LEARNING OBJECTIVES
• Discuss the physiologic adaptations that the neonate must make during the period of transition from the intrauterine to the extrauterine environment.
• Describe the behavioral adaptations that are characteristic of the newborn during the transition period.
• Explain thermoregulation in the neonate and the rationale for preventing heat loss.
• Recognize newborn reflexes and differentiate characteristic responses from abnormal responses.
• Discuss the sensory and perceptual functioning of the neonate.

KEY TERMS AND DEFINITIONS
acrocyanosis Peripheral cyanosis; blue color of hands and feet in most infants at birth that may persist for 7 to 10 days
brown fat Source of heat unique to neonates that is capable of greater thermogenic activity than ordinary fat; deposits are found around the adrenals, kidneys, and neck, between the scapulae, and behind the sternum for several weeks after birth
caput succedaneum Swelling of the tissue over the presenting part of the fetal head caused by pressure during labor
cold stress Excessive loss of heat that results in increased respirations and nonshivering thermogenesis to maintain core body temperature
erythema toxicum Innocuous pink papular neonatal rash of unknown cause, with superimposed vesicles appearing within 24 to 48 hours after birth and resolving spontaneously within a few days
habituation Psychologic and physiologic phenomenon whereby the response to a constant or repetitive stimulus is decreased
hyperbilirubinemia Elevation of unconjugated serum bilirubin concentrations
meconium Greenish black, viscous first stool formed during fetal life from the amniotic fluid and its constituents, intestinal secretions (including bilirubin), and cells (shed from the mucosa)
meconium
milia Small, white sebaceous glands, appearing as tiny, white, pinpoint papules on the forehead, nose, cheeks, and chin of the neonate
mongolian spots Bluish gray or dark nonelevated pigmented areas usually found over the lower back and buttocks present at birth in some infants, primarily nonwhite; usually fade by school age
physiologic jaundice Yellow tinge to skin and mucous membranes in response to increased serum levels of unconjugated bilirubin; not usually apparent until after 24 hours; also called neonatal jaundice, physiologic hyperbilirubinemia
sleep-wake states Variation in states of newborn consciousness from deep sleep to extreme irritability
surfactant Phosphoprotein necessary for normal respiratory function that prevents alveolar collapse (atelectasis)
thermogenesis Creation or production of heat, especially in the body
transition period Period from birth to 4 to 6 hours later; infant passes through period of reactivity, sleep, and second period of reactivity
vernix caseosa Protective gray-white fatty substance of cheesy consistency covering the fetal skin
The neonatal period includes the time from birth through day 28 of life. During this time the neonate must make many physiologic and behavioral adaptations to extrauterine life. Physiologic adjustment tasks are those that involve (1) establishing and maintaining respirations; (2) adjusting to circulatory changes; (3) regulating temperature; (4) ingesting, retaining, and digesting nutrients; (5) eliminating waste; and (6) regulating weight. Behavioral tasks include (1) establishing a regulated behavioral tempo independent of the mother, which involves self-regulation of arousal, self-monitoring of changes in state, and patterning of sleep; (2) processing, storing, and organizing multiple stimuli; and (3) establishing a relationship with caregivers and the environment. The term infant usually makes these adjustments with little or no difficulty.

**TRANSITION TO EXTRAUTERINE LIFE**

Infants undergo phases of instability during the first 6 to 8 hours after birth. These phases are collectively called the transition period between intrauterine and extrauterine existence. To detect disorders in adaptation soon after birth, nurses must be aware of normal features of the transition period. Labor and immediate neonatal events stimulate a sympathetic response reflected by changes in heart rate, color, respiration, motor activity, gastrointestinal function, and temperature of the infant. Behavioral characteristics also change during this transition period.

The first phase of the transition period lasts up to 30 minutes after birth and is called the first period of reactivity. The newborn’s heart rate increases rapidly to 160 to 180 beats/min but gradually decreases after 30 minutes or so to a baseline rate of between 100 and 120 beats/min. Respirations are irregular, with a rate between 60 and 80 breaths/min. Crackles may be present on auscultation; audible grunting, nasal flaring, and retractions of the chest also may be noted. In addition, brief periods of apnea (periodic breathing) may occur. Coincident with these changes in heart rate and respiratory rate, the infant is alert. The infant’s behavior is marked by spontaneous startle reactions, tremors, crying, and movement of the head from side to side. This characteristic exploratory behavior is accompanied by a decrease in body temperature and a generalized increase in motor activity, with an increase in muscle tone. Gastrointestinal manifestations of this first period of reactivity include the onset of bowel sounds, passage of meconium, and production of saliva.

Between 30 minutes and 2 hours after birth, the neonate enters a period of decreased responsiveness, characterized by a marked decrease in motor activity and/or sleep. Respirations are rapid and shallow with a rate of up to 60 breaths/minute. The heart rate averages 100 to 120 beats/min. At this time the infant’s color is pink. This period lasts for 60 to 100 minutes and is followed by a second period of reactivity.

The second period of reactivity occurs roughly between 2 and 8 hours after birth. This period of reactivity lasts from 10 minutes to several hours. The infant becomes more responsive to all types of stimuli. Periods of tachycardia and tachypnea occur, associated with increased muscle tone, skin color, and mucous production. Meconium is commonly passed at this time. As this period diminishes, the infant is relatively stable.

All well newborns experience this transition, regardless of gestational age or type of birth. The length of time the periods last will vary depending on the amount and kind of stress experienced by the neonate before or after birth.

**PHYSIOLOGIC ADAPTATIONS**

**Respiratory System**

With the cutting of the umbilical cord, the infant must undergo rapid and complex changes. The most critical adjustment of a newborn at birth is the establishment of respiration. At term the lungs hold approximately 20 ml of fluid per kilogram. Air must be substituted for the fluid that filled the respiratory tract. During normal vaginal birth, some lung fluid is squeezed or drained from the newborn’s trachea and lungs. With the first breath of air, the newborn begins a sequence of cardiopulmonary changes.

**Initiation of breathing**

Initial breathing is probably the result of a reflex triggered by pressure changes, chilling, noise, light, and other sensations related to the birth process. In addition, the chemoreceptors in the aorta and carotid bodies initiate neurologic reflexes when arterial oxygen pressure (Po2) decreases from...
80 to 15 mm Hg, arterial carbon dioxide pressure (P\textsubscript{CO\textsubscript{2}}) increases from 40 to 70 mm Hg, and arterial pH declines. In most cases, an exaggerated respiratory reaction follows within 1 minute of birth, and the infant takes a first gasping breath and cries. Certain respiratory patterns are characteristic of the normal term newborn. After respirations are established, breaths are shallow and irregular, ranging from 30 to 60 breaths/min, with short periods of apnea (less than 15 seconds). These short periods of apnea occur most often during the active (rapid eye movement [REM]) sleep cycle and decrease in frequency and duration with age. Apneic periods longer than 20 seconds should be evaluated.

