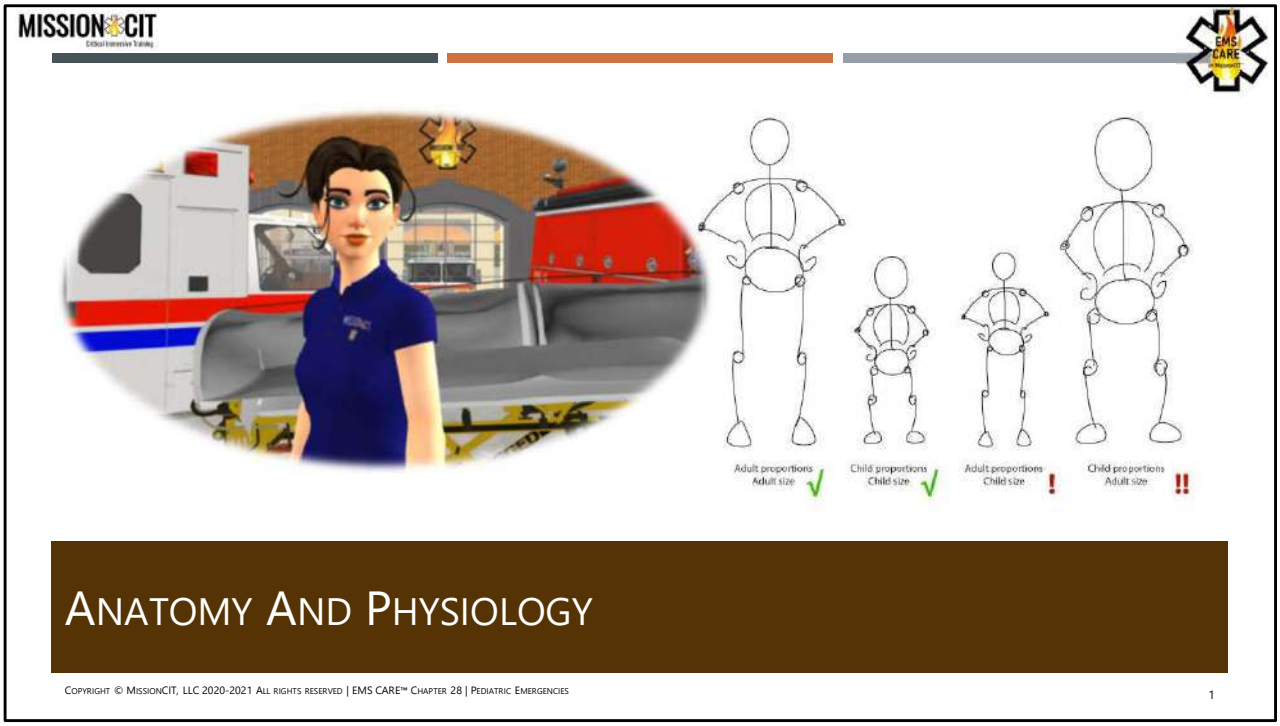
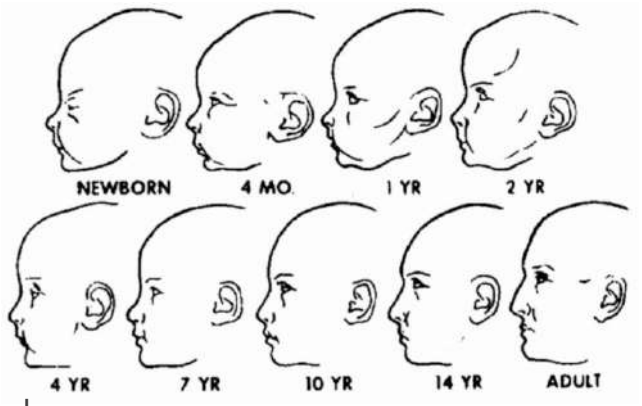


Hello and welcome to the first lesson where we talk about the anatomy and physiology of children and infants. Before we proceed, it is important to note that children must not be treated as little adults, because their anatomy is not as well develop as adults.

So, let's take a detailed look at the anatomy of children.

Pediatric Head

- Facial part is smaller than cranium. Ratio is 1:8. In adults, ratio is 1: 2.5
- Big forehead
- Cranium is elongated and bulbous
- Skill is pliable
- Large and broad junctions between bones that are exposed



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

So, let us start from the head.

