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Advanced Pediatric Assessment

ELLEN M. CHIOCCA

Third Edition

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Once again, I dedicate this book to
my daughter, Isabella, my heart and soul,
my husband, Ralph Zarumba, the great love of my life,
and to my brother, J. Paul Chiocca.
Thank you.

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UNIT III. ASSESSMENT OF CHILD MENTAL HEALTH AND WELFARE

UNIT IV. SYNTHESIZING THE COMPONENTS OF THE PEDIATRIC HEALTH ASSESSMENT

Preface

Pediatric healthcare experts agree that the healthcare needs of children are vastly different from those of adults. From infancy through adolescence, a child experiences many dramatic anatomical, physiologic, psychosocial, developmental, and cognitive changes. Thus, it is critical for the pediatric healthcare provider to possess specialized knowledge and skills to accurately assess children during health and illness. Concepts related to the health assessment and physical examination of adults cannot be universally applied to the care of children; children are not simply little adults.

The goal of the revised and updated third edition of *Advanced Pediatric Assessment* continues to emphasize the unique health needs of children when conducting a health assessment and to show that, depending on the child's age and developmental stage, the approach to obtaining the history and physical assessment can vary dramatically. Because this book focuses only on infants, children, and adolescents, the physical, psychosocial, developmental, and cultural aspects of child assessment can be addressed in greater detail than is possible in across-the-life-span textbooks. Consequently, this book has a dual focus: to serve not only as a course textbook in advanced practice nursing programs, but also as a reference for practicing pediatric healthcare providers.

The third edition of *Advanced Pediatric Assessment* continues to be divided into four units. Unit I: The Foundations of Child Health Assessment comprises five chapters that provide readers with the foundational approach to health assessment of the pediatric patient. Chapter 1 begins with a general overview of the anatomic and physiologic differences among infants, children, and adolescents, and continues with a brief survey of growth and development, a discussion of the communication skills required to work with children, a focus on the parent–child relationship, and general strategies for obtaining the child health history and performing the physical examination. Chapter 2 provides a detailed overview of the general principles of growth and development, including a discussion of selected developmental theorists. Both physical and psychosocial growth and development are discussed, including gross and fine motor, language, psychosocial, and cognitive development. Detailed tables list normal growth and developmental milestones from birth through adolescence, as well as developmental red flags and selected developmental screening tools. Chapters 3 through 5, which are devoted to communication with children, family assessment, and cultural assessment of children and families, complete the unit.

Unit II: The Pediatric History and Physical Examination focuses on obtaining subjective and objective data specific to the child health examination. Chapter 6 is devoted to the pediatric health history and Chapter 7 to assessing the safety of the child's environment. Chapter 8 details the specifics of the pediatric physical examination, including assessment techniques; developmental approaches to examining infants, children, and adolescents; and sequencing of the physical examination according to age and developmental level. Chapter 9 focuses on the well-child examination, and Chapter 10 on assessment of nutritional status in the pediatric patient. Chapter 11 is devoted to an in-depth discussion of assessment of the neonate.

The remaining 11 chapters in Unit II focus on physical assessment by body system. Each chapter is organized as follows:

- Anatomy and Physiology
- Developmental Considerations
- Cultural, Ethnic, and Racial Considerations
- Health History
- Physical Examination
- Common Diagnostic Studies
- Documentation of Findings

It is hoped that this uniform presentation of content will help the reader to think in a systematic and organized manner.

Unit III: Assessment of Child Mental Health and Welfare includes two chapters focusing on psychosocial issues. Chapter 23 surveys mental disorders in children, including screening for addiction, depression, and suicidal ideation. Chapter 24 specifically addresses various types of child abuse and neglect, and peer victimization.

Unit IV: Synthesizing the Components of the Pediatric Health Assessment also contains two chapters. Chapter 25, "The Complete History and Physical Examination: From Start to Finish" is devoted to integrating the knowledge gained from all previous chapters in the text, and using this knowledge in an organized manner to conduct a full, age-appropriate, head-to-toe pediatric health examination. Chapter 26, "Formulating a Differential Diagnosis" is new to the third edition and is aimed at describing the clinical reasoning process for the pediatric healthcare provider.

Child healthcare is both complicated and challenging, but every child deserves the safest, most comprehensive, culturally sensitive healthcare possible. It is my sincere hope that *Advanced Pediatric Assessment, Third Edition,* will assist both students and practicing pediatric healthcare providers to achieve this goal.

ACKNOWLEDGMENTS

It was both an honor and privilege to write the third edition of my book for Springer Publishing Company. Thank you once again to the wonderful Elizabeth Nieginski, Publisher, who has always been so supportive of this book, and to me personally.

I would also like to acknowledge my daughter, Bella, and my husband, Ralph, for their patience as I completed this project once again. *Ti amo tanto tanto.*

Ellen M. Chiocca, PhD, CPNP, RNC-NIC

UNIT I

THE FOUNDATIONS OF CHILD HEALTH ASSESSMENT

CHAPTER 1

Child Health Assessment: An Overview

CHAPTER OUTLINE

- Overview of Pediatric Health Variations
  - Anatomic and Physiologic Differences in Infants and Children
  - Growth and Development
- Communication Skills Required to Work With Children
- Obtaining the Pediatric Health History
- The Pediatric Physical Examination
- Understanding the Caregiver–Child Relationship
- Role of the Pediatric Healthcare Provider

OVERVIEW OF PEDIATRIC HEALTH VARIATIONS

Children experience dramatic changes in their bodies and minds, beginning at birth and continuing through adolescence. Because of these anatomic, physiologic, and developmental changes, it is crucial for the pediatric healthcare provider to possess specialized knowledge and skills to accurately assess infants, children, and adolescents during health and illness. Concepts related to health assessment and physical examination of the adult patient cannot be applied to children; they are *not* simply little adults. In order for the healthcare of children to be safe, thorough, and developmentally appropriate, the pediatric healthcare provider must ensure that child health assessment is based on a thorough knowledge of pediatric anatomy and physiology, pathophysiology, pharmacology, and child development. The child's social situation, the community in which he or she lives, and the family's culture are other important components that should be included. In addition, when working with children of different ages and developmental levels, effective, developmentally appropriate communication skills are essential. These skills are used to build rapport with children, their families, or caregivers, as well as to provide clear and objective documentation of assessment findings.

