PHYSICAL DEVELOPMENT

Anatomical and Physiological Differences Between Children and Adults

For Nurses

Caution

The intention of this module is to provide general information regarding pediatric care. Individual children may differ. Should the information in this module contradict the information given to you by your agency or by the child's physician, defer to the agency or physician information.

Target Audience

This module is mandatory for any RN or LPN with less than one year experience in pediatrics who will be caring for a child on the CAP/C program.

This module is recommended for other nurses, for nurse aides, and for case managers.

Objectives

- Apply knowledge of the following to care and interactions with pediatric patients:
  - Pattern of growth including proportional changes
  - Differences in skin and ability to thermoregulate
  - Differences in hydration and risk of dehydration
  - Differences in the lymphatic system
  - Skull development and fontanels
  - Childhood reflexes and neurological findings
  - Differences in vision and hearing
  - Differences in sinuses, airway, and breathing
  - Differences in the heart and the cardiac system

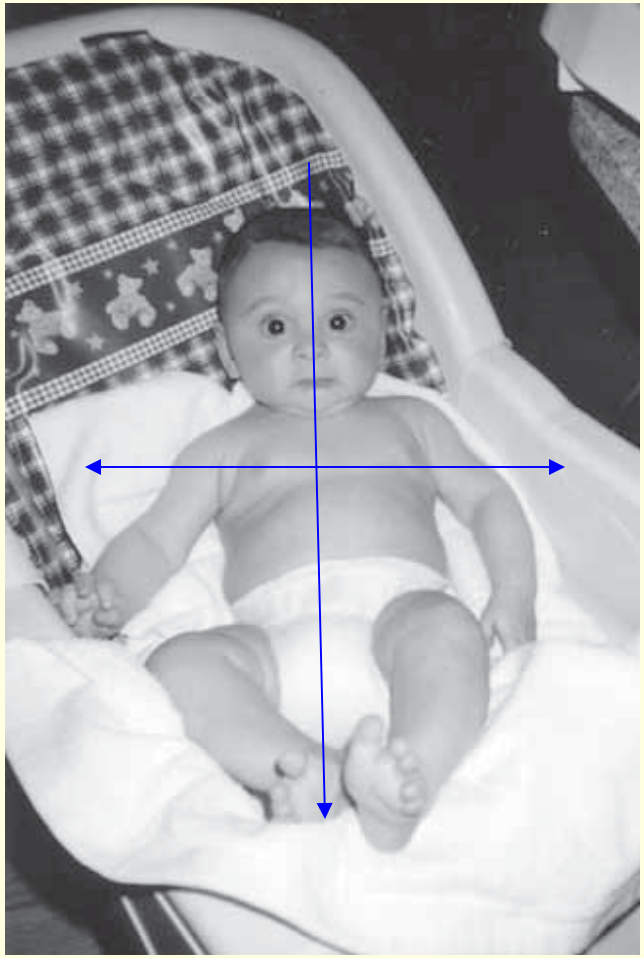
Objectives

- Differences in the abdomen
- Differences in muscle and bones
- Differences in spinal curvature
- Difference in the perception of pain

Pediatric versus Adult

Children are NOT short adults! Their bodies and the way they think are different, so their care is different. This section of the training points out the physical differences between adults and children. The next module explains children's psychosocial development. By learning these differences, you can effectively tailor your care to meet the child's and family's needs.

PATTERN OF GROWTH



Growth occurs

- from top to bottom (cephalocaudal) and
- from the center of the body outward (proximodistal).

Critical Thinking / Review

Q

What would an infant be able to do first:

reach for a toy, or

pick up a toy?

Critical Thinking / Review

A

Reach for a toy.
Growth and development proceed from the center outward, so large muscles (gross motor skills) like arms and legs are used before small muscles (fine motor skills) like fingers and toes.

CHANGES IN BODY PROPORTION DURING GROWTH

Changes in body proportions with age

- In early childhood the head is a major contributor to body height, while the lower limb makes a small contribution. At maturity, in contrast, the lower limbs make a larger contribution than the trunk or the head.
- Before puberty, the legs grow faster than the trunk. Because the onset of puberty is later in boys this pre-pubescent period of growth is longer in boys and is one of the reasons why young men are on average taller than young women.

Critical Thinking / Review

Q

Why do toddlers always seem to hit their head when they fall?