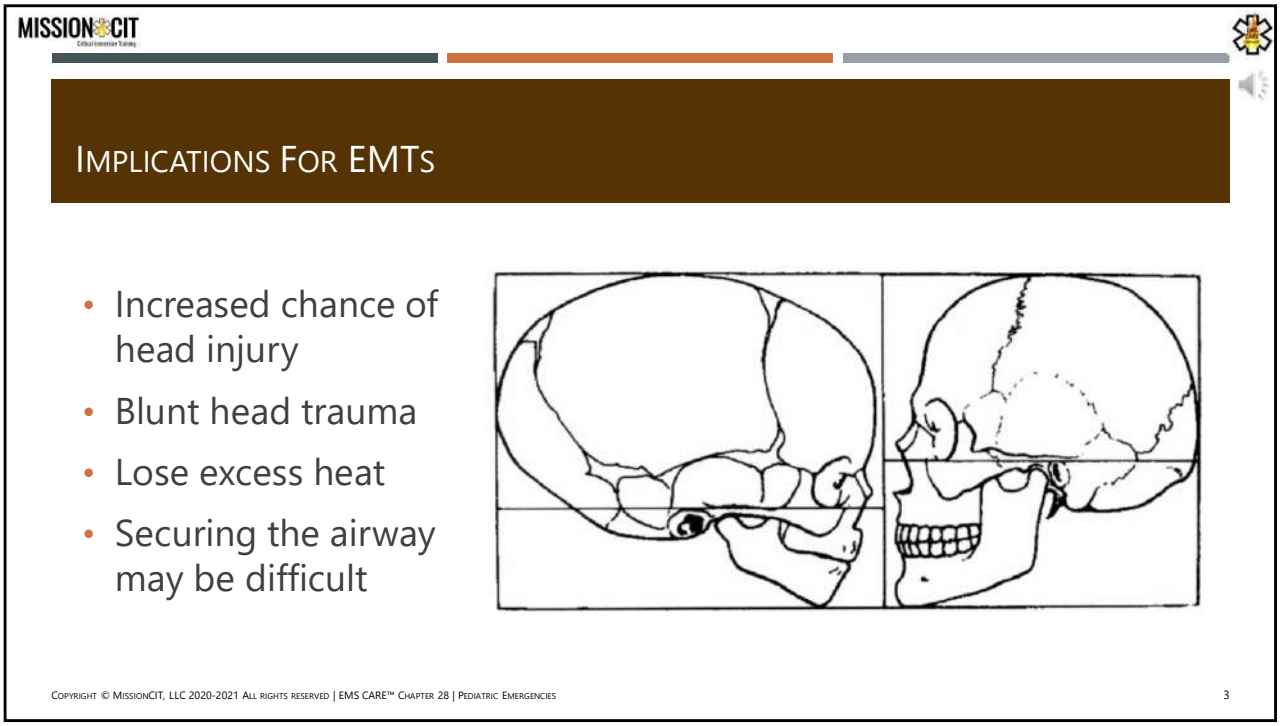
At the time of birth, the facial part of the head is much smaller than the cranium. The face to cranium ratio is 1 is to 8. Compare this with the ratio of an adult, which is 1 is to two point five. Further, the newborn's forehead is high and possibly even bulged because the frontal part of the brain is big.

Overall, children have a large head and a small face, and this pattern is visible up to 7 to 8 years of age. The shape of the head changes when there is a vertical growth of the head due to tooth eruptions and increasing

respiratory needs.

Similarly, the shape of the head also undergoes a lot of changes from infancy to adulthood. In the case of infants, the cranium is more elongated and bulbous. The head's circumference at the time of birth is around 13 to 14 inches. This increases by 17% during the first three months of life, and by 25% at six months of age. The size increases by one inch during the second year, and a half-inch from the third to the fifth year. By the time a child becomes 20 years, the head circumference would have increased by about four inches.

Another key difference is that the skulls of infants and children are pliable because of the arrangement of the skull bones. Remember, the skull is just a loosely joined set of bones at the time of birth, and it slowly joins as the child grows. Still, there are large and broad junctions between the bones, to expose a thin fibrous sheath to the external environment.



So, what are the implications of these differences in the size, shape, and flexibility of the head?

First off, there is an increased chance of head injury and blunt head trauma. This means, an infant or a child can get injured even when they have a fall from a relatively small height, so this is something you should watch out for.

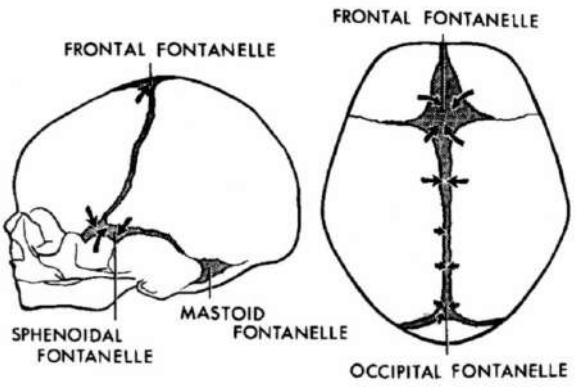
Also, babies tend to lose excess heat through their heads because of their large size when compared to the rest of the body. What this essentially means is that you have to cover the baby's head to prevent the loss of heat, as it

can get much colder when compared to an adult.

The third implication is that securing the airway may be a bit difficult. You will have to keep a towel or a roll under the baby's shoulders to open the baby's airways during respiratory distress.

FONTANELLE

- Fontanelle is the soft spot between the bones of an infant's skull
- Covered by tough membranes
- Anterior – Meeting of two frontal and parietal bones
- Posterior – Meeting of two parietal bones with occipital bone
- Sunken fontanelle – Dehydration
- Bulging fontanelle - ICP



COPYRIGHT © MISSIONCIT, LLC 2020-2021 ALL RIGHTS RESERVED | EMS CARE™ CHAPTER 28 | PEDIATRIC EMERGENCIES

A fontanelle, or a soft spot, is the space between the bones of an infant's skull. This area is covered by tough membranes to protect the underlying tissues and brain.

Typically, there are two fontanelles, and they are the anterior and posterior fontanelle. The anterior fontanelle is the place where the two frontal and parietal bones meet, and this can remain soft until about 18 months to 2 years of age.

The posterior fontanelle, on the other hand, is the place where the two parietal bones meet the occipital bone.

