotor), IV (Trochlear), VI (Abducens)
- Will the infant follow objects?
- Does the infant have a conjugate or dysconjugate gaze (EOMs)?
- Do the eyelids open spontaneously without drooping (ptosis)?
- Do the pupils react equally and briskly to direct and consensual light testing?
- Is there anisocoria (unequal pupils) or hippus (jiggling)?
- Is there fixed constriction or dilation of the pupil?

Any change in pupillary size, shape, equality or response to light should be communicated to the hospital, since this may be a sign of ↑ ICP. In the absence of direct ocular injury, a unilaterally dilated pupil with sluggish or absent light reflex that is deviated down & out is presumptive evidence of an expanding (herniating) intracranial mass, i.e., epidural, subdural or intracerebral hematoma.

V: Trigeminal
- Does the infant have a strong suck?
- Is the corneal reflex intact?
- Does the infant respond to touch or pain on the face?

VII: Facial: Does the infant have symmetrical facial movements?

VIII: Vestibular/acoustic: Does the infant respond to sounds appropriately?

IX/X Glossopharyngeal/Vagus: Does the infant drool excessively? Is the gag reflex intact?

XI: Accessory: Does infant turn his head from side to side?

Motor function

Assess bilateral motor strengths/weaknesses in a conscious child. Focal deficits may be a stress response. Elicit motor response to a pain stimulus in an uncooperative or unconscious child. Note asymmetry or impairment of motion, position or muscle tone. In charting motor findings, the **best** response is recorded, but a notation should be made regarding any "deficits".

Sensory function
Does the infant respond purposefully to pain?
Does the infant respond to pain without posturing? Infants do not characteristically demonstrate classic abnormal flexor or extensor posturing.

Reflexes: Does the infant demonstrate the infantile automatisms appropriate for age? (ie: blink, palmar, grasp, rooting, sucking, tonic neck, and Moro)

Babinski reflex: (Not done by EMS) Dorsi-flexion of toes is normal in a child less than 18 months, but abnormal in a child who is walking.

↑ ICP

Recognition of ↑ ICP involves an ongoing assessment of the **level of consciousness (LOC) and responsiveness**.

Cushing's response: (↑ BP, ↓ P, change in RR and effort) is a late indication of ↑ ICP

Other signs of ↑ ICP in an infant

- Vomiting
- High-pitched, shrill cry
- Irritability; Are they consolable or inconsolable?
- Bulging, full anterior fontanelle

Other signs of ↑ ICP in older children: Headache; photophobia (light sensitivity)

References

Alisic, E., Hoysted, C., Kassam-Adams, N. et al. (2015). Psychosocial care for injured children: worldwide survey among hospital emergency department staff. Published on line Dec. 17, 2015: http://www.jpeds.com/article/S0022-3476(15)01306-2/pdf .

American Academy of Pediatrics & American Heart Association. (2010). *Pediatric Advanced Life Support*.

Anello, J., Feinberg, B., Heinegg, J., Lindsey, R., Wojdylo, C., Wong, O. (Aug. 2016). Guidelines on pediatric sedation by the American Academy of Pediatrics and the American Academy of Pediatric Dentistry. Accessed on line: Medscape.

Bledsoe, B.E., Porter, R.S., & Cherry, R.A. (2017). Pediatric emergencies. In Bledsoe et al (Eds) *Paramedic Care: Principles & Practice* 5th ed. Boston: Pearson.

Coté CJ, Wilson S. (2016). American Academy of Pediatrics, American Academy of Pediatric Dentistry Guidelines for monitoring and management of pediatric patients before, during, and after sedation for diagnostic and therapeutic procedures: Update 2016. *Pediatrics*; 138(1):e20161212

Dubin, A.M. (2013.) Supraventricular tachycardia in children: AV reentrant tachycardia (including WPW) and AV nodal reentrant tachycardia. UpToDate. Retrieved Nov. 29, 2014, from www.uptodate.com/contents/supraventricular-tachycardia-in-children-av-reentrant-tachycardia-including-wpw-and-av-nodal-reentrant-tachycardia

Martinon, C., Duracher, C., Blanot, S., Escolano, S. et al. (2011). Emergency tracheal intubation of severely head-injured children: Changing daily practice after implementation of national guidelines. Pediatr Crit Care Med, 12(1), 65-70.

Mills, L.C., Gow, R.M., Myers, K., et al. (2013). Lone atrial fibrillation in the pediatric population. Can J Cardiol, 29(10),1227–1233.

Shah, B.R. (2013) Atlas of pediatric emergency medicine, 2nd edition. New York: McGraw-Hill Medical.

National Model EMS Clinical Guidelines maintained by the National Association of State EMS Officials based on work done by their Medical Directors Council. They are evidence or consensus-based and are available at www.nasemso.org.