Anatomic and Physiologic Differences in Infants and Children

To recognize abnormalities found during the physical examination, the pediatric healthcare provider must have strong knowledge of the anatomic and physiologic differences among infants, children, and adults. Because each body system is immature until at least age 2 years, the provider must adjust expectations for physical findings according to the child's age. In addition, an infant or young child's physical condition can go from stable to life-threatening very quickly because of immature body systems that lack fully developed feedback mechanisms. This helps to explain both the varied physiologic responses seen in infants and children, and why infants and young children absorb, distribute, metabolize, and excrete drugs very differently than do adults. These factors affect the frequency, timing, and length of pediatric healthcare visits. Table 1.1 presents an overview of the major anatomic, physiologic, metabolic, and immunologic differences among infants, children, and adults and the corresponding clinical implications of these differences.

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Skin	Thin stratum corneum	Infants; toddlers until approximately age 2–3 years, when skin becomes thicker because of daily friction and pressure	Blood vessels are visible through newborn's skin, causing ruddy appearance; increased absorption of topical drugs; skin burns easily; prone to hypothermia and dehydration
	Thin layer of subcutaneous fat	Neonates	Affects temperature control
	Epidermis is more loosely bound to dermis (Ball, Bindler, Cowen, & Shaw, 2017)	Infants; children through early school age	Skin layers separate readily, causing easy blistering (e.g., adhesive tape removal); susceptible to superficial bacterial skin infections and more likely to have associated systemic symptoms with some skin infections; skin is a poor barrier, contributing to fluid loss
	Sebaceous glands are active in neonate because of maternal androgen levels (Hockenberry, Wilson, & Rodgers, 2019) and again at puberty because of hormonal changes (Ball et al., 2017)	Neonates; adolescents	Milia develop in neonates; acne develops in adolescents
	Eccrine glands are functional at birth; full function does not occur until age 2–3 years (Blackburn, 2018)	Infants; toddlers until preschool age	Palmar sweating occurs; helps to assess pain in neonate
	Apocrine glands are nonfunctional until puberty (Blackburn, 2018)	Adolescents	Function of apocrine glands at puberty causes body odor
	Production of melanin reaches adult levels by adolescence (Ball et al., 2017)	Infants; children until adolescence	Affects assessment of skin color as child ages
	Greater body surface area	Infants; toddlers until age 2 years	Increases exposure to topically applied drugs; may result in toxicity in some instances
Head and neck	Head is proportionately larger than other body structures because of cephalocaudal development. Head circumference exceeds chest circumference from birth to age 2 years	Infants; toddlers until age 2 years	Larger, heavier head increases potential for injury during falls or collisions when body is thrown forward, resulting in a high incidence of head trauma in this age group

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Head and neck (*cont.*)	Cranial sutures are not fully fused at birth to accommodate brain growth	Infants: Posterior fontanelle should be closed by 2 months; anterior fontanelle should be closed by 12–18 months	Full anterior fontanelle can indicate increased intracranial pressure; sunken anterior fontanelle can indicate dehydration
	Short neck and prominent occiput (Bissonnette et al., 2011). Neck lengthens at age 3–4 years (Hockenberry et al., 2019)	Infants; children until age 3–4 years	Increased potential for injury in infants and toddlers; airway structures are closer together; affects intubation technique in children younger than preschool age
Eyes	Eye structure and function are immature at birth; pupils are small with poor reflexes until about 5 months of age; transient nystagmus and esotropia are common in neonates younger than 6 months of age (Ball et al., 2017); irises have little pigment until 6–12 months of age (Hockenberry et al., 2019)	Neonates; infants	Affects expected findings in physical examination
	Vision is undeveloped at birth; by age 4 months, infants can fixate on an image with both eyes simultaneously; ability to distinguish color begins by age 8 months; children are farsighted until about age 6–7 years (Ball et al., 2017)	Infants; children until school age	Affects expected findings in and approach to physical examination and vision screening
Ears	Newborns can hear loud sounds at 90 dB (Hockenberry et al., 2019)	Neonates	Newborns react to loud sounds with startle reflex; they react to low-frequency sounds by quieting; differences affect techniques for hearing assessment
	Short, wide eustachian tube, lying in horizontal plane	Infants; toddlers until approximately age 2 years	Fluid in middle ear cannot easily drain into pharynx; prone to middle ear infections and effusions
	External auditory canal is short and straight with upward curve	Infants; toddlers until age 3 years	Pinna should be pulled down and back to perform otoscopic examination
	External auditory canal shortens and straightens as child grows	Preschoolers aged 3 years and older	Pinna should be pulled up and back to perform otoscopic examination