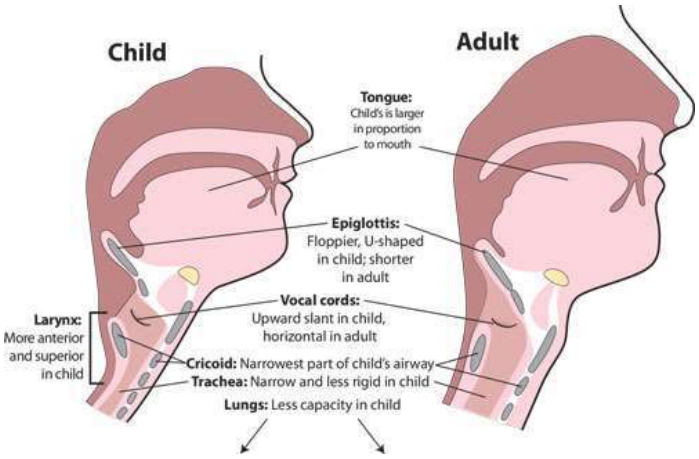
Both these fontanelles close as the infant becomes older. And out of the two, the posterior closes earlier than the anterior.

From an EMT standpoint, a sunken fontanelle may indicate dehydration. Also, a bulging fontanelle can be a sign of ICP, provided the infant is not crying.

MISSION CIT

Pediatric Airways

- Smaller in diameter
- Shorter in length
- Larger tongue
- Epiglottis is longer , narrower, and floppier
- Narrowest part of the airway is below glottis



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

The airways in children are very different in terms of anatomy and physiology when compared to an adult. Specifically, the pediatric airway is much smaller in diameter and shorter in length, and this can have implications for airway management.

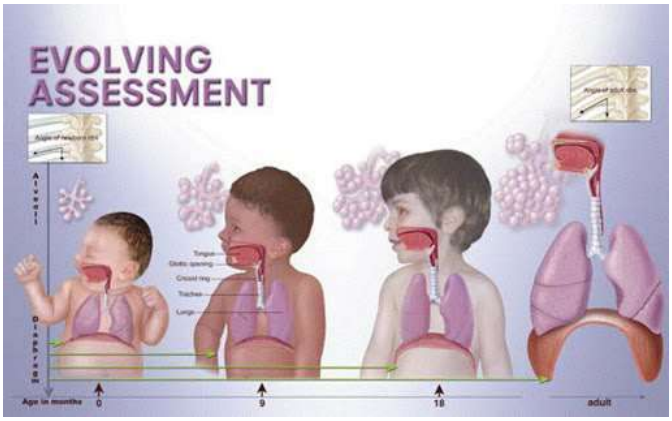
Also, a child's tongue tends to be much larger on the oropharynx side than an adult's. The next difference is that the larynx in adults and young children is more anterior than adults, while the epiglottis is longer, narrower, and maybe even floppier than adults.

If the child is under 10 years of age, the narrowest part

of the airway is located just below the glottis.

Implications For EMTs

- Small caliber of pediatric upper jaw increases airway obstruction
- Large head and occiput flex the neck
- Large tongue obstructs spontaneous ventilation
- Hypoxemia



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

From an EMT's perspective, these anatomical differences impact airway management during emergencies.

First off, the small caliber of the pediatric upper jaw, large tongue, and floppy epiglottis tend to increase airway obstruction. Also, the large head and occiput flex the neck when they lie on a flat surface. This is why you must put a towel or a roll to achieve a neutral position of the head, so the airway will open up.

Further, a large tongue and the possibility of adenoids and tonsils can pose problems with mask ventilation and

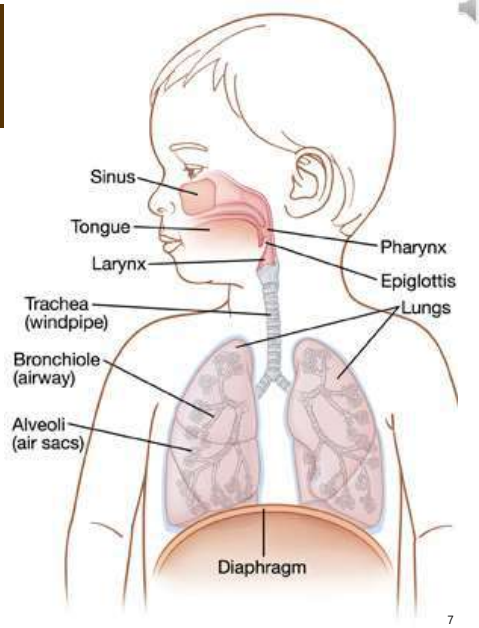
can present obstruction during spontaneous ventilation.

All these physiological challenges predispose children to hypoxemia, which is the lack of oxygen to different tissues in the body.

MISSION CIT

Pediatric Chest And Lungs

- Pediatric Airway anatomy and Lung anatomy
- Intercostal muscles are not developed until school age
- Internal diameter is smaller
- More heart beats per minute than adults



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

The pediatric respiratory system can be divided into two parts, and they are, pediatric airway anatomy and pediatric lung anatomy.

The pediatric airway anatomy includes the epiglottis, glottis, or the airway opening to the trachea, two mainstream bronchi, and bronchioles that take air to the alveoli.

The pediatric lung anatomy, on the other hand, includes the lobes and segments that allow gas exchange in the alveoli.

Some of the ways in which a pediatric chest and lungs differ from that of the adult are:

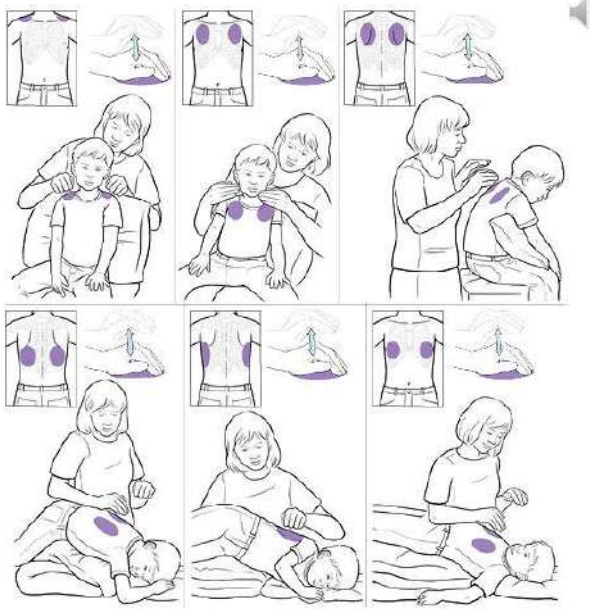
- The intercostal muscles that run between the ribs are not developed till school age, so it can be difficult to lift a child when he or she is lying flat.
- The internal diameter of the airway is smaller, so it can cause more respiratory distress
- Children have more heart beats per minutes than adults.