Critical Thinking / Review

A

Because growth proceeds from the top down, toddlers are “top-heavy” - their head is larger and heavier in proportion to the rest of their body than is an adult’s.

SKIN/THERMOREGULATION

Newborns have

- poorly developed subcutaneous fat (thinner skin),
- a relatively large body surface area, and an
- inability to shiver.

Therefore, newborns lose heat much faster than adults, and they are more likely to develop hypothermia.

Their skin is also less protective against burns.

SKIN/THERMOREGULATION

But newborns don’t have to be bundled up! Dress them the same as you or maybe with <u>one</u> additional layer of clothing, such as an undershirt.

Critical Thinking / Review

Q

You are taking care of a baby who requires continuous pulse oximetry.

What intervention should be part of your plan of care to protect the baby's skin?

Critical Thinking / Review

A

Change the site frequently. Babies can receive burns from pulse oximeters left in one place too long.

HYDRATION

- The body of a baby is about 78% water, compared to 65% at one year of age, and 55%-60% for adults.
- Skin turgor (pinching the skin to see how rapidly it returns to normal), rather than excessive sweating or dryness is a better indication of hydration in infants and children.

Critical Thinking / Review

Q

You are caring for a 6 month old who has watery diarrhea. You are most concerned about

_____.

Critical Thinking / Review

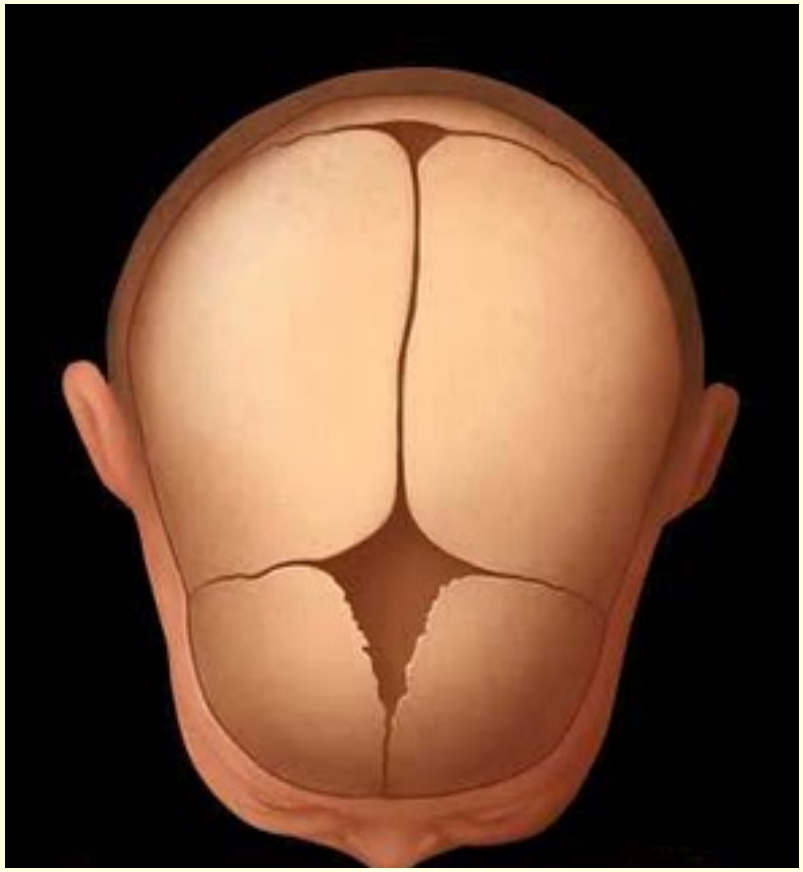
A

Dehydration. Compared to adults, babies' bodies are made up of more water. So loss of water has a bigger impact, making babies more susceptible to dehydration. Report the diarrhea, and offer extra fluids such as Pedialyte.

THE LYMPHATIC SYSTEM

- Lymph nodes are more easily felt in children, especially between the ages of 6-9. Then they regress to adult levels by puberty.
- The thymus gland in the neck continues to enlarge until puberty, then involutes becoming a rudimentary organ in the adult.
- Tonsils are normally much larger during early childhood than after puberty. An enlargement of the tonsils in children is not necessarily an indication of problems.