**NURSE ALERT** Newborn infants are preferential nose breathers. The reflex response to nasal obstruction is to open the mouth to maintain an airway. This response is not present in most infants until 3 weeks after birth, therefore cyanosis or asphyxia may occur with nasal blockage.

### Signs of respiratory distress

Most term infants breathe spontaneously and continue to have normal respirations (Fig. 18-1, A). However, infants can manifest other problems through respiratory distress. Signs of respiratory distress may include nasal flaring, retractions (indrawing of tissue between the ribs, below the rib cage, or above the sternum and clavicles), or grunting with expirations. Any increased use of the intercostal muscles may be a sign of distress. Seesaw respirations, instead of normal respirations (Fig. 18-1, B), within the first hour after birth the respiratory rate is between 40 and 60 breaths/min and should thereafter range from 30 to 60 breaths/min. A respiratory rate that is less than 30 or greater than 60 breaths/min with the infant at rest must be reported to the pediatrician. The respiratory rate of the infant may be slowed or depressed by the analgesics or anesthetics administered to the mother during labor and birth. Apneic episodes may be related to a number of events (rapid increase in body temperature; hypothermia, low blood glucose, and sepsis) that require careful evaluation. Tachypnea may result from inadequate clearance of lung fluid, or it may be an indication of newborn respiratory distress syndrome (RDS).

**Maintaining adequate oxygen supply**

During the first hour of life, the pulmonary lymphatics continue to remove large amounts of fluid. Removal of fluid also is a result of the pressure gradient from alveoli to interstitial tissue to blood capillary. Reduced vascular resistance accommodates this flow of lung fluid. Retention of lung fluid may interfere with the infant’s ability to maintain adequate oxygenation, especially if other factors (meconium aspiration, congenital diaphragmatic hernia, esophageal atresia with fistula, chondal atresia, congenital cardiac defect, immature alveoli) that compromise respirations are present. Auscultation of the chest reveals loud, clear breath sounds that seem very near, because little chest tissue intervenes. The ribs of the infant articulate with the spine at a horizontal rather than a downward slope; consequently, the rib cage cannot expand with inspiration as readily as that of an adult. Because neonatal respiratory function is largely a matter of diaphragmatic contraction, abdominal breathing is characteristic of newborns. The newborn infant’s chest and abdomen rise simultaneously with inspiration (Fig. 18-1, A). Characteristics of the respiratory system of the neonate and the effects of these characteristics on respiratory function are listed in Table 18-1. The alveoli of the term infant’s lungs are lined with surfactant, a protein manufactured in type II cells of the lungs. Lung expansion is largely dependent on chest wall contraction and adequate presence of secretion of surfactant. Surfactant reduces surface tension, therefore reducing the pressure required to keep the alveoli open with inspiration, and prevents total alveolar collapse on exhalation, thereby maintaining alveolar stability.

### Cardiovascular System

The cardiovascular system changes markedly after birth. The infant’s first breaths, combined with increased alveolar capillary distention, inflate the lungs and reduce pulmonary vascular resistance to the pulmonary blood flow from the pulmonary arteries. Pulmonary artery pressure drops, and pressure in the right atrium declines. Increased pulmonary blood flow from the left side of the heart increases pressure in the left atrium, which causes a functional closure of the foramen ovale. During the first few days of life, crying may...
reverse the flow through the foramen ovale temporarily and lead to mild cyanosis.

The ductus arteriosus begins to constrict as pulmonary circulation increases and arterial oxygen tension increases. In term infants the ductus arteriosus functionally closes within 24 hours; permanent closure may take several weeks. With the clamping and severing of the cord, the umbilical arteries, umbilical vein, and ductus venosus are functionally closed and are converted into ligaments within 2 to 3 months (Kliegman, 2002). Table 18-2 summarizes the cardiovascular changes at birth.

**Heart rate and sounds**

The term newborn has a resting heart rate between 100 and 160 beats/min, with brief fluctuations above and below these values, usually noted during sleeping and waking states. Shortly after the first cry the infant’s heart rate may accelerate as high as 180 beats/min. The range of the heart rate in the term infant is about 85 to 100 beats/min during deep sleep and 120 to 160 beats/min while the infant is awake. A heart rate of 180 beats/min is not unusual when the infant cries. A heart rate that is either high (more than 160 beats/min) or low (fewer than 100 beats/min) should be reevaluated within 30 minutes to 1 hour or when the activity of the infant changes. Immediately after birth the heart rate can be palpated by grasping the base of the umbilical cord.

By term the infant’s heart lies midway between the crown of the head and the buttocks, and the axis is more transverse than that in an adult (Fig. 18-2). The apical impulse (point of maximal impulse (PMI)) in the newborn is at the fourth intercostal space and to the left of the midclavicular line. The PMI is often visible because of the thin chest wall.

Auscultation should be for a full minute, preferably when the infant is asleep. An irregular heart rate is not uncommon in the first few hours of life. After this time an irregular heart rate not attributed to changes in activity or respiratory pattern should be further evaluated.

Heart sounds during the neonatal period are of higher pitch, shorter duration, and greater intensity than those during adult life. The first sound is typically louder and duller than the second sound, which is sharp. Transient murmurs are common during the first few hours after birth. Most heart murmurs heard during the first few days of life have no pathologic significance; they usually result from a patent ductus arteriosus, tricuspid regurgitation, or the acute angle of the pulmonary artery bifurcation (Lissauer, 2002). If a murmur is present, it is important to note the presence of other signs of cardiovascular dysfunction such as tachypnea, tachycardia, pallor, cyanosis, absence of peripheral pulses, or poor perfusion (Miller & Newman, 2005).

**Blood pressure**

The newborn infant’s average systolic blood pressure (BP) is 60 to 80 mm Hg, and the average diastolic pressure is 40 to 50 mm Hg. A decrease in systolic BP of approximately 15 mm Hg during the first hour of life is common. Neonates are considered hypotensive if the mean BP is less than the gestational age. Hypertension is present if the mean pressure exceeds 50 to 70 mm Hg (Sniderman & Taeusch, 2005). Crying and movement result in changes in BP.
especially in the systolic pressure. BP also is sensitive to the changes in blood volume that occur with the adaptations in circulation. The measurement of BP is best accomplished with a Doppler device and while the infant is at rest. The correct-size BP cuff must be used for accurate measurement of an infant’s BP.

**Blood volume**

The blood volume of the newborn depends on the amount of blood transferred placently. The blood volume of the term infant is about 80 to 85 ml/kg of body weight. Immediately after birth the total blood volume averages 300 ml, but this volume can increase by as much as 100 ml, depending on the length of time the infant is attached to the placenta. The preterm infant has a proportionately greater blood volume than that of the term newborn. This occurs because the preterm infant has a greater plasma volume, not a greater red blood cell (RBC) mass (Hockenberry, 2003; Luchtmans-Jones, Schwartz, & Wilson, 2002).

Early or late clamping of the umbilical cord changes circulatory dynamics of the newborn. Early clamping of the cord reduces the mean blood volume, whereas late clamping expands the blood volume from the so-called placental transfusion. This, in turn, causes an increase in heart size, higher systolic BP, and increased respiratory rate.