These anatomical differences make it necessary to treat children in a specialized way.

MISSION CIT

Implications For EMTs

- Increases the volume of air using the accessory muscles
- Diaphragmatic breathing is common
- Less pulmonary reserve
- Small abdominal cavity, so diaphragm can't move much
- Never exacerbate the pulmonary event
- Focused examination



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

As an EMT, understanding the anatomical difference is critical to provide the most appropriate care. Since a child's bones are not fully calcified, the child's body will attempt to increase the volume of air by using the accessory muscles. Also, children's ribs tend to be more horizontal and provide little leverage to increase the anterior and posterior diameters. Due to these reasons, you're likely to see diaphragmatic breathing.

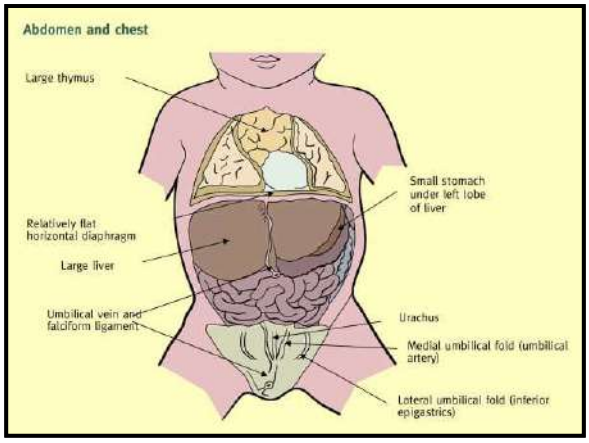
Further, children have less pulmonary reserve than adults. Also, the abdominal cavity is small and has many large organs compressed within it. As a result, children

rely heavily on the rate of respiration because they can’t move the diaphragm like adults.

Hence, you must keep these aspects in mind while identifying the respiratory condition of a child. Never upset the child and exacerbate the pulmonary event. Likewise, do a focused examination, gather as many details as you can, and discuss with the online medical control if you have to.

Pediatric Abdomen

- Very fragile
- Abdominal viscera is not protected by bone
- Organs like liver and kidneys are exposed
- Abdominal girth and chest are same size
- As the child gets into an erect posture, many changes occur



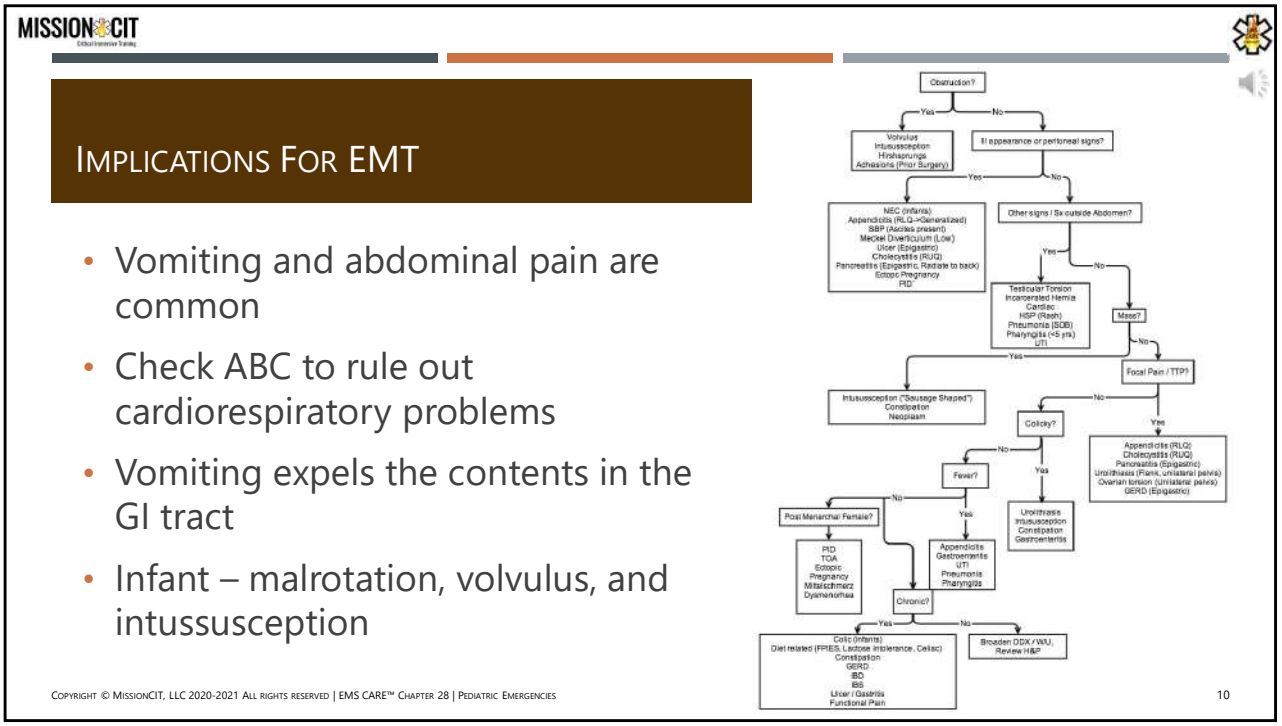
Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

The pediatric abdomen is a lot more fragile when compared to adults. The abdominal viscera in children are not protected by bone, so many organs like the liver and kidneys are relatively exposed. Also, the bladder is located outside the pelvic area, thereby increasing the chances for injuries.