SKULL DEVELOPMENT



In infants, the skull bones are soft and separated. There are soft spots (fontanels) at the front and back of the head. The one at the back (posterior fontanel) usually closes by two months of age, and the one at the front (anterior fontanel) usually closes by two years of age. The rest of the skull begins to harden and close at about six years of age and is finished by adulthood.

FONTANELLES

- The fontanels (soft spots) are actually covered by very tough membranes, and aren't as fragile as many parents believe.
- It is normal for the anterior fontanel to bulge when a child is crying, coughing, or exerting some other type of pressure. But a persistently bulging fontanel may be a sign of hydrocephalus.

FONTANELS

- Above: Normal anterior fontanel
- Top right: persistently bulging anterior fontanel
- Bottom right: Baby with hydrocephalus and VP shunt visible

SKULL AND BRAIN DEVELOPMENT

- Until about age 4 years, the head is larger and heavier relative to the rest of the body.
- The developing brain, particularly to age 5 years, is more vulnerable to injury, infection, and poisons.
- The dura mater (outermost of the three protective layers of the brain, called meninges) is very firmly attached to the skull and is more apt to tear and bleed with injury.
- Brain growth continues until 12-15 years of age.
- Coordinated sucking and swallowing is a function of the cerebellum.

Critical Thinking / Review

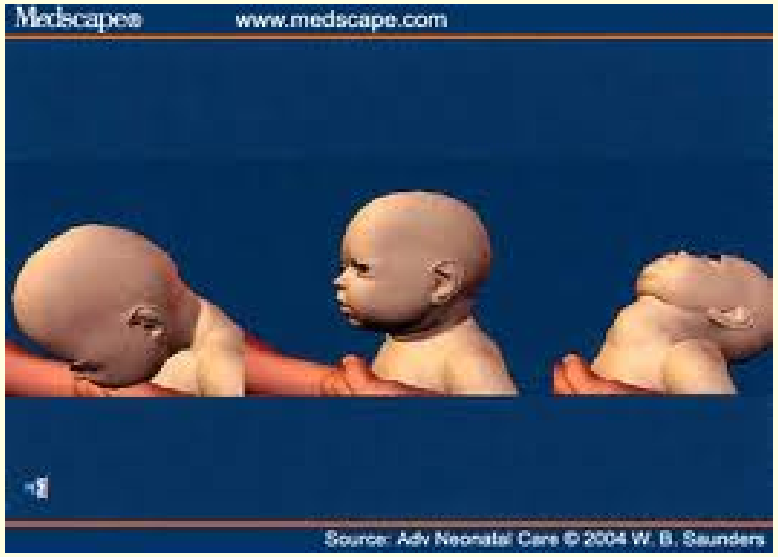
Q

The effects of this form of infant child abuse are a result of

- the infant's larger, heavier head
- The infant's softer brain (more water content), which is more susceptible to injury
- The infant's weaker neck muscles

Critical Thinking / Review

A



Shaken Baby Syndrome

When an infant is violently shaken, the brain bounces around inside the skull, causing bruising, swelling, and bleeding, and leading to permanent brain damage.

As you can see by this picture, shaken baby syndrome is caused by violent shaking, not by playful bouncing.

REFLEXES

Reflexes appear and disappear at various times throughout infancy.

reflex	what happens	appears	disappears
palmar	infant grasps your finger when it is placed in his/her hand	birth	by 3 months
plantar	big toe curls upward and others fan out when you stroke the sole of the foot	birth	by 8 months
moro	“startle” when head and trunk drops from semi-sitting to 30 degree angle	birth	by 6 months
stepping	infant appears to walk when the soles of the feet are allowed to touch the surface of the table	birth- 8 weeks	before voluntary walking
placing	when the side of the foot is touched to the table, the infant will flex the hips and the knees and lift the foot as is stepping up onto the table	4 days	varies
fencing	With the baby supine, turn the head to one side and the arm and leg on that side will extend while the arm and leg on the other side flex	2-3 months	by 6 months

NEUROLOGIC SOFT SIGNS

Soft signs are generalized functional neurological findings that often provide subtle clues to an underlying central nervous system deficit or a neurological maturation delay. Children with multiple soft signs are often found to have learning problems.