**Signs of risk for cardiovascular problems**

Close monitoring of the infant’s vital signs is important for early detection of impending problems. Persistent tachycardia (more than 160 beats/min) may indicate RDS, whereas persistent bradycardia (less than 120 beats/min) may be a sign of a congenital heart block. Any prolonged cyanosis other than in the hands or feet may indicate respiratory
and/or cardiac problems. A difference between upper and lower extremity BP may be an early sign of coarctation of the aorta. The presence of jaundice may indicate ABO or Rh factor problems (see Chapter 27).

Hematopoietic System

The hematopoietic system of the newborn exhibits certain variations from that of the adult. Levels of RBCs and leukocytes differ, but platelet levels are relatively the same.

Red blood cells

Because fetal circulation is less efficient at oxygen exchange than the lungs, the fetus needs additional RBCs for transport of oxygen in utero. Therefore at birth the average levels of RBCs and hemoglobin are higher than those in the adult. Cord blood of the term newborn may have a hemoglobin concentration of 14 to 24 g/dl (mean, 17 g/dl). The hematocrit ranges from 44% to 64% (mean, 55%). The RBC count is correspondingly elevated, ranging from 4.8 to 7.1 mm$^3$ (mean, 5.14). By 2 weeks of age, slight decreases in hemoglobin (mean, 16.5 g/dl), hematocrit (mean, 50%), and RBC count (mean, 4.2 mm$^3$) are found. At 3 months, hemoglobin ranges from 9.5 g/dl to 14.5 g/dl (mean, 12), and hematocrit ranges from 31% to 41% (mean, 36%) (Luchtman-Jones, Schwartz, & Wilson, 2002; Scott, 2002).

The initial blood values may be affected by delayed clamping of the cord, which results in an increase in hemoglobin level, RBC count, and hematocrit value. The source of the sample is another important factor because capillary blood yields higher values than venous blood. The time after birth when the blood sample was obtained also is significant; the slight increase in RBC numbers after birth is followed by a substantial decrease. At birth 80% of the infant’s blood contains fetal hemoglobin, but because of the shorter life span of the cells containing fetal hemoglobin, the percentage decreases to 55% by 5 weeks and to 5% by 20 weeks. Iron stores are generally sufficient to sustain normal RBC production for 5 months, and therefore mild, brief anemia is not serious.

Leukocytes

Leukocytosis, with a white blood cell (WBC) count of approximately 18,000/mm$^3$ (range, 9000 to 30,000/mm$^3$), is normal at birth. The number of WBCs, predominantly polymorphonuclear leukocytes, increases to 23,000 to 24,000/mm$^3$ during the first day after birth. This early high WBC count of the newborn decreases rapidly, and a resting level of 12,000/mm$^3$ is normally maintained during the neonatal period (Scott, 2002). Serious infection is not well tolerated by the newborn, and a marked increase in the WBC count is unlikely, even in critical sepsis (infection). In most instances, sepsis is accompanied by a decline in WBCs, particularly in neutrophils. The activity of the bone marrow is accurately reflected by the number of circulating cells, both RBCs and WBCs.

Platelets

The platelet count ranges between 150,000 and 300,000/mm$^3$ and is essentially the same in newborns as in adults. The levels of factors II, VII, IX, and X, found in the liver, are decreased during the first few days of life because the newborn cannot synthesize vitamin K. However, bleeding tendencies in the newborn are rare, and unless the vitamin K deficiency is great, clotting is sufficient to prevent hemorrhage (Kliegman, 2002).

Blood groups

The infant’s blood group is genetically determined and established early in fetal life. However, during the neonatal period, a gradual increase occurs in the strength of the agglutinogens present in the RBC membrane. Cord blood samples may be used to identify the infant’s blood type and Rh status.

Thermogenic System

Next to establishing respirations, heat regulation is most critical to the newborn’s survival. Thermoregulation is the maintenance of balance between heat loss and heat production. Newborns attempt to stabilize their internal body temperatures within a narrow range. Hypothermia from excessive heat loss is a common and dangerous problem in neonates. The newborn infant’s ability to produce heat (thermogenesis) often approaches that of the adult; however, the tendency toward rapid heat loss in a cold environment is increased in the newborn and poses a hazard.

Thermogenesis

The shivering mechanism of heat production is rarely operable in the newborn. Nonshivering thermogenesis is accomplished primarily by metabolism of brown fat, which is
Changes in environmental temperature can disturb body temperature. This may lead to serious consequences in the newborn. Brown fat metabolism is activated in response to changes in environmental temperature perceived by the thermal sensors in the newborn’s skin, even when the temperature of the newborn is unchanged. When exposed to cold, the newborn may cry, become restless, and increase muscular activity to generate heat. However, crying increases workload and energy expenditure. Newborns also may increase their respiratory rates in an attempt to stimulate muscular activity.

Cold stress imposes metabolic and physiologic demands on all infants, regardless of gestational age and condition. The respiratory rate increases in response to the increased need for oxygen. In the cold-stressed infant, oxygen consumption and energy are diverted from maintaining normal brain and cardiac function and growth to thermogenesis for survival. If the infant cannot maintain an adequate oxygen tension, vasoconstriction jeopardizes pulmonary perfusion. As a consequence, the partial pressure of arterial oxygen (PO2) is decreased, and the blood pH declines. These changes aggravate existing RDS. Moreover, decreased pulmonary perfusion and oxygen tension may maintain or re-open the right-to-left shunt across the patent ductus arteriosus.

The basal metabolic rate increases with cold stress (Fig. 18-3). If cold stress is protracted, anaerobic glycolysis occurs, resulting in increased production of acids. Metabolic acidosis develops, and if a defect in respiratory function is present, metabolic acidosis can lead to respiratory failure. In the newborn, an increased respiratory rate may compensate for decreased cardiac output. However, if metabolism is not increased, a sudden and profound decrease in blood pH can occur. As blood pH declines, metabolic demand increases, and the respiratory rate must increase to compensate. When this occurs, the acidosis can be corrected.
respiratory acidosis also develops. Excessive fatty acids displace the bilirubin from the albumin-binding sites. The resulting increased level of circulating unbound bilirubin heightens the risk of kernicterus even at serum bilirubin levels of 10 mg/dl or less.

Hyperthermia develops more rapidly in the newborn than in the adult because of the larger surface area of an infant. Although newborns have six times as many sweat glands per unit area as adults, these glands do not function. Serious overheating of the newborn can cause cerebral damage from dehydration or heat stroke and death.

Renal System

At term gestation, the kidneys occupy a large portion of the posterior abdominal wall. The bladder lies close to the anterior abdominal wall and is an abdominal as well as a pelvic organ. In the newborn, almost all palpable masses in the abdomen are renal in origin.

A small quantity (approximately 40 ml) of urine is usually present at birth in the bladder of a term infant. Newborns usually void within the first 24 hours of life.

NURSE ALERT: Noting and recording the first voiding is important. An infant who has not voided by 24 hours of age should be assessed for adequacy of fluid intake, bladder distention, restlessness, and symptoms of pain. The pediatrician also should be notified.