Besides, the abdominal dimensions also vary greatly. In children below two years of age, the abdominal girth is about the same size as the chest. This circumference starts increasing after the age of two.

When a child gets into an erect posture, there is a

reduction in the anterior-posterior diameter of the abdomen followed by an increase in the lumbar region. These changes are fairly gradual and occur from childhood through adolescence.



Vomiting and abdominal pain are common emergencies, so check the child's airways, breathing and circulation, to rule out any cardiorespiratory process. Vomiting is coupled with abdominal pain as the body forcefully expels the contents in the GI tract.

In infants, it could indicate anatomic defects such as malrotation, volvulus, and intussusception that would require a surgeon's intervention. If there are triggers to cough, it can result in gagging and emesis, so this is something to watch out for.

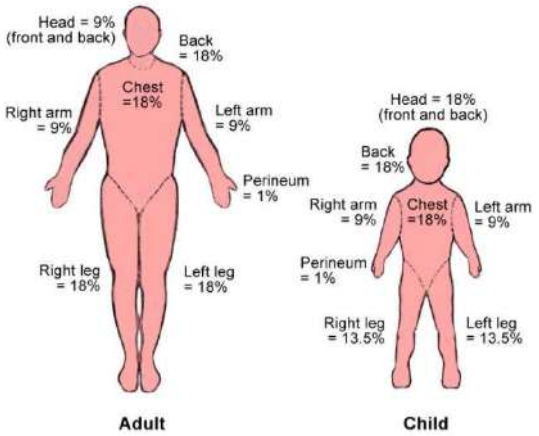
In older children and adolescents, gastroenteritis,

obstructions, infections, GU, toxins, and diabetic ketoacidosis are some of the causes of abdominal pain.

MISSION CIT

Pediatric Extremities

- Length of all extremities same until two years of age
- In adults, lower limb is one-sixth longer than upper limb
- Bones are less firm. More prone to trauma
- Cartilage joins the bone shaft around puberty



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

11

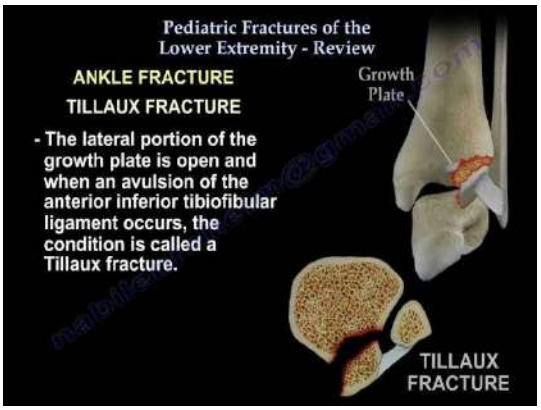
The size and length of extremities, including skeletal embryology, are different. At around two years, the lengths of all the extremities are equal. When you compare it with adults, the lower limb is about one-sixth longer than the upper limbs.

The long bones go through many developmental stages, so the bones are less firm, and more prone to trauma. The adult bone strength is achieved over the years when the cartilage of the epiphyseal plate joins the bone shaft. In females, this happens about 2-3 years earlier than males.

Even in males, this is completed by 20 years of age.

Implications For EMTs

- Inappropriate alignment, deformities, malformations
- Range of motion of all joints
- Tenderness, swelling, and temperature
- Higher chances of injuries
- Limp can indicate infection, inflammation, cancer, lesions, presence of foreign bodies



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

While examining children, understand the anatomical limitations. Look at the upper and lower extremities carefully to identify inappropriate alignment, protuberances, deformities, malformations, and integument abnormalities.

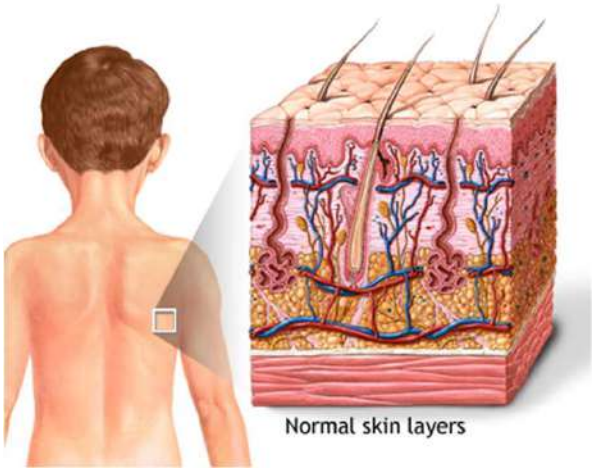
Next, determine the range of motions in all joints to identify possible problems. Also, look at the palpation of extremities to identify tenderness, swelling, and temperature. The tone and strength of the muscles can indicate conditions such as Duchenne muscular dystrophy. Also, the overall chances of injury is high.

If a child is limping, it could indicate infection, neurologic problems, allergies, inflammatory processes, cancer, lesions, and the presence of foreign bodies, all of which require a visit to the hospital for further examination and treatment.

MISSION CIT

Integumentary Differences

- Starts in the uterus and continues through one's life
- Infants' skin is mature and develops rapidly
- Conducive for wound repair
- Sensitive
- Prone to injury
- Smaller corneocytes and thinner stratum
- Higher TEWL
- Increased skin hydration



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

The integumentary system starts in the uterus and continues all through one's life. At birth, the skin of infants is mature and develops rapidly through the first year of life.