Neurologic Soft Signs

Soft Sign Finding	Latest Expected Age of Disappearance
Stiff-legged gait with foot-slapping quality, unusual posture of arms	3 years
Difficulty walking on heels and/or toes for a distance of 10 feet	7 years
difficulty walking heel-to-toe, unusual posturing of arms	7 years
Unable to stand on one foot longer than 5-10 secs	5 years
Unable to rhythmically hop on one foot	6 years
Difficulty standing with feet together, arms in front and eyes closed: arms drift, writhing movements of hands and fingers	3 years
Difficulty following objects with eyes when head still, nystagmus	5 years
Rapid touching thumb to fingers in sequence is uncoordinated, and child is unable to suppress mirror movements in other hand	8 years
Irregular speed and rhythm with alternate pronation and supination of hands on knees	10 years
Unable to alternately touch examiner's finger and own nose consecutively	7 years
Unable to identify right and left sides of own body	5 years
Difficulty in localizing and discriminating when touched in one or twp places	6 years
Unable to identify geometric shapes you draw in child's own hand	8 years
Unable to identify common objects placed in own hand	5 years

VISION

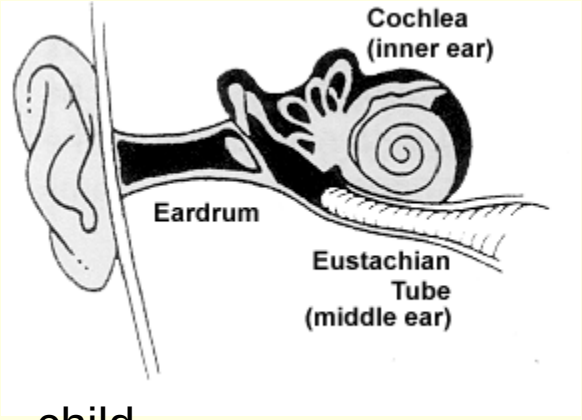
AGE	VISUAL ACUITY
3 yrs	20/50
4 yrs	20/40
5 yrs	20/30
6-8 yrs	20/20

a kindergarten eye chart

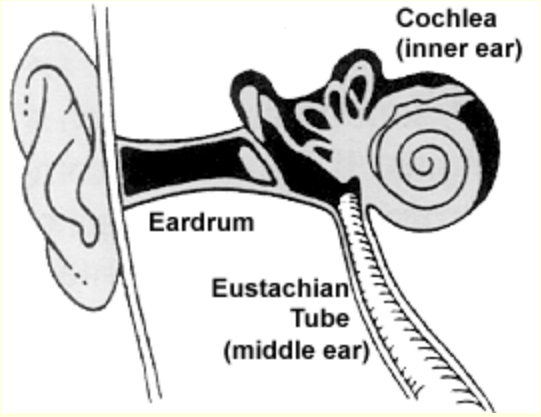
EARS

- The ear canal is shorter and curvier than an adult's.
- The Eustachian tube is wider, shorter, and straighter than an adult's.

  These differences allow easier back-flow of nasopharyngeal secretions into the ear, and therefore more ear infections.