The frequency of voiding varies according to the amount of fluid intake. It is expected that infants will void at least once during the first 24 hours, twice during the second 24 hours, and three times during the third 24 hours. Formula-fed infants may void more frequently; however, in breastfed infants, the urine output increases after the third or fourth day of life, when the mother’s milk has “come in.” After the fourth day of life, all newborns should have at least six to eight voidings of straw-colored urine every 24 hours.

Term infants are unable to concentrate urine; therefore the specific gravity of the urine may range from 1.001 to 1.020 (Pagana & Pagana, 2002). The ability to concentrate urine fully is attained by about age 3 months. After the first voiding, the infant’s urine may appear cloudy (because of mucous content) and have a much higher specific gravity, which decreases as fluid intake increases. Normal urine during early infancy is usually straw colored and almost odorless. Sometimes pink-tinged stains (brick dust) appear on the diaper. These stains are caused by uric acid crystals and are normal during the first few days, but if seen later can be a sign of dehydration. Blood may be found on a diaper of a female infant. This pseudomenstruation is caused by the withdrawal of maternal hormones. Male infants may have some minimal bloody spotting from a circumcision. If there is no apparent cause of bleeding, the physician should be notified.

Loss of fluid through urine, feces, lungs, increased metabolic rate, and limited fluid intake results in a 5% to 10% loss of the birth weight (weight loss greater than 7% should be evaluated by the health care provider). This usually occurs during the first 3 to 5 days of life. If the mother is breastfeeding and her milk supply has not come in yet (which happens on the third or fourth day after birth), the neonate is usually protected from dehydration by its increased extracellular fluid volume. The neonate should regain the birth weight within 14 days after birth.

Because renal thresholds are low in the infant, bicarbonate concentration and buffering capacity are decreased, which may lead to acidosis and electrolyte imbalance.

Fluid and electrolyte balance

Approximately 40% of the body weight of the newborn is extracellular fluid. Each day the newborn takes in and excretes roughly 600 to 700 ml of fluid, which is 20% of the total body fluid or 50% of the extracellular fluid. The glomerular filtration rate of a newborn is approximately 30% to 50% that of the adult. This results in a decreased ability to remove nitrogenous and other waste products from the blood.

Sodium reabsorption is decreased as a result of a reduced sodium- or potassium-activated adenosine triphosphatase (ATPase) activity. The decreased ability to excrete excessive sodium results in hypotonic urine compared with plasma, with a higher concentration of sodium, phosphates, chloride, and organic acids and a lower concentration of bicarbonate ions. The infant has a higher renal threshold for glucose.

Signs of risk for renal system problems

The renal system has a wide range of functions, and dysfunction can result from physiologic abnormalities ranging from the lack of a steady stream of urine to gross anomalies. Gross anomalies such as hypospadias and exstrophy of the bladder can be identified prenatally by ultrasound examination of the pregnant woman.

Gastrointestinal System

The term newborn is capable of swallowing, digesting, metabolizing, and absorbing proteins and simple carbohydrates, and emulsifying fats. With the exception of pancreatic amylase, the characteristic enzymes and digestive juices are present even in low-birth-weight neonates.

In the adequately hydrated infant the mucous membrane of the mouth is moist and pink. The hard and soft palates are intact. Retention cysts, small whitish areas (Epstein’s pearls), may be found on the gum margins and at the junction of the hard and soft palate. The cheeks are full because of well-developed sucking pads. These, like the labial tubercles (sucking calluses) on the upper lip, disappear when the sucking period is over, around the age of 12 months.

Even though sucking motions in utero have been recorded by ultrasonography, these motions are not coordinated in any infant who weighs less than 1500 g at birth or is born before 32 weeks of gestation. Sucking behavior is...
EVIDENCE-BASED PRACTICE
Early Maternal Skin-to-Skin Contact with Healthy Infants

BACKGROUND
• Early, continuous maternal-infant contact after birth is our evolutionary norm. Until comparatively recently, separation of mothers and infants at birth was routine within the Western medical model. For the mother, touch, warmth, and odor are vagal stimulants that release oxytocin, which increases social responsiveness, decreases anxiety, and increases the temperature around the breasts. The newborn in the first awake-alert period has a heightened response to maternal smell. During the sensitive minutes and hours after birth, close contact primes the synchronicity between mother and infant. Skin-to-skin contact (SSC) for more than 50 minutes after birth leads to an eightfold increase in spontaneous nursing and may be a critical component in breastfeeding success. Mothers of premature infants benefit from SSC by improved bonding and confidence, and thus duration of breastfeeding is increased. (See “Kangaroo Care for Low-Birth-Weight Infants,” Evidence-Based Practice box in Chapter 27.)

OBJECTIVES
• Reviewers sought to examine whether early SSC results in beneficial or adverse maternal and infant outcomes. Specific outcomes to be examined included:
  1. Breastfeeding duration and problems
  2. Maternal bonding and attachment behaviors (en face position [eye-to-eye contact while being held], kissing, smiling, holding, and encompassing)
  3. Maternal psychologic changes (anxiety, self-efficacy, parenting competence)
  4. Infant physiologic changes (temperature, respiratory rate, heart rate, and blood glucose)
  5. Infant behavioral changes (crying and grimacing)
  6. Other outcomes, such as length of stay, cost, and long-term morbidity

METHODS
Search Strategy
The reviewers searched MEDLINE and Cochrane Central Register of Controlled Trials (CENTRAL). Search keywords were baby, infant, newborn, neonate, infant care, mother-child relations, mothers, maternal behavior, infant behavior, neonatal, nursing, breastfeeding, lactation, monitoring physiologic, heart rate, respiration, skin temperature, object attachment, touch, therapeutic touch, early contact, immediate contact, kangaroo, and skin-to-skin. Reviewers selected 17 studies, involving a total of 806 women from both upper and lower socioeconomic classes. The studies, dating from 1977 to 1999, were from Canada, Guatemala, Spain, Sweden, Taiwan, and the United States. All were controlled trials. The intervention was some protocol for SSC, with the naked or diapered infant placed on the mother’s chest and covered with a warmed blanket. The controls received standard postpartum care. Sixteen studies used random assignments, while one was quasi-random (assignment not based on patient or clinician preference).

Statistical Analyses
• Reviewers performed metaanalyses of studies with comparable outcomes. The reviewers then compared outcomes to see if the outcomes influenced one another.