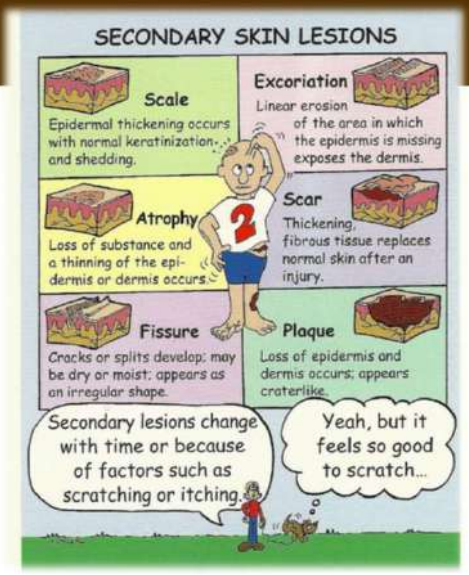
Pediatric integumentary is known to be conducive for wound repair and gives a youthful appearance. At the same time, it is more sensitive and prone to injury when compared to adults.

In terms of structure, infants have smaller corneocytes and have a thinner stratum. This means, children have higher Transepidermal Water Loss or T E W L and hence,

increased skin hydration.

Implications For EMTs

- More permeable.
- Increased chance for xerosis or dry skin
- Increased irritation and allergic contact dermatitis
- Extensive transcutaneous fluid loss and infections
- Secondary skin lesions

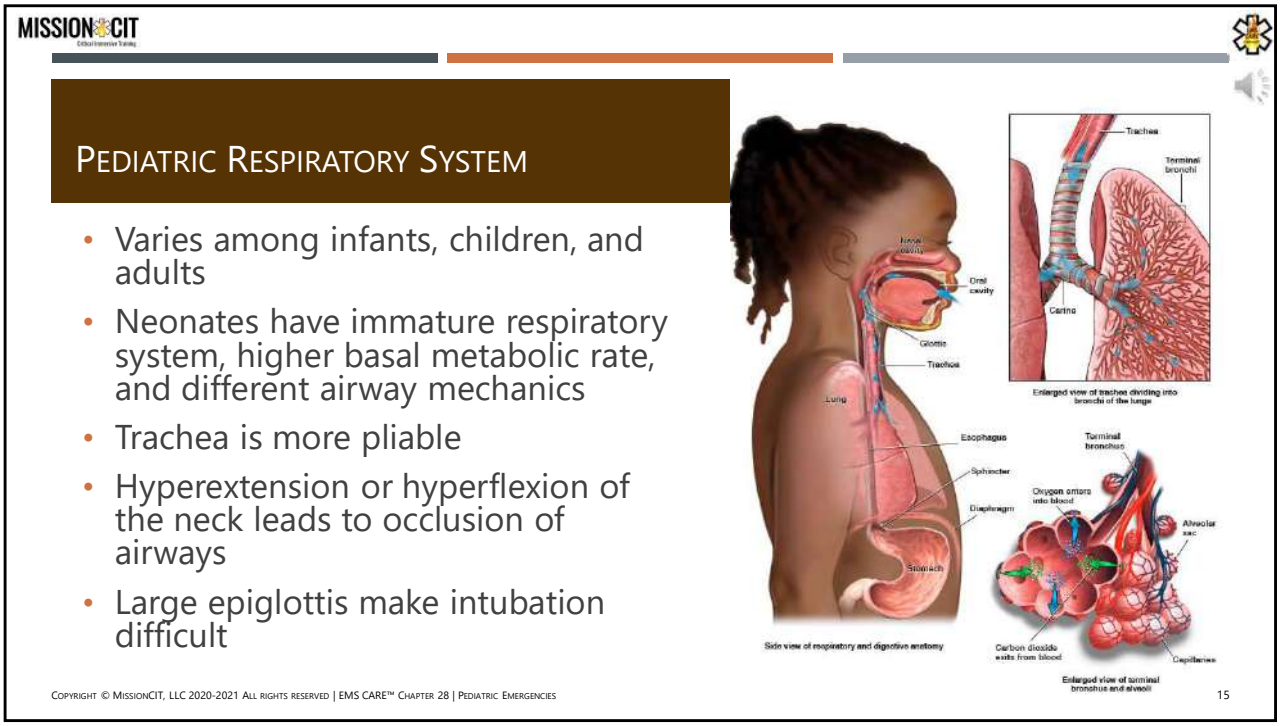


Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

Since the pediatric skin is more permeable, there is an increased chance to develop xerosis, which is excessively dry skin. This manifests as white patches with fine white scales, in particular on the facial part of the skin. This also increases the possibility of irritation and enhances the chances of allergic contact dermatitis.

In some cases, it can also lead to extensive transcutaneous fluid loss and infections.