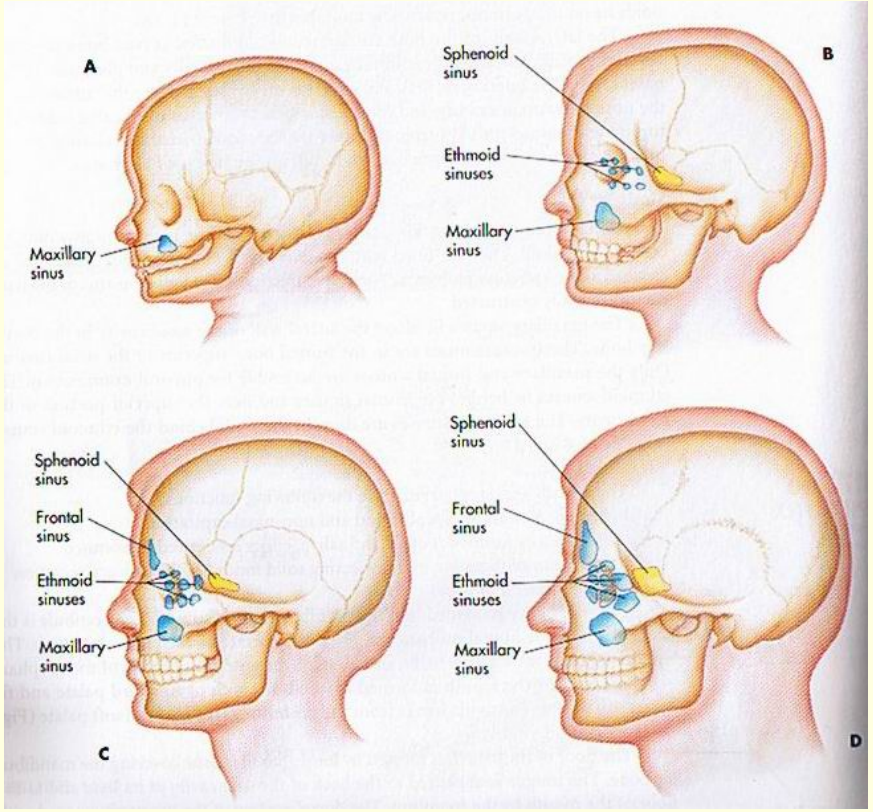


child



adult

SINUSES



- Sinuses are smaller in children
- The frontal sinuses (above/between the eyebrows) do not develop until 7 or 8 years of age.

AIRWAY AND BREATHING

- Newborns are obligatory nose breathers for the first few months.
- The pattern of a newborn's breathing will vary with room temperature, feeding, and sleep.
- Periodic breathing, a sequence of relatively vigorous breaths followed by 10-15 seconds of not breathing, is common in premature babies and should disappear at about the time the baby reaches full-term age.
- Infants breathe with their abdominal muscles rather than their chest muscles. By age 6 or 7, they start using their chest (intercostal) muscles.

Critical Thinking / Review

Q

Why are orogastric instead of nasogastic tubes used in preemies and newborn babies?

Critical Thinking / Review

A

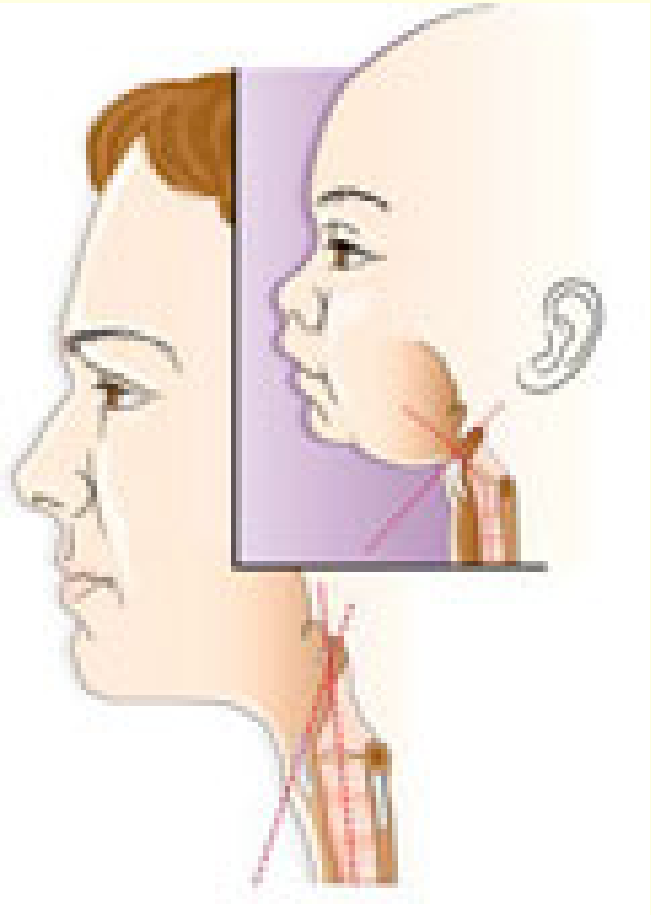
Because babies this age can only breathe through their nose, it is preferable to not use a tube that will block one of the nasal passages.

AIRWAY AND BREATHING, CONT'D.

- Nasal passages are relatively smaller and more easily obstructed with discharge or foreign bodies.
- The tongue is relatively larger and more easily able to obstruct the upper airway.
- The trachea is relatively much narrower and shorter and its cartilage more elastic and collapsible, thus it is more vulnerable to swelling, pressure, and inflammation, and hyperextension or flexion can "crimp" and obstruct it.