FINDINGS
• There seemed to be a “golden 2 hours,” beginning immediately after birth, that resulted in maximum benefit. Spontaneous, effective suckling occurred at about 55 minutes and lasted through the following hour. More effective suckling was associated with long-term breastfeeding success. Significantly less breast engorgement occurred in the SSC group than with standard care. The SSC group was twice as likely as controls to still be breastfeeding at 3 months. Breastfeeding was also more likely in the SSC group at 1 year, but not significantly so. The benefits to breastfeeding were significant even if SSC was delayed by up to 24 hours, but they were most notable when SSC was instituted immediately after birth. Mothers in the SSC group showed significantly more ma-ternal attachment behavior than controls. Studies found that mothers in the SSC group practiced more affectionate love touch during breastfeeding at 36 to 48 hours, kissed the infant more at 3 months, and increased en face positioning, holding, and touching—effects that persisted up to a year later. Newborns in the SSC group had significantly higher temperatures, with less variability, and remained in the thermoneutral zone. Blood glucose was significantly higher and respiratory rate was significantly lower in the SSC group, demonstrating conservation of energy. Heart rate was also decreased with SSC, but not significantly. Infants in the SCC group showed significantly less crying and grimacing than the controls. This is important for the preterm infant, for whom crying causes hypoxemia, fluctuating cerebral blood flow and risk for hemorrhage, intracranial pressure, and wasted calories.

LIMITATIONS
• It would be difficult to blind a randomization such as SSC from the staff and patients. Measured outcomes in the studies varied, making comparison challenging. Protocols also varied. Some SSC was initiated immediately, whereas in other studies SSC was delayed as long as 24 hours. Infant physiologic measurements were done on examination tables instead of in the SSC intervention.

CONCLUSIONS
• By all measures studied, SSC was a beneficial intervention for maternal and infant well-being. No adverse effects of SSC were noted. Our evolutionary norm is strengthened.

IMPLICATIONS FOR PRACTICE
• In particular, SSC during the “golden 2 hours” immediately after birth seems to strengthen bonding and increase success and duration of breastfeeding. Infant physiologic changes and lower risk for hemorrhage, intracranial pressure, and wasted calories.

IMPLICATIONS FOR FURTHER RESEARCH
• More research on SSC effects with preterm and cesarean births would be useful. There is a need to standardize the measures in future trials, especially of maternal emotional well-being and attachment behaviors.

influenced by neuromuscular maturity, maternal medications and anesthetics received during labor and birth, and the type of initial feeding.

A special mechanism present in normal newborns coordinates the breathing, sucking, and swallowing reflexes necessary for oral feeding. Sucking in the newborn takes place in small bursts of three to eight sucks at a time. In the term newborn, longer and more efficient sucking attempts occur a few hours after birth. The infant is unable to move food from the lips to the pharynx; therefore placing the nipple (breast or bottle) well inside the baby’s mouth is necessary. Peristaltic activity in the esophagus is uncoordinated in the first few days of life. It quickly becomes a coordinated pattern in normal infants, and they swallow easily.

Teeth begin developing in utero, with enamel formation continuing until about age 10 years. Tooth development is influenced by neonatal or infant illnesses, medications, and illnesses of or medications taken by the mother during pregnancy. The fluoride level in the water supply also influences tooth development. Occasionally an infant may be born with one or more teeth. Native American infants are commonly born with teeth.

Bacteria are not present in the infant’s gastrointestinal tract at birth. Soon after birth, oral and anal orifices permit entry of bacteria and air. Generally the highest bacterial concentration is found in the lower portion of the intestine, particularly in the large intestine. Normal colonic bacteria are established within the first week after birth, and normal intestinal flora help synthesize vitamin K, folate, and biotin. Bowel sounds can usually be heard shortly after birth.

The capacity of the stomach varies from 30 to 90 ml, depending on the size of the infant. The emptying time for the stomach is highly variable. Several factors, such as time and volume of feedings or type and temperature of food, may affect the emptying time. The cardiac sphincter is immature, and nervous control of the stomach is not well established, so some regurgitation may occur. Regurgitation during the first day or two of life can be decreased by avoiding overfeeding, by burping the infant, and by positioning the infant with the head slightly elevated.

Digestion

The infant’s ability to digest carbohydrates, fats, and proteins is regulated by the presence of certain enzymes. Most of these enzymes are functional at birth. One exception is amylase, produced by the salivary glands after about 3 months and by the pancreas at about 6 months of age. This enzyme is necessary to convert starch into maltose. The other exception is lipase, also secreted by the pancreas; it is necessary for the digestion of fat. Therefore the normal newborn is capable of digesting simple carbohydrates and proteins but has a limited ability to digest fats.

Further digestion and absorption of nutrients occur in the small intestine in the presence of pancreatic secretions, secretions from the liver through the common bile duct, and secretions from the duodenal portion of the small intestine.

Stools

At birth the lower intestine is filled with meconium. Meconium is formed during fetal life from the amniotic fluid and its constituents, intestinal secretions (including bilirubin), and cells (shed from the mucosa). Meconium is greenish black and viscous and contains occult blood. The first meconium passed is sterile, but within hours, all meconium passed contains bacteria. The majority of normal term infants pass meconium within the first 12 hours of life, and almost all do so by 24 hours. Stools change in color and consistency over the first 2 to 3 days as the infant feeds. Breast milk stools are generally more frequent and more liquid than formula stools. They contain small yellow curds, whereas formula stools are more pasty in appearance, with larger green-brown curds. Progressive changes in the appearance of stools and in the stooling pattern indicate a properly functioning gastrointestinal system (Box 18-1). Stooling also is an indicator of the adequacy of nutritional intake. For example, breastfed infants should have at least three stools per 24 hours after day 3 or 4 of life when the mother’s milk is in.

Feedings

Variations occur among infants regarding interest in food, symptoms of hunger, and amount ingested at one time. The amount of food that the infant takes in at any feeding depends on the size, hunger level, and alertness of the infant. When put to breast, some infants feed immediately, whereas others require a longer learning period before breastfeeding is completely effective. Random hand-to-mouth movement and sucking of fingers are well developed at birth and intensified when the infant is hungry. Caregivers should be alert and responsive to these hunger cues.

**Change in Stooling Patterns of Newborns**

**MILK STOOL**

- Usually appear by third day after initiation of feeding; yellowish brown to yellowish green, thin, and less sticky than meconium; may contain some milk curds

**MECONIUM**

- Infant’s first stool is composed of amniotic fluid and its constituents, intestinal secretions, shed mucosal cells, and possibly blood (ingested maternal blood or minor bleeding of alimentary tract vessels)

- Passage of meconium should occur within first 24 to 48 hours, although it may be delayed up to 7 days in very low-birth-weight infants

**TRANSITIONAL STOOLS**

- Usually appear by third day after initiation of feeding; greenish brown to yellowish brown, thin, and less sticky than meconium; may contain some milk curds

**FORMULA-FED INFANTS**

- Stools pale yellow to light brown, firmer in consistency, with an odor similar to that of sour milk

- Formulas have no major impact on stooling patterns
**Signs of risk for gastrointestinal problems**

The time, color, and character of the infant’s first stool should be noted. A lack of passage of stool could indicate bowel obstruction related to conditions such as an inborn error of metabolism (e.g., cystic fibrosis) or a congenital disorder (e.g., Hirschsprung disease or an imperforate anus). An active rectal "wink" reflex (contraction of the anal sphincter muscle in response to touch) usually is a good sign of sphincter tone.