1. List the formulas used to calculate the average norms for the following:

   Weight:_____

   Ave. Systolic blood pressure in children 1-10:_____

   Systolic hypotension in children 1-10:_____

2. Identify three differences in a child's airway as compared to an adult's:

   _____

   _____

   _____

3. What structure is the narrowest point of a child's airway?

4. What injuries can occur due to the extreme flexibility of a child's chest wall?

   _____

   _____

   _____

   _____

5. List four factors that contribute to the fact that an infant has no pulmonary reserve and cannot increase his tidal volume to compensate for hypoxia.

   _____

   _____

   _____

   _____

6. A resting respiratory rate of 28 would be normal for which aged child?

   A. Infant
   B. Pre-school
   C. School age
   D. Adolescent

7. Why is a young child rate dependent to maintain cardiac output?

   _____

   _____

8. Why does bradycardia cause a significant drop in CO in young children?

   _____

   _____

9. Why can children be hemodynamically stable until approximately 30% of their circulating blood volume is lost?

10. List three signs and symptoms of dehydration in an infant/child:

    _____

    _____

    _____

11. Why are children at risk for developing hypoglycemia?

12. List two ways in which a child would be predisposed to hypothermia

_____

_____

13. What are the main consequences of "cold stress" in young children?

_____

_____

_____

_____

14. Why is aspirin contraindicated as an anti-pyretic agent in children who are experiencing a viral illness such as chickenpox?

_____

_____

15. List 4 S&S of a partial airway obstruction in a child.

_____

_____

_____

_____

16. How should an infant with altered mental status be positioned to optimally open the airway?

17. What is the smallest size suction catheter that should be used on an infant?

    For what complication of suctioning is a child at risk?

18. What is the upper limit of suction application time in a child?

19. List four possible indications for pediatric intubation.

_____

_____

_____

_____

20. True or false

    When intubating a child, their vocal cords are easier to visualize than an adult's.

21. Why are E-T tubes generally uncuffed in children less than 8 years of age?

22. How should a paramedic estimate the appropriate size ET tube to select in a child?

23. Very young children should be intubated using a _____ laryngoscope blade.
    A. Curved
    B. Straight

24. When performing DAI on a young child with protective airway reflexes intact, what premedication (list drug and dose) should be administered?

    What sedative (drug name, dose, route) should be given?

25. A surgical cric may be performed by SOP in children ≥ _____ years.

26. List four S&S of respiratory/ventilatory distress in a 2 y/o child

    _____

    _____

    _____

    _____

27. True or false: A child's pulse oximetry reading should easily remain ≥ 96% on room air.

28. What age range should be ventilated using a pediatric size BVM? _____

    What tidal volume does this bag deliver? _____

29. Hypotension is an early / late sign of shock in children.

30. Where should pulses be palpated in an infant or young child?

31. What factors must be taken into consideration when interpreting the significance of the pulse assessment?

    _____

    _____

    _____

    _____

32. What pulse finding often signals severe hypoxia and extreme distress?
    A. Tachycardia
    B. Bradycardia

33. What assessment finding in children suggests decreased peripheral perfusion with ↑ peripheral vascular resistance/vasoconstriction?

    _____

34. What two rhythms are responsible for 90% of the dysrhythmias seen in pediatric cardiac arrests?

    _____

    _____

35. What joule sequencing is to be used for a child found in PVT or VF?

    _____ → _____ → _____ J/kg

36. What is the most common cause of cardiac arrest in children?

37. Name five signs of cardiorespiratory instability in children:

_____

_____

_____

_____

_____

38. What is the preferred site for venous access in a child?

What gauge catheter should be used for a 6 year old who needs fluid challenges?

What is the formula for initial crystalloid volume resuscitation in a child?

If the child weighs 40 lbs, how much fluid should be given?

How should this fluid be administered?

What should a-Paramedic do if the child fails to respond adequately to the initial volume?

39. If a peripheral vein cannot be accessed in an unresponsive child, how must vascular access be achieved?

Device_____

Insertion points_____

Indicators of proper placement:_____

Complications of the procedure:_____

40. Give one example of an assessment that would evaluate a child's response to the environment.

41. If a child is having early persistent post-traumatic seizures and an IV cannot be secured, what drug, dose, and route should be given?

42. Why is it very important to avoid applying traction when immobilizing a child's c-spine,?

43. List three reasons why children are more prone to severe head trauma

_____

_____

_____

44. Infants with a large epidural bleed can / cannot lose enough blood into their skull to become hypotensive.

45. What causes a "growing" skull fracture?

46. Why is cyanosis an unreliable indicator of respiratory failure or perfusion in children?

47. List two early, subtle clues of a potentially acute abdominal injury in a child.
    -
    -

48. What is the significance of a long bone fracture through the epiphyseal plate?