AIRWAY AND BREATHING, CONT'D.

- The larynx is higher and more forward, and thus more 'available' for aspiration.
- The position of the larynx also makes direct visualization of the cords during intubation more difficult. Use cricoid pressure.



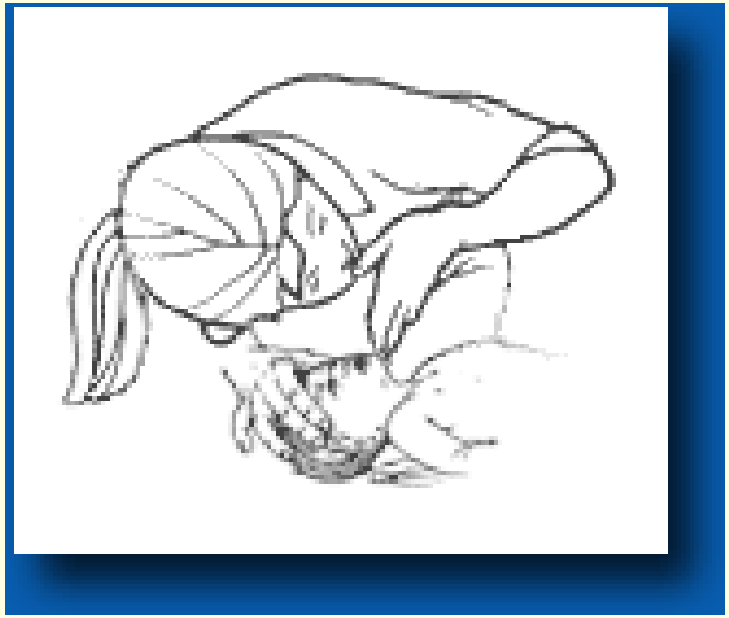
AIRWAY AND BREATHING, CONT'D.

- In some children less than 8 years of age, the cricoid cartilage provides a natural seal for an endotracheal tube, making cuffed trachs unnecessary and possibly damaging. Cuffed trachs may be seen in some patients per the recommendation of their pulmonologist.

Critical Thinking / Review

Q

Why is the “sniffing” position used for infant CPR?



Critical Thinking / Review

A

Because hyperextending the neck like you would for an adult will crimp the trachea and obstruct airflow.

AIRWAY AND BREATHING, CONT'D.

- The rib cage is more elastic and flexible, less vulnerable to injury, and more apt to allow retractions during periods of respiratory distress.
- Lung tissue is more fragile and more easily contused (bruised).
- A higher metabolic rate and greater oxygen requirement increase vulnerability to hypoxemia (low levels of oxygen in the blood).

AIRWAY AND BREATHING, CONT'D.

intercostal retractions

AIRWAY AND BREATHING, CONT'D.

AGE	BREATHS PER MINUTE
Newborn	30-80
1 year	20-40
3 years	20-30
6 years	16-22
10 years	16-20
17 years	12-20

CHEST

- An infant's chest is round and about the same circumference as the head until about two years of age, then they start growing toward adult proportions.
- The chest wall of infants and young children is thinner, so that the bones are more prominent and heart sounds and lung sounds are louder and harsher.

HEART AND CIRCULATION

- In infants and children, the heart lies more horizontally in the chest and the apex of the heart is higher. The adult heart position is usually reached by 7 years of age.
- Infants and children have a relatively smaller total circulating blood volume, but will lose as much blood as an adult from a similar laceration.
- When a significant loss of blood or fluid volume is lost, children maintain their blood pressure longer than adults do.
- An early sign of shock is tachycardia.
- Bradycardia is usually the result of hypoxia, and may herald cardiac arrest.

HEART AND CIRCULATION, CONT'D.

- Children may have sinus arrhythmia, in which the heart rate is faster during inspiration and slower during expiration. This is not a cause for concern.
- The heart is also very close to the chest wall, so it is easy to detect 'innocent' or 'functional' heart murmurs caused by the sound of the blood rushing through the heart.

HEART AND CIRCULATION, CONT'D.

AGE	RATE
Newborn	120-170
1 year	80-160
3 years	80-120
6 years	75-115
10 years	70-110

Infants' heart rates are more variable than those of older children; they can vary with eating, sleeping, waking, and stress of any sort (exercise, fever, tension).

