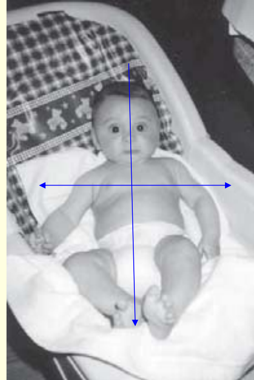
SECTION 18

NORMAL PEDIATRIC GROWTH AND DEVELOPMENT

Learning Objectives

1. Identify ways in which children are different from adults.
2. Identify major developmental milestones in the areas of language, mobility, and self-care.
3. Develop a plan of care for a child based on medical needs rather than age-appropriate needs.

PATTERN OF GROWTH



Growth occurs

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

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This pattern of growth explains why children are “top-heavy” (have relatively larger heads) and why gross motor skills develop before fine motor skills (infants can move their entire arm toward a toy before they can manipulate their fingers enough to be able to pick it up.)

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.

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.

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However, newborns do not have to be 'bundled up'. Newborns can be dressed the same as an adult or with one additional layer of clothing.

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.

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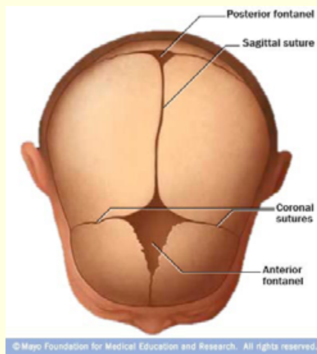
Infants and toddlers are more susceptible to dehydration because so much of their body is made up of water; a loss has a bigger impact.

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



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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.

The fontanels (soft spots) are actually covered by very tough membranes, and aren't as fragile as many parents believe.

A persistent bulging of the anterior fontanel may be a sign of hydrocephalus.

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.

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	toes curl downward when you touch the bottom of the foot near the toes	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.

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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

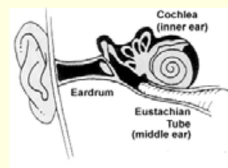
AGE	VISUAL ACUITY
3 yrs	20/50
4 yrs	20/40
5 yrs	20/30
6-8 yrs	20/20

a kindergarten eye chart

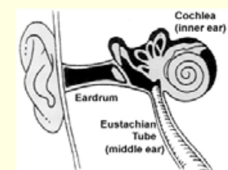
EARS

- 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

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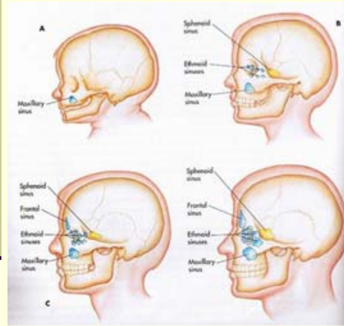
SINUSES



- 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.

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Newborns are obligatory nose breathers, so

suction the nose frequently, and

use an OG tube, not an NG tube

because obstruction of the nasal passages can cause significant respiratory distress.

Because infants do not normally use their chest muscles for breathing, retractions (a 'sinking in' between the ribs during breathing) are a sign of respiratory distress. Anything that obstructs the diaphragm can lead to respiratory failure – decompress the stomach and maintain the patient in an upright position.

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.
- The larynx is higher and more forward, and thus more ‘available’ for aspiration.

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In children less than 8 years of age, the cricoid cartilage provides a natural seal for an endotracheal tube. Cuffed trachs are unnecessary, and may cause airway damage.

The possibility of the trachea ‘crimping’ and obstructing with hyperextension or hyperflexion is why we use the ‘sniffing position’ for infant CPR.

The position of the larynx also makes direct visualization of the cords during intubation more difficult. Use cricoid pressure.

AIRWAY AND BREATHING, CONT'D.