Some infants do not digest specific formulas well. If an infant is allergic to or unable to digest a formula, the stools may become very soft with a high water content that is seen as a distinct water ring around the stool on the diaper. Forceful ejection of stool and a water ring around the stool are signs of diarrhea. Care must be taken to avoid misinterpreting transitional stools for diarrhea. The loss of fluid in diarrhea can rapidly lead to fluid and electrolyte imbalance.

Passage of meconium from the vagina or urinary meatus is a sign of a possible fistulous tract from the rectum.

Abdominal distention at birth usually indicates a serious disorder such as a ruptured viscus (from abdominal wall defects) or tumors. Distention that occurs later may be the result of overfeeding or may signal gastrointestinal disorders. A scaphoid (sunken) abdomen with bowel sounds heard in the chest and signs of respiratory distress indicate a diaphragmatic hernia.

The amount and frequency of regurgitation ("spitting up") after feedings must be recorded. Color change, gagging, and projectile (very forceful) vomiting occur in association with esophageal and tracheoesophageal anomalies.

**Hepatic System**

In the newborn the liver can be palpated about 1 cm below the right costal margin because it is enlarged and occupies about 40% of the abdominal cavity. The infant’s liver plays an important role in iron storage, carbohydrate metabolism, conjugation of bilirubin, and coagulation.

**Iron storage**

The infant’s iron store in the liver is proportional to the body weight and, for the term infant, should be sufficient for the first 4 to 6 months. Preterm and small-for-date infants have lower iron stores, which are sufficient for only 2 to 3 months.

**Carbohydrate metabolism**

At birth the newborn is cut off from its maternal glucose supply and, as a result, has an initial decrease in serum glucose levels. The newborn’s increased energy needs, decreased hepatic release of glucose from glycogen stores, increased RBC volume, and increased brain size may initially contribute to the rapid depletion of stored glycogen within the first 24 hours after birth. In most healthy term newborns, blood glucose levels stabilize at 40 to 60 mg/dl during the first several hours after birth, by the third day of life the blood glucose levels should be approximately 60 to 70 mg/dl. The initiation of feedings assists in the stabilization of the newborn’s blood glucose levels. If the infant appears to be jittery or has tremors, the blood glucose level should be determined to rule out hypoglycemia.

**Conjugation of bilirubin**

Bilirubin is a yellow pigment derived from the hemoglobin released with the breakdown of RBCs and the myoglobin in muscle cells. The hemoglobin is phagocytized by the reticuloendothelial cells, converted to bilirubin, and released in an unconjugated form. Unconjugated bilirubin, termed *direct bilirubin*, is relatively insoluble and almost entirely bound to circulating albumin, a plasma protein. The unbound bilirubin can leave the vascular system and permeate other extravascular tissues (e.g., the skin, sclera, and oral mucous membranes). The resultant yellow coloring is termed *jaundice*.

In the liver the unbound bilirubin is conjugated with glucuronic acid in the presence of the enzyme glucuronyl transferase. The conjugated form of bilirubin is excreted from liver cells as a constituent of bile. This form is termed *direct bilirubin* and is water soluble. Along with other components of bile, direct bilirubin is excreted into the biliary tract system that carries the bile into the duodenum. Bilirubin is converted to urobilinogen and stercobilinogen within the duodenum by the action of the bacterial flora. Urobilinogen is excreted in urine and feces; stercobilinogen is excreted in the feces (Fig. 18-4). The total serum bilirubin level is the sum
of the levels of both conjugated (direct) and unconjugated (indirect) bilirubin.

Adequate serum albumin-binding sites are available unless the infant has asphyxia neonatorum (respiratory failure in the newborn), cold stress, or hypoglycemia. A mother’s prebirth ingestion of medications such as sulfis drugs and aspirin can reduce the amount of serum albumin-binding sites in the newborn. Although the neonate has the functional capacity to convert bilirubin, physiologic hyperbilirubinemia commonly occurs in infants.

**Physiologic jaundice**

Physiologic jaundice or neonatal jaundice or hyperbilirubinemia occurs in as many as 60% of newborn infants but is more severe in preterm infants (Frank, Cooper, & Merenstein, 2002; Reiser, 2004). The incidence and severity of physiologic jaundice is increased in Asian and Native American infants (Hockenberry, 2003). Although neonatal jaundice is considered benign, bilirubin may accumulate to hazardous levels and lead to a pathologic condition. Physiologic jaundice results from characteristics of normal newborn physiology, such as increased bilirubin production resulting from increased RBC mass, shortened life span of the fetal RBCs, and liver immaturity. Newborns also tend to reabsorb bilirubin from the small intestine.

The infant who is diagnosed with physiologic jaundice appears to be otherwise well and exhibits signs of jaundice after age 24 hours. Jaundice is clinically visible when bilirubin (unconjugated) is no more than 12 mg/dl by 3 days of age. In preterm infants the peak is higher (15 mg/dl) and tends to occur later. The peak indirect bilirubin level may be higher in breastfed infants (15 to 17 mg/dl). Jaundice is considered to be pathologic if it appears before 24 hours of age, increases more than 0.5 mg/dl/hr, peaks at greater than 13 mg/dl in a term infant, or is associated with anemia and hepatosplenomegaly. Jaundice that appears before 24 hours of age always warrants immediate attention. Pathologic jaundice is usually caused by blood group incompatibility or infection but may rarely be the result of RBC enzyme defects (glucose-6-phosphate dehydrogenase [G6PD], pyruvate kinase), RBC membrane disorders (spherocytosis, ovalocytosis), or hemoglobinopathy (thalassemia) (Frank, Cooper, & Merenstein, 2002).

**Kernicterus**

Jaundice appears in a cephalocaudal manner. It is generally first noticed in the head, especially the sclera and mucous membranes, and then progresses gradually to the thorax, abdomen, and extremities. It dissipates in the reverse order.

Feeding practices may influence the appearance and degree of physiologic hyperbilirubinemia. Early (within the first hour) and frequent feeding tends to keep the serum bilirubin level low by stimulating intestinal activity (the gastrocolic reflex) and passage of meconium.

Cold stress of the newborn may result in acidosis and increase the level of free fatty acids. In the presence of acidosis, albumin binding of bilirubin is weakened, and bilirubin is freed.

Kernicterus, or bilirubin encephalopathy, is the most serious complication of neonatal hyperbilirubinemia. It occurs when bilirubin is deposited in the basal ganglia and brainstem, disrupting neuronal function and metabolism. Kernicterus usually occurs when bilirubin levels are higher than 25 mg/dl but may be noted with levels that are lower than 20 mg/dl in the presence of sepsis, meningitis, hypothermia, hyperbilirubinemia, prematurity, and bilirubin-displacing drugs. In the acute stage of kernicterus, the infant is lethargic and hypotonic and has a poor suck. If untreated, the infant becomes hypertonic (with backward arching of the neck and trunk), has a high-pitched cry, and may develop fever. If an infant survives kernicterus, there may be residual cerebral palsy, epilepsy, and mental retardation. Although neonatal jaundice is common and kernicterus is rare, in recent years, there has been a resurgence in the number of infants with kernicterus. This may be related to the shortened hospital stays after birth, an increase in the incidence of neonatal jaundice, and a lack of concern and attention to infants exhibiting...
signs of jaundice (Maisels, 2001) (see Chapters 19 and 27). The Joint Commission on Accreditation of Healthcare Organizations (2001) issued a sentinel event alert with guidelines for the prevention of neonatal k GMC by health care workers and institutions.