HEART AND CIRCULATION, CONT'D.

- Blood pressure is lower in children; at one year of age it is typically 94-104/50-56, and gradually increases until adult values are reached.
- For children greater than 1 year of age: the expected systolic blood pressure (top number) is 80 + (2 X the child's age in years)

HEART AND CIRCULATION, CONT'D.

- Cyanosis of the hands and feet (acrocyanosis) is common in newborns in cool environments.

ABDOMEN

An infant's abdomen should be rounded and dome shaped because the musculature is not fully developed.

Toddlers have a 'pot-bellied' appearance.

After age 5, the abdomen is more convex.

ABDOMEN, CONT'D.

- The liver and spleen are relatively larger and have a larger blood supply; thus they are less protected by the ribs and more susceptible to injury.

MUSCLES AND BONES

- Ligaments (tissue connecting bones to bones, serving to support and strengthen joints) are stronger than bones until adolescence; therefore injuries to long bones and joints are more likely to result in fractures than in sprains.
- Rapid growth during adolescence results in decreased strength in the ends of the long bones, as well as general decreased strength and flexibility, leading to greater potential for injury.

MUSCLES AND BONES, CONT'D.

- Genu valgum (knock-knees) is common until 18 months of age
- All babies are flat-footed. The arch should be visible when the child is not bearing weight by 3 years of age.

SPINE

- A convex curvature to the spine will be apparent when a baby is in the sitting position until the baby is able to sit without support.
- Toddlers normally have an exaggerated lumbar curve.
- Adolescents may have slight kyphosis (convex curvature of upper spine).

PAIN

- An infant is able to feel pain anywhere in the body, but cannot localize or isolate it.
- Signs of pain: shallow breathing, irritable crying, splinting, facial expression change when touched or moved, resists movement, rigid posturing