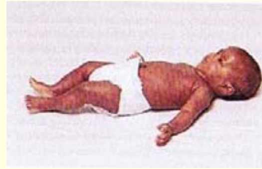
- The rib cage is more elastic and flexible, less vulnerable to injury, and more apt to allow retractions during periods of respiratory distress.
- Lung tissue is more fragile and more easily contused (bruised).
- A higher metabolic rate and greater oxygen requirement increase vulnerability to hypoxemia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

For a patient in respiratory distress, deliver the highest possible concentration of oxygen.

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).

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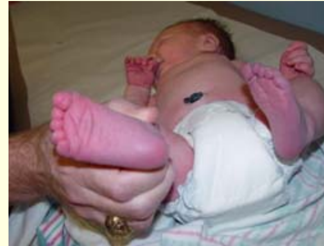
HEART AND CIRCULATION, CONT'D.

- 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.

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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.

NORMAL PEDIATRIC DEVELOPMENTAL MILESTONES					
AGE	LANGUAGE	MOVEMENT	EATING	TOILETING	BATHING/DRESSING/ GROOMING
birth	cries	kicks legs, thrashes arms			
1 mo	cries in a special way when hungry, responds to voices.	raises head and chest when lying on stomach			
2 mo	makes sounds – ah, eh, ugh, smiles	holds heads steady when held sitting	reacts to sight of bottle or breast		
3 mo		makes crawling movements	one hand on bottle while feeding		
4 mo	squeals, ah-goo, laughs	holds own hands together			
5 mo	makes 'raspberry' sound	rolls over stomach to back			
6 mo	babbles, responds to name	rolls over back to stomach			
7 mo	da, ba, ga, ka, ma	sits without support			
8 mo	ma-ma, da-da, ba-ba	crawls	feeds self cracker or cookie		
9 mo	imitates speech sounds you make	pulls self to standing	both hands to hold bottle		
10 mo	understands single words like bye-bye, nite-nite	sidesteps around furniture while holding on			
11 mo	uses mama and dada specifically for parent	stands alone well	picks up spoon by handle		
12 mo	says one word clearly	climbs up on chairs or other furniture, walks with one hand held	transition to 'sippy cup' and milk instead of formula		cooperates with dressing, removes socks, holds foot out for shoe, holds arm out for sleeve, pushes arms and legs through shirts and pants

NORMAL PEDIATRIC DEVELOPMENTAL MILESTONES, CONTINUED					
3 ½ y	combines sentences using ‘and’, ‘or’, or ‘but’	hops on one foot without support, cuts across paper with small scissors			Washes face without help
4y	vocabulary 1500 words or more; speaks in 6-8 word sentences; may continue with lisping, stuttering, and sound substitutions as above	climbs well, hops on one foot	holds utensils like an adult, makes own bowl of cereal	toilets independently, night time bedwetting still common	brushes teeth with supervision only; washes hands unassisted; removes T shirt independently, uses buckles, zippers, and laes, knows front and back of clothing, puts on shoes with little assistance
4 ½ y	reads a few letters	skips, broad jumps			
5 y	speaks fluently; may lisp; may stutter; may substitute f for th and w for r , l, or y ; may mispronounce 3-4 syllable words	swings, pumps self prints first name		20% of five years old still have night-time bedwetting	dresses and undresses alone except some help with buttons/zippers/shoelaces, wants to bathe on their own but still needs assist washing body and hair
6y	can spell some simple words; may still mispronounce some 3-4 syllable words; may still substitute w for r and f for th; may still lisp; stutters only when emotional	somersaults	may start using knife to cut soft foods or spread butter	night time bedwetting still common, untreated until age 8	Buttons back buttons; ties shoes;
8y					selects clothes appropriate for weather