There is also an increased chance for secondary skin lesions



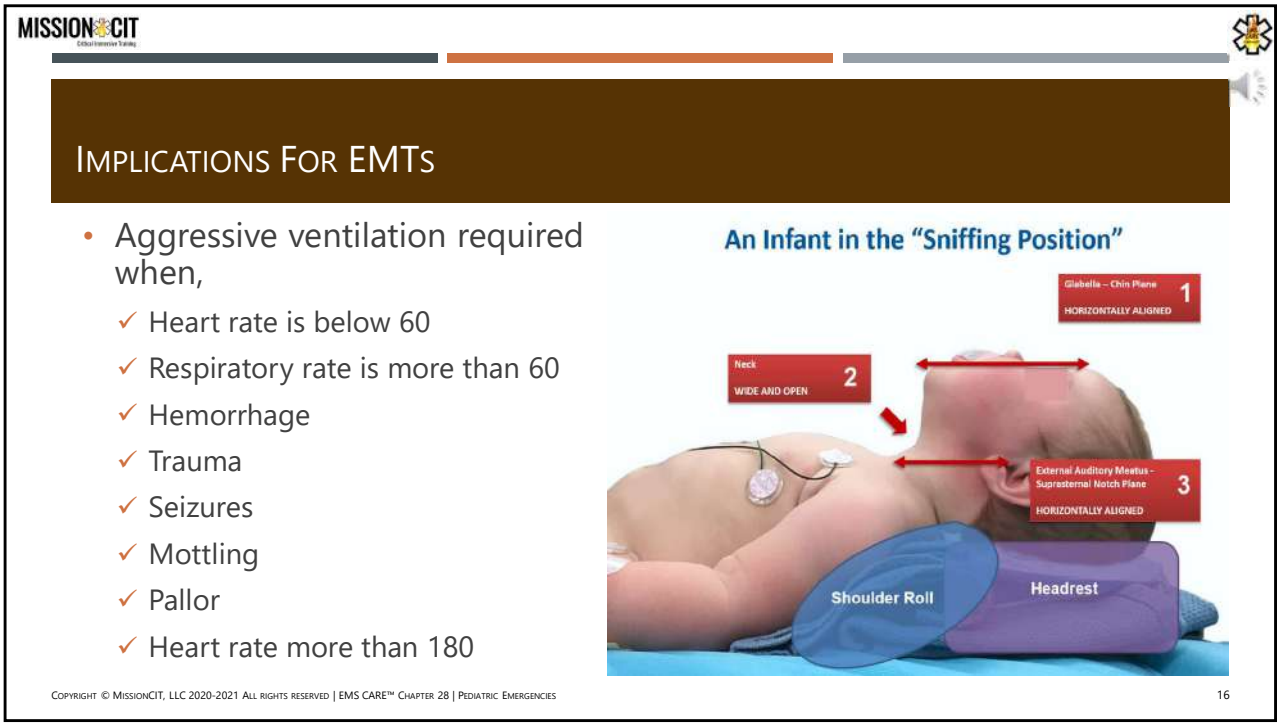
The anatomy of the respiratory system varies greatly among infants, children, and adults.

In general, neonates have an immature respiratory system, inefficient respiratory muscles, a higher basal metabolic rate, and different airway mechanics.

In terms of anatomy, children have a longer tongue than adults, and this increases the possibility of airway occlusion, as there's less room for swelling. The trachea is also much more pliable as hyperextension or hyperflexion of the neck can lead to occlusion of the

airway too.

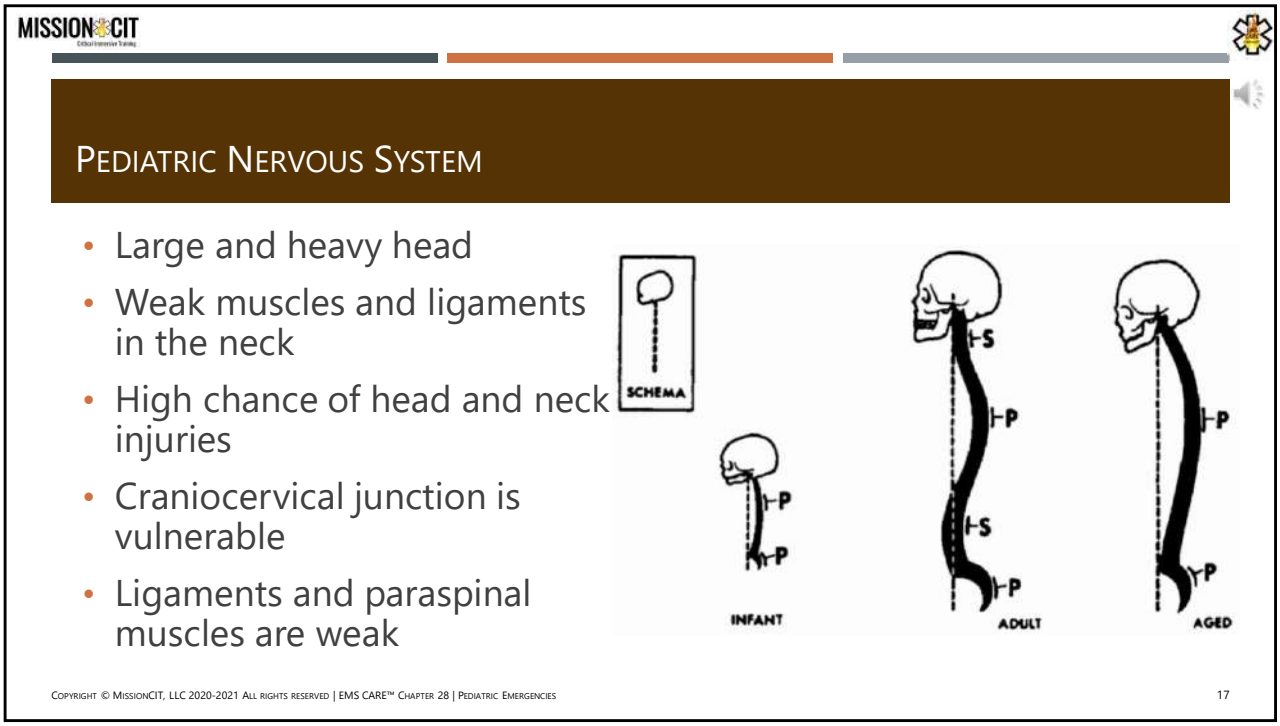
The large epiglottis makes intubation difficult while the larynx is at the level of the first and second vertebrae, as opposed to the fourth or fifth cervical vertebrae of adults. The bronchi in young children have less angle as well.