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Mouth, nose, throat, and sinuses	Saliva is minimal at birth; increases by age 3 months; salivary secretions increase after age 3 months (Hockenberry et al., 2019)	Infants	Increased aspiration risk; presence of drooling does not signify teething
	Deciduous teeth should erupt between ages 6 and 24 months	Infants; toddlers	Delay may signify hypothyroidism or poor nutrition
	Obligate nose breathers	Neonates; infants until age 4–5 months	Nasal passages are easily obstructed by secretions; affects airway patency and ability to feed
	Airway and nasal passages are small and narrow; larynx is narrowest at level of cricoid cartilage (subglottis; Bissonnette et al., 2011); 1 mm of edema can narrow an infant's airway by 60% (Bissonnette et al., 2011)	Infants; children through age 5 years (Bissonnette et al., 2011)	Increased potential for airway obstruction and infection; endotracheal intubation difficult, and accidental extubation more likely with movement (Bissonnette et al., 2011)
	Large tongue in proportion to mouth size (Bissonnette et al., 2011)	Infants; children until age 8–12 years when mandible has a growth peak	Potential for airway obstruction is greater
	Proportionately large soft palate and large amount of soft tissue in the airway	Infants; children until approximately age 11–12 years (Bissonnette et al., 2011)	Any soft tissue swelling increases the risk of airway obstruction
	Ability to coordinate swallowing and breathing is immature (Bissonnette et al., 2011)	Neonates; infants until age 4–5 months	Increased risk of aspiration and GER (Bissonnette et al., 2011)
	Proportionately large, floppy, and long epiglottis (Bissonnette et al., 2011)	Infants; children through school age	Increased potential for airway obstruction with swelling; endotracheal intubation difficult
	Maxillary and ethmoid sinuses are the first to develop; both are present at birth (American Academy of Pediatrics [AAP], 2001)	Infants; toddlers until age 3 years	Often early sites of infection (AAP, 2001)
	Sphenoid sinuses become visible on radiograph at roughly 5 years of age, and frontal sinuses at 7–8 years of age (AAP, 2001)	School-aged children; adolescents	Clinical findings of acute sinusitis similar to viral upper respiratory infection (Wald, 2018); judicious use of antibiotics essential; imaging tests not done in uncomplicated cases (Centers for Disease Control and Prevention [CDC], 2017)

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Thorax and lungs	Hypoxic and hypercapnic drives are not fully developed (Bissonnette et al., 2011)	Neonates; infants until age 3 months	Periodic breathing (i.e., apnea ≤ 10 seconds) without cyanosis or bradycardia is within normal limits because of neurologic immaturity of respiratory drive. Central apnea lasts longer than 20 seconds and is outside normal limits
	Chest circumference should closely match head circumference from age 6 months to 2 years; chest circumference should exceed head circumference at age 2 years (Hockenberry et al., 2019)	Infants; toddlers	Assists provider in assessing normal growth
	Easily compressible cartilage of chest wall (Bissonnette et al., 2011) with very little musculature	Infants; toddlers until age 2 years	Limits tidal volume; lowers functional residual capacity; rib cage is flexible and provides little support for lungs; negative intrathoracic pressure is poorly maintained, causing increased work of breathing (Bissonnette et al., 2011); soft thoracic cage collapses more easily during labored breathing
	Rounded thorax in infancy; ribs lie in horizontal plane; xiphoid process is moveable (Bissonnette et al., 2011)	Infants; toddlers until age 3 years	Limits tidal volume (Bissonnette et al., 2011); ribs are flexible and provide very little support for lungs; negative intrathoracic pressure is poorly maintained, causing increased work of breathing
	Alveoli are thick walled at birth; infants have only 10% of the total number of alveoli found in the adult lung; over the child's first 8 years of life, alveoli increase in number and size (Bissonnette et al., 2011)	Infants; children through age 8 years	Affects gas exchange; oxygen consumption in neonates is almost twice that in adults (Bissonnette et al., 2011); accounts for increased respiratory rate; children with pulmonary damage or disease at birth can regenerate new pulmonary tissue and may have normal pulmonary function; contributes to high number of respiratory diagnoses when infant or child is acutely ill; respiratory failure is common in premature infants because of surfactant deficiency, causing alveolar collapse (Bissonnette et al., 2011)
	Smaller lung volume; tidal volume is proportional to child's weight (7–10 mL/kg; Ball et al., 2017)	Infants; children until age 10 years	High respiratory rate, which decreases to adult value by adolescence

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Thorax and lungs (*cont.*)	Newborns produce little respiratory mucus (Bissonnette et al., 2011)	Neonates	Increased susceptibility to respiratory infections
	Mucous membranes lining the respiratory tract are loosely attached and very vascular	Infants; toddlers	Potential for airway edema is greater, causing potential airway obstruction; more respiratory secretions are produced, increasing the potential for obstruction or aspiration
	Larynx is located 2–3 cervical vertebrae higher than in adults at level of C3–C4 (Bissonnette et al., 2011)	Infants; children until approximately age 8–10 years	Child is vulnerable to aspiration
	Proportionately small and narrow oropharynx; trachea is proportionately shorter and has a small diameter (Ball et al., 2017); tracheal cartilage is elastic and collapses easily; the trachea continues to grow in diameter until age 5 years (Ball et al., 2017) and triples in size between birth and puberty	Infants; children until adolescence	Great potential for airway obstruction, mucus, and foreign body; resistance to airflow; air is warmed and humidified much less effectively
	Right bronchus is significantly shorter, wider, and more vertical than left (Patwa & Shaw, 2015); child's trachea bifurcates at higher level than adult's (Ball et al., 2017)	Children beginning at age 2 years	Breath sounds are loud and high in pitch; easily heard through thin chest wall; inhaled foreign bodies are easily aspirated into right bronchus
	Tracheobronchial tree has large amount of anatomic dead space where gas exchange does not take place (Bissonnette et al., 2011)	Infants; children through school age	Fast respiratory rate is needed to meet oxygen requirements; child is at risk for respiratory acidosis if lungs cannot remove carbon dioxide (CO_2) quickly enough
	Infants and children breathe using diaphragm and abdominal muscles	Infants; children until age 6 years (Ball et al., 2017)	Respirations may be inefficient when crying or with anything that restricts breathing, such as abdominal distension; child may retain CO_2 as a result, causing acidosis
	Breathing becomes thoracic as in the adult	Children aged 8–10 years	Respiratory rate decreases to near adult levels