NORMAL PEDIATRIC DEVELOPMENTAL MILESTONES, CONTINUED					
15 mo	says 2 words besides mama and dada., makes sounds in sequences that sound like sentences, points	walks without help, crawls up stairs	feeds self with a spoon		
18 mo	uses 5-10 words as names of things, follows a few simple instructions	runs stiffly	eats with a fork, drinks from cup using two hands		helps brush teeth
2 y	2-3 word sentences; beginning to understand rules of grammar – “runned”, “mouses”; receptive skills exceed expressive skills	runs well		may be ready for toilet training	removes unfastened coat, removes shoes if laces untied, finds armholes in shirt and helps push garment down
2 ½ y	Refers to self as “I” Knows full name	goes up stairs alternating feet			removes pull-down garment with elastic waist, tries to put on socks, puts on front-button type shirt, unbuttons one large button
3 y	300-500 word vocabulary; speech mostly understandable to strangers; may lisp; may stutter; may substitute w for r, d for th, and t for k	stands on one foot momentarily, rides tricycle	one handed cup holding, drinks from open cup without spilling	uses toilet often, needs help with wiping after bowel movement, stays dry during the day but occasionally wets bed at night	washes hands assisted, unbuttons clothing, buttons large front buttons, puts on shoes – may be wrong feet, does not tie; puts on and takes off t-shirt with assistance, zips and unzips without separating or inserting shank

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

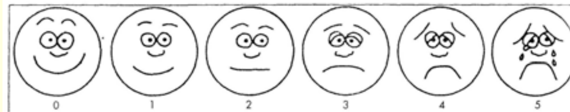
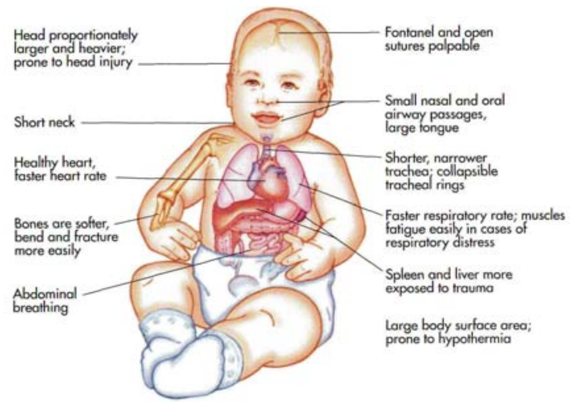


FIGURE A-5
Wong/Baker Faces Rating Scale. Explain to the patient that each face is for a person who feels happy because he has *no* pain (hurt) or sad because he has some or a lot of pain. **Face 0** is very happy because the person doesn't hurt at all. **Face 1** hurts just a little bit. **Face 2** 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



REVIEW QUESTIONS

Please make sure you can answer the following questions before proceeding to the next section.

1. The normal visual acuity of a pre-schooler is _____________ than that of a normal adult.
   A. better
   B. worse
   C. the same

2. True or False: Newborns can <u>NOT</u> breathe through their mouths.

3. Infants breathe with their
   A. abdominal muscles
   B. chest muscles

4. A child's larynx is higher and more anterior than an adult's, making children at higher risk for ____________________.

5. Heart rates and respiratory rates of infants are
   A. very stable
   B. variable

6. True or False: Infants cannot feel pain.

7. True or False: A five-year-old should be able to bathe themselves with supervision only.

8. True or False: Night time incontinence can be a normal developmental occurrence at six years of age.

REVIEW ANSWERS

1. Worse. 20/20 vision does not develop until 6-8 years of age.

2. True. Newborns can only breathe through their nose, making them have more difficulty with nasal congestion, or nasogastric tubes.

3. A. abdominal muscles. Use of chest muscles before the age of 6 or 7 is a sign of respiratory distress.

4. Aspiration

5. B. variable. Rates are affected by room temperature, feeding, sleeping, waking, and stressors such as fever.

6. False. Infants can feel pain; they just can not localize it.

7. False. A 5-year-old still needs hands-on assist with bathing.

8. True. Nighttime incontinence is relatively common because the bladder grows at a smaller rate compared to the other organs.