When you assess a child keeping these respiratory differences in mind, you can help the child from going into a cardiopulmonary arrest. You have to provide aggressive ventilation when a child has

- A heart rate that is below 60
- The respiratory rate that is more than 60
- Hemorrhage
- Trauma
- Nasal flaring
- Respiratory distress
- Seizures

- High fever with rash
- Mottling
- Pallor
- Heart rate greater than 180



The anatomy of the central nervous system is much different in children than adults, and these differences make a difference in providing critical care during a traumatic brain injury or a spinal cord injury.

First off, the head is large and heavy when compared to the child's body. And this is supported on a neck that has weak muscles and ligaments. All these mean that there is a high chance of head and neck injuries. A child's spine resembles an adult spine only by 8 to 9 years as the epiphyses fuse at different stages.

So, younger children have a higher chance of injury and

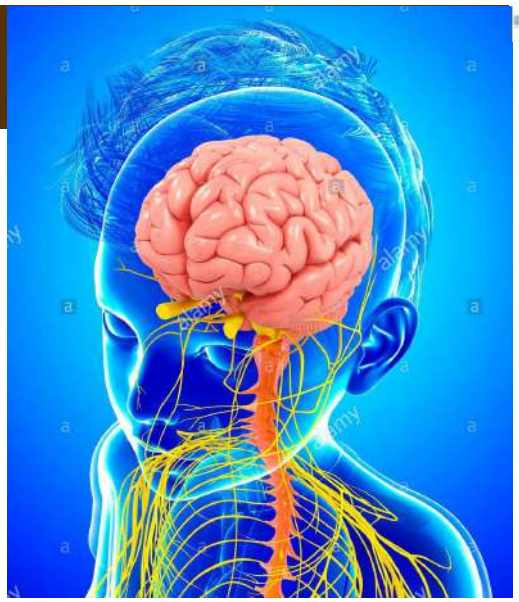
instability because the craniocervical junction is more vulnerable. The ligaments and paraspinal muscles are also weaker than adults.

Further, the brain requires almost twice as much cerebral blood flow than adults. And finally, the subarachnoid space is small, and hence provides a lot less cushioning effect for the brain.

MISSION CIT

Implications For EMTs

- High cerebral blood requirements
- Increased risk of hypoxia
- Quick head movements can cause damage to nerves
- Cervical spine injuries are more common than ligamentous ones



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

First off, the high cerebral blood requirement of the pediatric brain increases the risk of hypoxia. Hypotension and hypoxia in the event of a head injury can be serious and ongoing.

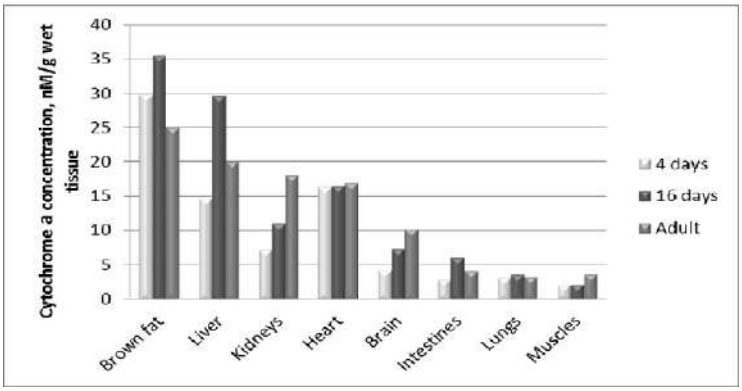
Also, quick head movements and momentum can cause damage to the nerves and the brain.

The chances for spinal cord injuries is low, and even in those cases, cervical spine injuries are more common than ligamentous ones.

MISSION CIT

METABOLIC DIFFERENCES

- Renal functions are at 25-30% of adults
- Higher levels of CYP enzymes
- Increased ability to metabolize
- Higher rate of metabolism



COPYRIGHT © MISSIONCIT, LLC 2020-2021 ALL RIGHTS RESERVED | EMS CARE™ CHAPTER 28 | PEDIATRIC EMERGENCIES

There are many metabolic differences between adults and children. There are many differences among neonates, children, and adolescents too because the body changes and its need for energy requirements also changes with it.

The renal function that is responsible for excretion is about 25 to 30 percent of adults at the time of birth, and this increases to 50 to 75 percent by six months of age. It reaches adult levels when a child is 2 or 3 years old.

Further, children have higher levels of CYP enzymes, which means children have an increased ability to

metabolize. By puberty, the levels of CYP go down to the adult levels. Similarly, young children have a higher rate of metabolism and increased total body clearance.

Implications For EMTs

- More likely to absorb drugs
- Quicker effect
- More nutrition needed
- Chances for hypoglycemia
- Vomiting is common



Copyright © MissionCIT, LLC 2020-2021 All rights reserved | EMS CARE™ Chapter 28 | Pediatric Emergencies

20

From an EMT perspective, the higher metabolism rate means children are more likely to absorb drugs, so the effects of toxins and medications tend to be more profound.

Also, children are likely to require more nutrition than adults to meet the high metabolic rate. The protein, glucose, and lipids will be converted to energy quickly, but at the same time, the ability to break complex molecules quickly into energy can have a long-term negative impact on children. So, the chances for hypoglycemia are high in children than in adults.

Vomiting is common as well.

With this, we have come to the end of this chapter. In the next one, Justin will take you through the different developmental stages of children.