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Thorax and lungs (*cont.*)	Intercostal, scalene, sternocleidomastoid, and diaphragmatic muscles have few type I muscle fibers, which are used in sustained respiratory activity (Bissonnette et al., 2011)	Infants; toddlers until approximately age 2 years (Bissonnette et al., 2011)	Immature respiratory muscles must work hard to assist in respiratory effort; nasal flaring may occur; poorly developed respiratory muscles hinder expulsion of thick respiratory secretions; muscles are easily fatigued, which can lead to CO_2 retention, apnea, and respiratory failure
Heart and vasculature	With first breath at birth, pulmonary vascular resistance falls	Neonates	Increased pulmonary blood flow; low systemic blood pressure (BP)
	Left atrial pressure is greater than right atrial pressure	Neonates	Foramen ovale closes within first hour of life
	Increased arterial oxygen tension	Neonates	Ductus arteriosus closes about 10–15 hours after birth; fibroses develop within 2–4 weeks of age; systolic murmurs may be audible in the first 24–48 hours of life because of transition from fetal circulation
	Relatively horizontal position of heart at birth becomes more vertical as child grows	Infants; children until age 7 years	Heart sounds are easily audible because of thin chest wall; apical pulse is heard at fourth intercostal space to left of the midclavicular line; apex reaches fifth intercostal space at the midclavicular line by age 7 years; heart may seem enlarged when percussed; displacement of the apical pulse may indicate pneumothorax, dextrocardia, or diaphragmatic hernia
	Stroke volume is somewhat fixed because of less muscular and poorly developed left ventricle (Bissonnette et al., 2011)	Neonates; infants	Poor compliance and reduced contractility (Bissonnette et al., 2011)
	Resting cardiac output is high: 300–400 mL/kg/min at birth and 200 mL/kg/min within a few months (Bissonnette et al., 2011), decreasing to 100 mL/kg/min by adolescence (Bissonnette et al., 2011)	Neonates; infants through adolescents	Cardiac output must be high in neonate and infant to meet tissue oxygen demands; this is attained by increasing heart rate

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Heart and vasculature (*cont.*)	Cardiac output is heart-rate dependent, not stroke-volume dependent (Bissonnette et al., 2011)	Neonates; children until late school age; adolescents (Ball et al., 2017)	Heart rate is rapid in children; the younger the child, the more rapid the heart rate because of increased oxygen and energy needs for growth and higher metabolism. The provider should be familiar with age-specific norms for heart rate; the pulse rises with fever and hypoxia; tachycardia during sleep is abnormal
	Vagal parasympathetic tone dominant (Bissonnette et al., 2011)	Neonates; young infants	Prone to episodes of bradycardia
	ECG readings differ from adult's; heart rhythm varies more in children than adults (Bissonnette et al., 2011)	Infants; young children	ECG changes reflect ongoing development of myocardium (Bissonnette et al., 2011); sinus arrhythmia is within normal limits in children and common in adolescence
	Left ventricular muscle is undeveloped until age 6 years	Infants; children until school age	Radial pulse may not be palpable until age 6 years; apical pulse should be taken until then; the younger the child, the lower the BP; BP rises as child matures in correlation with increased blood volume and body weight, reaching adult levels by adolescence
	Reduced catecholamine stores; poor response to exogenously administered catecholamine (Bissonnette et al., 2011); baroreceptor reflexes are immature	Neonates; infants	Poor response to hypotension via vasoconstriction; hypotension without tachycardia is seen with hypovolemia in neonates and infants (Bissonnette et al., 2011)
	Innocent murmurs are common in children; may be present in up to 80% of children (Bissonnette et al., 2011)	Infants; preschool-aged children through adolescents	Innocent murmurs are heard during systole; they do not cause cyanosis, fatigue, shortness of breath, or failure to thrive
Abdomen	Weak abdominal musculature; abdomen is protuberant in neonates and is prominent in toddlers while standing but flat when supine	Infants; toddlers	Liver and spleen are not well protected; contributes to "pot-bellied" appearance in infants and toddlers
	Abdomen is larger than chest in young children	Infants; children until age 4 years	Distended or scaphoid abdomen is indicative of a pathologic finding
	Abdomen is cylindrical in shape	Infants	Peristalsis may be visible and may indicate a pathologic finding such as pyloric stenosis