Noninvasive monitoring of bilirubin by means of cutaneous reflectance measurements (transcutaneous bilirubinometry [TcB]) allows for repetitive estimations of bilirubin levels. These devices work well on dark- and light-skinned infants and correlate fairly well with serum measurements of bilirubin levels in term infants. With shorter maturity stays, the transcutaneous bilirubin measurement can be valuable as an assessment tool for home care follow-up. Transcutaneous bilirubin meters have been significantly improved in the last two decades and may reduce or obviate the need for blood sampling in certain healthy neonates (Briseoe, Clark, & Yokall, 2002). The TcB monitors provide accurate measurements within 2 to 3 mg/dl in most neonatal populations at serum levels less than 15 mg/dl (American Academy of Pediatrics [AAP], 2004). After phototherapy has been initiated, TcB is no longer useful as a screening tool. It is important to note that the intensity of jaundice is not always related to the degree of hyperbilirubinemia.

The use of hour-specific serum bilirubin levels to predict newborns at risk for rapidly rising levels has now become an official recommendation of the AAP Subcommittee on Hyperbilirubinemia (2004), for the monitoring of healthy neonates at 35 weeks of gestation or greater before discharge from the hospital. A nomogram with three levels (high, intermediate, or low risk) of rising total serum bilirubin may be used at the same time as the routine newborn profile (phenyketonuria [PKU], galactosemia, and others). In many institutions the hour-specific bilirubin risk nomogram is used to determine the infant’s risk for development of hyperbilirubinemia requiring medical treatment or closer monitoring. Risk factors recognized to place infants in the high risk category include gestational age less than 38 weeks, breastfeeding, previous sibling with significant jaundice, and jaundice appearing before discharge. It is now recommended that healthy infants (35 weeks or greater) receive follow-up care and assessment of bilirubin within 3 days of discharge if discharged at less than 24 hours and a risk assessment with tools such as the hour-specific nomogram; Likewise, newborns discharged at 24 to 47.9 hours should receive follow-up evaluation within 4 days (96 hours), and those discharged between 48 and 72 hours should receive follow-up within 5 days. Risk factors not be available to assess pathologic increases in circulating unbound bilirubin. Therefore all parents need instruction in how to assess jaundice and when to call the health care provider.

Jaundice associated with breastfeeding

Breastfeeding is associated with an increased incidence of jaundice. Two types have been identified; however, nomenclature may vary among experts. Breastfeeding-associated jaundice (early-onset jaundice) begins at 2 to 4 days of age and occurs in approximately 10% to 25% of breastfed newborns. The jaundice is related to the process of breastfeeding and probably results from decreased caloric and fluid intake by breastfed infants before the milk supply is well established; this is related to decreased hepatic clearance of bilirubin (Blackburn, 2003; Porter & Dennis, 2002).

Breast milk jaundice (late-onset jaundice) has been defined as a progressive indirect hyperbilirubinemia beyond the first week of life; it typically occurs after 3 to 5 days of age and peaks by about 2 weeks. Despite high levels of bilirubin that may persist for 3 to 12 weeks, these infants are well. The jaundice may be caused by factors in the breast milk that either inhibit the conjugation or decrease the excretion of bilirubin. Less frequent stooling by breastfed infants may allow for extended time for reabsorption of bilirubin from stools (Blackburn, 2003). (See Chapter 20 for a discussion of this topic.)

Coagulation

The liver plays an important role in blood coagulation. Coagulation factors, which are synthesized in the liver, are activated by vitamin K. The lack of intestinal bacteria needed to synthesize vitamin K results in a transient blood coagulation deficiency between days 2 and 5 of life. The levels of coagulation factors slowly increase to reach adult levels by age 9 months. An injection of vitamin K soon after birth helps prevent clotting problems. Any bleeding problems noted in an infant should be reported immediately, and tests for clotting ordered.

Signs of risk for hepatic system problems

Some problems such as kernicterus and hypoglycemia have already been discussed. The infant’s hemoglobin levels must be assessed for anemia. Because infants may develop a coagulation deficiency, a male child who has been circumcised must be observed closely for signs of hemorrhage. Hemorrhage also could be caused by a clotting defect, indicating a serious problem such as hemophilia.

Immune System

Immunity

The cells that provide the infant with immunity are developed early in fetal life; however, they are not activated for several months. For the first 3 months of life the infant is protected by passive immunity received from the mother. Natural barriers such as the acidity of the stomach and the production of pepsin and trypsin, which maintain sterility of the small intestine, are not fully developed until age 3 to

NURSE ALERT: In cases in which the infant is discharged from the hospital before 48 hours after birth or the infant is born at home, a professional attendant may not be available to assess pathologic increases in circulating unbound bilirubin. Therefore all parents need instruction in how to assess jaundice and when to call the health care provider.
4 weeks. The membrane-protective immunoglobulin A (IgA) is missing from the respiratory and urinary tracts, and unless the newborn is breastfed, it also is absent from the gastrointestinal tract. The infant begins to synthesize IgG, and about 40% of adult levels are reached by age 1 year. Significant concentrations of IgM are produced at birth, and adult levels are reached by age 9 months. The production of IgA, IgD, and IgE is much more gradual, and maximal levels are not attained until early childhood.

The infant who is breastfeeding receives passive immunity through the colostrum and breast milk. The protection provided varies with the age and maturity of the infant and the mother's level of immunity.

**Signs of risk for immune system problems**

All newborns and preterm newborns especially are at high risk for infection during the first several months of life. During this period, infection is one of the leading causes of morbidity and mortality. The newborn cannot limit the invading pathogen to the portal of entry because of the generalized hypofunctioning of the inflammatory and immune mechanisms. Any unusual discharges from the infant’s eyes, nose, mouth, or other orifice must be investigated. If a rash appears, it must be evaluated closely; many normal rashes in the newborn are not associated with any infection. When an infant is in a septic state, the usual response is respiratory distress. Infants must be protected from infections by the use of good handwashing techniques.

**Integumentary System**

All skin structures are present at birth. The epidermis and dermis are loosely bound and extremely thin. Vernix caseosa (a cheeselike, whitish substance) is fused with the epidermis and serves as a protective covering. The infant’s skin is very sensitive and can be easily damaged. The term infant has an erythematous (red) skin for a few hours after birth, after which it fades to its normal color. The skin often appears blotchy or mottled, especially over the extremities. The hands and feet appear slightly cyanotic (acrocyanosis); this is caused by vasoconstrictor instability, capillary stasis, and a high hemoglobin level. Acrocyanosis is normal and appears intermittently over the first 7 to 10 days, especially with exposure to cold.