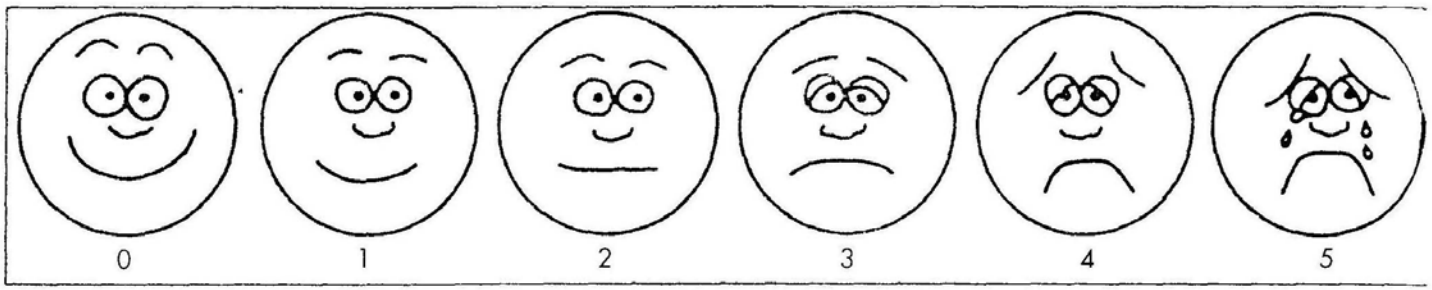
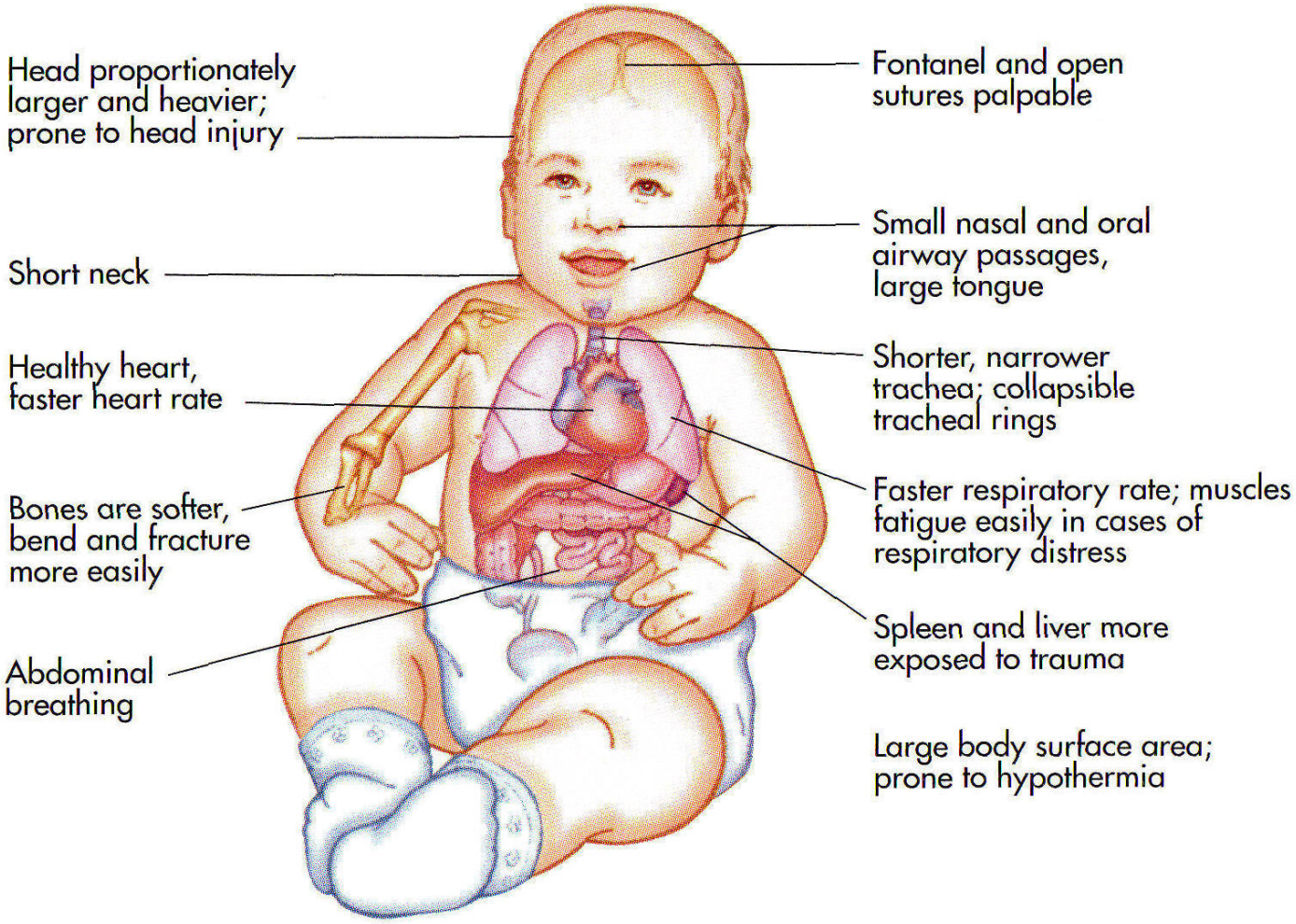


FIGURE A-5

Wong/Baker Faces Rating Scale. Explain to the patient that each face is for a person who feels happy because he has no pain (hurt) or sad because he has some or a lot of pain. **Face 0** is very happy because the person doesn't hurt at all. **Face 1** hurts just a little bit. **Face 2** hurts a little more. **Face 3** hurts a little more. **Face 4** hurts a whole lot. **Face 5** hurts as much as you can imagine, although you don't have to be crying to feel this bad. Ask the patient to choose the face that best describes how he or she is feeling. *Recommended for persons 3 years and older.*

Originally published by Whaley L and Wong D: *Nursing care of infants and children*, ed 3, 1987, Mosby. Reprinted by permission. Research reported in Wong D and Backer C: Pain in children: comparison of assessment scales, *Pediatric Nursing* 14(1):9-17, 1988.

SUMMARY


Head proportionately larger and heavier; prone to head injury
Short neck
Healthy heart, faster heart rate
Bones are softer, bend and fracture more easily
Abdominal breathing
Fontanel and open sutures palpable
Small nasal and oral airway passages, large tongue
Shorter, narrower trachea; collapsible tracheal rings
Faster respiratory rate; muscles fatigue easily in cases of respiratory distress
Spleen and liver more exposed to trauma
Large body surface area; prone to hypothermia