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Abdomen (*cont.*)	Abdominal contour changes to adult shape by adolescence	Preschool-aged children to adolescents	Affects provider expectations during physical examination
	Stomach lies in a transverse plane	Infants; toddlers until age 2 years	Affects normal area for auscultation and palpation during physical examination
	Gastric pH is alkalotic at birth; gastric acid production slowly increases to adult levels by age 2 years (Bissonnette et al., 2011)	Infants; toddlers until age 2 years	Affects oral medication absorption; increases incidence of GER
	Neonate has small stomach capacity (~60 mL); stomach capacity reaches approximately 500 mL by toddler age (Ball et al., 2017)	Neonates; infants; toddlers	Need for small feeding amounts at birth; increases incidence of GER
	Stomach capacity reaches 1,000–1,500 mL by adolescence	Adolescents	Correlates with increased appetite
	Lower esophageal sphincter tone (Ball et al., 2017)	Neonates	Increases incidence of GER
	Prolonged gastric emptying time (6–8 hours) and transit time through the small intestine (Batchelor & Marriott, 2013)	Neonates; infant: reaches adult levels by approximately age 6–8 months (Batchelor & Marriott, 2013)	Affects absorption of nutrients and medications, increasing the chance of adverse side effects and toxicities
	Length of small intestine is proportionately greater, with greater surface area for absorption relative to body size (Hockenberry et al., 2019)	Infants; toddlers	Child loses proportionately more water and electrolytes in stool with diarrhea
	Large intestine proportionately shorter with less epithelial lining (Batchelor & Marriott, 2013)	Infants	Less water absorbed, explaining soft stools of infancy
	Pancreatic enzyme (e.g., amylase, lipase, trypsin) activity decreased at birth (Ball et al., 2017)	Neonates; infants until age 4–6 months (Ball et al., 2017)	Varied bioavailability of drugs that may depend on specific enzymes to aid in drug absorption; enzymes not present in sufficient quantities to digest food fully
Liver and biliary glands	Liver functionally immature at birth (Bissonnette et al., 2011)	Neonates; infants (Ball et al., 2017)	Bilirubin is excreted in low concentrations in newborns; prothrombin levels in neonate are only 20%–40% of adult levels, which affects clotting; vitamin storage is inadequate, which contributes to young children's frequent infectious illnesses; process of gluconeogenesis is immature

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Liver and biliary glands (*cont.*)	Liver occupies more of abdominal cavity than in adults; palpable at 0.5–2.5 cm below the right costal margin in infants, 1–2 cm below the right costal margin in toddlers (Hockenberry et al., 2019). Liver reaches adult size and function by adolescence	Infants; children until adolescence	Affects normal area for palpation and percussion; organs are typically nonpalpable by school age; enlarged liver can indicate right-sided heart failure
	Decreased hepatic enzyme function in young children (Bissonnette et al., 2011); drug enzyme systems mature at different rates	Infants; children until age 3–4 years	Enzyme systems for biotransformation of drugs are not fully developed, which affects drug dosing; infants and children metabolize drugs more slowly than adults; can easily build up toxic levels of drugs
	Liver conjugation reactions are impaired (Bissonnette et al., 2011)	Neonates	Jaundice; long drug half-lives (infants and children have short drug half-life; Bissonnette et al., 2011)
	Liver synthesizes and stores glycogen less effectively (Bissonnette et al., 2011)	Neonates; infants until 1 year	May become hypoglycemic easily; hypoglycemia in neonate can cause permanent neurologic damage; young children need to eat more frequently during childhood (e.g., a.m. and p.m. snacks)
	Maternal iron stores in liver are depleted by age 6 months	Neonates; infants until age 6 months	Infant requires outside source of iron (e.g., iron drops, fortified cereal) beginning at age 6 months
	Lower level of plasma albumin and globulin (Bissonnette et al., 2011); endogenous compounds such as bilirubin and free fatty acids are already bound to albumin	Neonates; infants until age 1 year	Protein binding of drugs is decreased in newborns; high levels of free drug remain in bloodstream, which can lead to toxic level of drug or neonatal coagulopathy; endogenous compounds (e.g., bilirubin) can also displace a weakly bound drug; high loading doses of protein-bound drugs may be needed in neonate. Certain drugs (e.g., sulfonamides) can displace bilirubin from albumin-binding sites, causing kernicterus in the neonate

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Lymphatics	Lymph tissue is well-developed at birth and reaches adult size by age 6 years; it continues to grow until age 10–12 years, when a maximum size of approximately twice the normal adult size is reached; lymph tissue then rapidly declines to normal adult size by end of adolescence (Ball et al., 2017)	Infants; children through adolescence	Potential for airway obstruction with upper respiratory infections, chronic tonsillar or adenoidal swelling, or both; large tonsils and adenoids can make intubation difficult
	Spleen may be palpable 1–2 cm below the left costal margin (Hockenberry et al., 2019)	Infants; toddlers	Affects approach to physical examination; spleen should be nonpalpable by preschool age
Blood	Vitamin K–dependent clotting factors and platelet function are inefficient	Neonates through early infancy	Vitamin K is administered at birth to prevent bleeding disorders in newborns
	Blood volume is weight dependent. Total circulating blood volume (mL of blood per kg of body weight) is greater than adult by 25%. Blood volume is highest in neonate (80–90 mL/kg); in premature infants approximately 105 mL/kg; normal adult values are 70–80 mL/kg (Bissonnette et al., 2011)	Neonates	Overhydration and dehydration occur more quickly than in an adult; blood loss can cause hypovolemic shock and anemia in infant or young child more quickly than in an adult
	At birth, 70%–90% of hemoglobin is HbF (Bissonnette et al., 2011)	Neonates; infants until age 4 months	HbF has higher affinity for oxygen than adult HbA; protects red blood cells from sickling in those with sickle cell disease; oxygen saturation curve is left-shifted for HbF; oxygen is not delivered as readily to tissues; HbF is replaced by HbA by age 4 months
Immunity	Infants fight infection primarily by passive immunity acquired transplacentally (Ball et al., 2017) and by breastfeeding (Hockenberry et al., 2019)	Neonates; infants until age 6–8 months (Ball et al., 2017) or until breastfeeding is discontinued	After age 6 months, infants are prone to infection and build immunity to common illnesses as they are exposed to them
	Humoral and cell-mediated immunity is not fully developed	Neonates; children until age 6 years (Ball et al., 2017)	Frequent infectious illnesses occur in children younger than ~6 years
	Reticuloendothelial system is active in childhood	Infants; children until approximately age 10 years	Lymphatic tissue, tonsils, and adenoids swell rapidly in response to mild infections; swollen tissues can cause airway obstruction

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Kidneys and urinary tract	Kidneys are proportionately larger than in adults, and are surrounded by less fat (Ball et al., 2017)	Infants; toddlers; preschoolers	Tip of right kidney may be palpated because of thin abdominal wall, especially during inspiration; child's kidneys are susceptible to trauma
	Ureters are relatively short; urinary bladder lies between symphysis and umbilicus (Hockenberry et al., 2019)	Infants; toddlers	Bladder descends into pelvis by age 3 years; until then location affects provider's approach to physical examination
	Kidneys are immature at birth; increased renal vascular resistance; incomplete glomerular and tubular development causes decreased renal blood flow, glomerular filtration rate, and tubular function (Bissonnette et al., 2011)	Neonates; toddlers until age 2 years (Bissonnette et al., 2011)	Kidneys cannot concentrate and dilute urine effectively (most pronounced in first year of life); young infants cannot handle large amounts of solute-free water or concentrated infant formulas; prone to dehydration with fluid losses (e.g., diarrhea, vomiting) or decreased oral intake; prone to fluid overload; electrolyte secretion and absorption are suboptimal: infants' kidneys cannot conserve or excrete sodium; kidneys play a role in excreting metabolized drugs, determining half-life of drugs excreted through glomerular filtration; prolonged dosage adjustments may be needed; minimum urine output is 1–2 mL/kg/hour
	Renal system is not mature at birth	Premature neonates	Decreased creatinine clearance; poor sodium retention, glucose excretion, and bicarbonate reabsorption; ineffective ability to concentrate and dilute urine; great potential for fluid overload, insensible losses, and dehydration; consequent potential cardiac complications, and electrolyte imbalances
	Testicles enlarge between 9.5 and 13.5 years	School-aged children; adolescents	Early puberty is present if testicles enlarge before 9.5 years

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Fluid balance	Proportion of fluid to body weight is larger than in adults; total body water is 80%–85% of body weight in infants (90% in premature infants); total body water reaches adult values (65%) by approximately age 3 years (Bissonnette et al., 2011); this change is caused by decrease in extracellular fluid, which is approximately 45% in a term infant and reaches adult levels (25%) by age 3 years (Bissonnette et al., 2011)	Infants; toddlers until age 2 years	Poor adjustment to fluid deficit or overload; increased potential for dehydration or hypovolemia in children younger than 2 years; response to fluid loss is tachycardia and vasoconstriction, causing increased capillary refill time and mottling; greater fluid volume for distribution or dilution of a drug in young children may require dose adjustment
	Large body surface area	Infants; toddlers until age 2 years	Increased potential for insensible water loss (e.g., perspiration, tachypnea, fever); increased risk for dehydration; metabolism and heat production influence fluid loss; allows large amounts of fluid to be lost via insensible water loss through perspiration
Bones and muscles	Spine is C-shaped at birth (Hockenberry et al., 2019)	Infants until age 3–4 months	Affects infant's head control
	Bones are not fully ossified until adulthood; bones are soft and easily bent (Ball et al., 2017)	Infants; children through adolescence	Types and locations of fractures in very young children must be fully evaluated to distinguish between intentional and unintentional injuries
	Percentage of cartilage in ribs is high; ribs are flexible and compliant (Ball et al., 2017)	Infants; children through adolescence	Rib fractures are uncommon in young children; ribs provide minimal protection to underlying organs and blood vessels
	Lordosis is a normal variation in infants and toddlers (Hockenberry et al., 2019)	Infants; toddlers	Causes appearance of abdominal distention in this age group
	Skeleton grows continuously (at varying rate and pace among children) over a period of 19–20 years (Ball et al., 2017)	Infants; children through adolescence	Normal growth pattern
	Skeleton grows faster than muscles	Adolescents	Hands and feet grow faster than body

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Bones and muscles (*cont.*)	Body growth spurts occur during puberty	Adolescents: peaks at age 12 years for females and 14 years for males	Provider should expect considerable growth during this time
	Bow-leggedness because of leg muscles bearing weight of relatively large trunk	Infants; toddlers	Normal growth pattern
	Lower muscle mass (Bissonnette et al., 2011)	Neonates	Use of intramuscular route for medication administration limited
	Muscles have less tone and coordination during infancy; muscles comprise 25% of weight in infants compared with 40% in adults (Ball et al., 2017)	Neonates; infants	Increased risk for injury; muscle growth contributes greatly to weight gain during childhood; walking and weight bearing stimulate growth of bone and muscle
Brain and nerves	The neurologic system is anatomically complete at birth; however, since it is not fully myelinated, it is functionally immature; myelination is rapid in the first 2 years of life and is completed by approximately age 7 years (Bissonnette et al., 2011)	Infants; children through school age	Nerve impulses do not travel as quickly down unmyelinated nerves; these impulses are slower and less predictable. Myelination occurs cephalocaudally and proximodistally and corresponding advances in gross and fine motor function are seen, as evidenced by more localized stimulus response, increasing sphincter control, and better balance, memory, and comprehension; most actions in newborns are primitive reflexes
	BBB underdeveloped at birth but develops quickly postnatally (Bissonnette et al., 2011)	Neonates	More permeable BBB allows passage of large, lipid-soluble molecules (e.g., bilirubin) and some drugs (e.g., some antibiotics, barbiturates, opioids; Bissonnette et al., 2011), causing some drugs to have an increased and variable central nervous system effect or unpredictable duration of action
	Brain growth is very rapid; half of postnatal brain growth is completed by age 1 year; brain reaches 75% of adult size by age 3 years (Hockenberry et al., 2019)	Infants; toddlers until age 2 years	Head circumference should increase as a reflection of brain growth
	Brain reaches 90% of adult size by age 6 years (Hockenberry et al., 2019); brain reaches adult size by age 12 years	School-aged children; adolescents	Reflection of brain growth

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Brain and nerves (*cont.*)	Spinal cord ends at intervertebral level L3, reaching adult level of L1–L2 by age 8 years (Bissonnette et al., 2011)	Infants; children until age 8 years	Necessitates altered approach for lumbar puncture and epidural anesthesia in children younger than 8 years
	Cerebral vessels are thin-walled and fragile (Bissonnette et al., 2011)	Premature infants	Increased risk for intraventricular hemorrhage
	Immature parasympathetic and sympathetic function (Bissonnette et al., 2011)	Neonates; infants	Neonates have less ability to control BP; they may respond to pain with tachycardia, increased BP
Thermoregulation	Body surface area is three times that of an adult; head is proportionately larger until age 2 years, creating a greater surface area for heat loss in infants, especially when the head is exposed	Neonates; infants	Heat loss is greater in children than in adults; susceptible to hypothermia and hyperthermia; thermoregulation is difficult because of thin epidermis, little subcutaneous fat, and poorly developed sweating and vasoconstriction mechanisms (Bissonnette et al., 2011); the premature infant is even more prone to hypothermia because of thin skin and minimal fat stores; low body temperature can cause respiratory depression, acidosis, and decreased cardiac output (Bissonnette et al., 2011)
	Body heat is lost by radiation, conduction, convection, and evaporation	Neonates	Lower body temperature increases risk for respiratory depression, acidosis, and infection; when neonate loses body heat, body attempts to conserve heat through acrocyanosis (i.e., hands and feet turn blue); if infant's hands or feet do not become pink when warmed, provider should consider congenital heart disease
	Thermogenesis by shivering is undeveloped (Bissonnette et al., 2011)	Infants; children until age 6 years	Requires body heat to be produced in other ways (e.g., brown fat thermogenesis), which causes metabolic acidosis; oxygen consumption also increases in cold-stressed neonates because it is needed to metabolize brown fat
	Sweating and vasodilation mechanisms not fully developed; peripheral vasodilation is inefficient because of incomplete myelination	Infants; toddlers until age 2 years	Infants do not flush to release body heat with increased body temperature or fever; body does not cool as fast, making child prone to febrile seizures

(*continued*)

TABLE 1.1 Anatomic and Physiologic Differences Among Infants, Children, and Adolescents (*continued*)

BODY STRUCTURE/ FUNCTION	ANATOMIC/PHYSIOLOGIC DIFFERENCES	AGE GROUP AFFECTED	CLINICAL IMPLICATIONS
Metabolism	Metabolic rate is higher than in adults	Infants; children through adolescence	Need more oxygen than adult to support rapid body growth, work of breathing; metabolic rate increases during fever or illness; children have difficulty maintaining homeostasis during illness; young children are prone to hypoxia and dehydration, have high heart rates, and have high caloric and fluid requirements to support active metabolism; certain drugs are metabolized faster in children than adults
	Proportion of fat to lean body mass increases with age (Bissonnette et al., 2011)	Infants; children until age 12 years	Distribution of fat-soluble drugs is limited in children; a drug's lipid or water solubility affects the dose for the infant or child
Endocrine glands	Not fully mature until adolescence with hormonal and physical changes that occur in puberty	Infants; children until adolescence	Affects bone growth, thyroid function, adrenal cortex, and secretion of sex hormones
	Thelarche normally takes place between 8 and 13 years; pubarche between 8 and 14 years; menarche about 2 years after thelarche	School-aged children; adolescents	Affects physical examination; provider should be aware of precocious or delayed puberty; gynecomastia in adolescent boys may be caused by pubertal changes, obesity, or use of marijuana or anabolic steroids; pubic hair heralds the onset of puberty in boys; thelarche signifies puberty in girls

BBB, blood–brain barrier; BP, blood pressure; GER, gastroesophageal reflux; HbA, adult hemoglobin; HbF, fetal hemoglobin.

Growth and Development

The physical, psychosocial, and cognitive aspects of child development are interrelated key indicators of the child's overall health and must be assessed at every healthcare visit. The assessment of a child's growth and development helps to evaluate the child's physical growth and progress toward maturity, provides clues to health conditions that impede physical growth, shows cognitive delays, and may point to abuse or neglect. Normal growth and development occurs in a *predictable* sequence but at a *variable* rate and pace, which is influenced by a variety of factors (see Chapter 2, Assessment of Child Development and Behavior). Deviations from this pattern may signify an abnormality, making it essential for the provider to be familiar with normal developmental milestones and children's growth patterns and to monitor these trends over time.

In this book, infants, children, and adolescents are arranged into six age groups: neonates, infants, toddlers, preschoolers, school-aged children, and adolescents. The corresponding ages are:

- Neonates: birth to 28 days
- Infants: 1 month to 1 year
- Toddlers: 1 to 3 years
- Preschoolers: 3 to 6 years
- School-aged children: 6 to 12 years
- Adolescents: 12 to 21 years

For each age group, the pediatric provider must be knowledgeable about age-appropriate developmental abilities:

- *Gross and fine motor abilities*, particularly until age 6 years.
- *Language and communication abilities*. Assessment of language milestones is very important;

delays can signal hearing loss, learning problems, even neglect. Depending on the child's age, temperament, and developmental level, the child may not be able to verbalize anxiety, fear, or pain, making it necessary for the provider to make these assessments independently or to rely on the parent.

- *Cognitive abilities* depend on interplay of genetics as well as family, educational, and social environment. These abilities change and develop as the child grows.
- *Psychosocial and behavioral stages*. Knowledge of normal psychosocial developmental stages can be used to make an accurate developmental assessment of a child and to engage the child in the healthcare encounter in an age-appropriate manner. (See Chapter 2, Assessment of Child Development and Behavior.)

COMMUNICATION SKILLS REQUIRED TO WORK WITH CHILDREN

The pediatric healthcare provider must be able to communicate with children of all ages and at all developmental levels. This is quite challenging because each developmental stage requires vastly different approaches specific to the age, developmental stage, and temperament of the child. The provider must also know when the child is developmentally, cognitively, and temperamentally able to provide his or her own answers during the medical history. In addition, each child must be viewed within the context of the family, culture, and social situation. (See Chapter 3, Communicating With Children and Families.)

OBTAINING THE PEDIATRIC HEALTH HISTORY

The reason for the child's visit dictates the type of history that the healthcare provider obtains (see Chapter 6, Obtaining the Pediatric Health History). For example, interval histories involve a specific complaint and require only injury- or illness-specific data. During health maintenance visits, the provider obtains a complete history. Data that provide information about the child's growth and development, nutrition, daily life, health and safety, environment, parental knowledge base, and teaching needs are especially important. The complexity of life in the 21st century presents new risks to children that also require assessment such as obesity; exposure to violent and sexually explicit media; exposure to community and domestic violence; assessment of television, computer, and video time; family structure, including an assessment of all persons living in the home and their relationship to the child; parenting style and disciplinary methods; as well as assessment of depression, eating disorders, and sexual activity. (See Chapter 6, Obtaining the Pediatric Health History.)

THE PEDIATRIC PHYSICAL EXAMINATION

A child's age and developmental level determine the provider's approach to the physical examination. The approach also depends on the severity of illness or injury and whether the child's primary caregiver is present. It is usually recommended that a complete physical examination be done in an organized, head-to-toe fashion to minimize any omissions of body system assessments. However, this sequence should be adjusted to the child's age, temperament, and developmental level. For example, infants and toddlers dislike intrusive procedures such as inspection of the throat and ears, and these examinations often elicit crying. For this reason, it is wise to first auscultate the young child's heart, lungs, and abdomen when the child is quiet and inspect the ears and mouth last. Children who are preschool age and older are typically able to cooperate with a physical examination that proceeds in a head-to-toe direction. (See Chapter 8, The Pediatric Physical Examination.)

UNDERSTANDING THE CAREGIVER–CHILD RELATIONSHIP

In all pediatric health encounters, whether the child is well or ill, the provider should appraise the child's social situation and home environment, paying particular attention to the parent–child interaction during the healthcare encounter. The caregiver's responses to and interactions with the child can provide a wealth of information regarding the child's emotional health and the parent–child relationship; it can also present valuable teaching opportunities. Children are also highly influenced by the emotional state of their caregiver. This can be reflected in the child's overall behavior, sleep patterns, appetite, school performance, and peer relationships. The provider must also be sure to assess these relationships within the context of the family's culture. (See Chapter 4, Assessment of the Family, and Chapter 5, Cultural Assessment of Children and Families.)

ROLE OF THE PEDIATRIC HEALTHCARE PROVIDER

The role of the pediatric healthcare provider is to provide safe, age- and developmentally appropriate care, to collaborate and cooperate with the child's parent or primary caregiver and to advocate for and protect the child's best interests. Children are dependent on the adults in their lives for many years, and the healthcare provider can greatly influence the quality of care that they receive from their family. If parents feel supported and validated by the healthcare provider, they are more likely to feel comfortable asking questions that will enhance their child's emotional and physical health. This can be achieved by creating a partnership with the child and family in promoting health and preventing illness. Bright Futures, a developmentally based approach to child health assessment, health promotion, and illness prevention, has delineated six steps for building the provider–child–family partnership (Hagan, Shaw, & Duncan, 2017):

1. Model and encourage open, respectful, nonjudgmental communication, building trust and empathy.
2. Identify health issues through effective listening and by asking open-ended questions.
3. Affirm strengths of the child and family, praising the achievements of the child and family.
4. Identify mutual and shared goals, reinforcing the notion of a partnership among provider, child, and family. Refer the child and family to appropriate community resources as needed.
5. Develop a plan of action on the basis of shared goals. Goals should be simple, achievable, measurable, and time specific.
6. Evaluate the effectiveness of the partnership on an ongoing basis.

The pediatric healthcare provider cares for the entire family when assessing and treating a child. During the healthcare encounter, the provider can have a significant impact on the parent's and child's confidence, competence, and health behaviors through teaching, role modeling, positive reinforcement, and reassurance. Fostering a trusting, caring, provider–family relationship leads to healthful behaviors and healthy psychosocial development of the child. Having well-developed pediatric assessment skills is the first step in delivering excellent care to the child and family.

Key Points

- Health assessment in infants, children, and adolescents is different from health assessment of the adult.
- In order for the healthcare of children to be safe, thorough, and developmentally appropriate, the pediatric healthcare provider must ensure that child health assessment is based on a thorough knowledge of pediatric:
  - anatomy and physiology
  - pathophysiology
  - pharmacology
  - growth and development
- The pediatric healthcare provider must be able to communicate with children of all ages and at all developmental levels (see Chapter 3).
- The reason for the child's visit dictates the type of history that the healthcare provider obtains (see Chapter 6).
- A child's age and developmental level determine the provider's approach to the physical examination (see Chapter 8).
- In all pediatric health encounters, whether the child is well or ill, the provider should appraise the child's social situation and home environment, paying particular attention to the parent–child interaction during the healthcare encounter.
- The role of the pediatric healthcare provider is to provide safe, age, and developmentally appropriate care, to collaborate and cooperate with the child's parent or primary caregiver, and to advocate for and protect the child's best interests.
- During the healthcare encounter, the provider can have a significant impact on the parent's and child's confidence, competence, and health behaviors through teaching, role modeling, positive reinforcement, and reassurance.

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