The healthy term newborn is plump. Subcutaneous fat accumulated during the last trimester acts as insulation. The newborn’s skin may be slightly tight, suggesting fluid retention. Fine lanugo hair may be noted over the face, shoulders, and back. Actual edema of the face and ecchymosis (bruising) or petechiae may be present as a result of face presentation or forceps-assisted birth.

Creases can be found on the palms of the hands. The simian line, a single palmar crease, is often found in Asian infants or in infants with Down syndrome. The soles of the feet should be inspected for the number of creases. Premature newborns have few if any creases. Increasing numbers of creases correlate with a greater maturity rating.

**Caput succedaneum**

Caput succedaneum is a generalized, easily identifiable edematous area of the scalp, most commonly found on the occiput (Fig. 18-5, A). With vertex presentation the sustained pressure of the occiput against the cervix results in compression of local vessels, thereby slowing venous return. The slower venous return causes an increase in tissue fluids within the skin of the scalp, and an edematous swelling develops. This boggy edematous swelling, present at birth, extends across suture lines of the fetal skull and disappears spontaneously within 3 to 4 days. Infants who are born with the assistance of vacuum extraction usually have a caput (and bruising) in the area where the cup was applied.
Cephalhematoma

Cephalhematoma is a collection of blood between a skull bone and its periosteum; therefore a cephalhematoma does not cross a cranial suture line (Fig. 18-5, B). Caput succedaneum and cephalhematoma often occur simultaneously. Bleeding resulting in cephalhematoma may occur with spontaneous birth from pressure against the maternal bony pelvis. Low forceps birth and difficult forceps rotation and extraction also may cause bleeding. This soft, fluctuating, irreducible fullness of cephalhematoma does not pulsate or bulge when the infant cries. It appears several hours or the day after birth and may not become apparent until a caput succedaneum is absorbed. A cephalhematoma is usually largest on the second or third day, by which time the bleeding stops. The fullness of a cephalhematoma spontaneously resolves in 3 to 6 weeks. It is not aspirated because infection may develop if the skin is punctured. As the hematoma resolves, hemolysis of RBCs occurs, and jaundice may result. Hyperbilirubinemia may occur after the newborn is home.

Subgaleal hemorrhage

Subgaleal hemorrhage is bleeding into the subgaleal compartment. The subgaleal compartment is a potential space that contains loosely arranged connective tissue; it is located beneath the galea aponeurosis, the tendinous sheath that connects the frontal and occipital muscles and forms the inner surface of the scalp. The injury occurs as a result of forces that compress and then drag the head through the pelvic outlet (Paige & Carney, 2002). There have been reports of concern regarding the increased use of the vacuum extractor at birth and an association with cases of subgaleal hemorrhage and neonatal mortality (Garas et al., 2001; Ross, Fresquez, & El-Haddad, 2001); however, the rates of such outcomes are reportedly declining (Putta & Spencer, 2000). The bleeding extends beyond bone, often posteriorly into the neck, and continues after birth, with the potential for serious complications such as anemia or hypovolemic shock.

Early detection of the hemorrhage is vital; serial head circumference measurements and inspection of the back of the neck for increasing edema and a firm mass are essential. A boggy scalp, pallor, tachycardia, and increasing head circumference may also be early signs of a subgaleal hemorrhage (Putta & Spencer, 2000). Computerized tomography or magnetic resonance imaging is useful in confirming the diagnosis. Replacement of lost blood and clotting factors is required in acute cases of hemorrhage. Another possible sign of subgaleal hemorrhage is a forward and lateral positioning of the infant’s ears because the hematoma extends posteriorly. Monitoring the newborn for changes in level of consciousness and a decrease in the hematocrit are also key to early recognition and management. An increase in serum bilirubin levels may be seen as a result of the degrading blood cells within the hematoma.

Desquamation

Desquamation (peeling) of the skin of the term infant does not occur until a few days after birth. Its presence at birth is an indication of postmaturity.

Sweat and oil glands

Sweat glands are present at birth but do not respond to increases in ambient or body temperature. Some fetal sebaceous (oil) gland hyperplasia and secretion of sebum result from the hormonal influences of pregnancy. Vernix caseosa is a product of the sebaceous glands. Removal of the vernix is followed by desquamation of the epidermis in most infants. Distended, small, white sebaceous glands (milia) may be noticeable on the newborn face.

Mongolian spots

Mongolian spots, bluish-black areas of pigmentation, may appear over any part of the exterior surface of the body, including the extremities. They are more commonly noted on the back and buttocks (Fig. 18-6). These pigmented areas are most frequently noted in babies whose ethnic origins are in the Mediterranean area, Latin America, Asia, or Africa. They are more common in dark-skinned individuals, regardless of race. They fade gradually over months or years. Mongolian spots have no clinical significance but can be mistaken for bruises.

Nevi

Known as “stork bites” or “angel kisses,” telangiectatic nevi are pink and easily blanched (Fig. 18-7, A). They may appear on the upper eyelids, nose, upper lip, lower occipital area, and nape of the neck. They have no clinical significance and fade by the second year of life.

The strawberry mark, or nevus vasculosus, is a common type of capillary hemangioma. It consists of dilated, newly formed capillaries occupying the entire dermal and subdermal layers, with associated connective tissue hypertrophy. The typical lesion is a raised, sharply demarcated, bright or
dark red, rough-surfaced swelling that resembles a strawberry. Lesions usually are single but may be multiple, with 75% occurring on the head. These lesions can remain until the child is of school age or sometimes even longer.

A port-wine stain, or nevus flammeus, is usually observed at birth and is composed of a plexus of newly formed capillaries in the papillary layer of the corium. It is red to purple; varies in size, shape, and location; and is not elevated. True port-wine stains do not blanch on pressure or disappear. They are most frequently found on the face.

**Erythema toxicum**

A transient rash, erythema toxicum, is also called erythema neonatorum, newborn rash, or flea bite dermatitis. It has lesions in different stages: erythematous macules, papules, and small vesicles (Fig. 18-7, B). The lesions may appear suddenly anywhere on the body. The rash is thought to be an inflammatory response. Eosinophils, which help decrease inflammation, are found in the vesicles. The rash is found in term neonates (gestational age of 36 weeks or more) during the first 3 weeks after birth. Although the appearance is alarming, the rash has no clinical significance and requires no treatment.

**Signs of risk for integumentary problems**

Close observation of the newborn’s skin color can lead to early detection of potential problems. Any pallor, plethora (deep purplish color from increased circulating RBCs), petechiae, central cyanosis, or jaundice should be noted and described. The skin should be examined for signs of birth injuries, such as forceps marks and lesions related to fetal monitoring. Bruises or petechiae may be present on the head, neck, and face of an infant born with a nuchal cord (cord around the neck) or in an infant who had a face presentation at birth. When bruises are present, the infant’s bilirubin levels may become elevated. Petechiae may be present if increased pressure was applied to an area. Petechiae scattered over the infant’s body should be reported to the pediatrician because their presence may indicate underlying problems such as low platelet count or infection. Unilateral or bilateral periocular papillomas (skin tags) occur fairly frequently. Their occurrence is usually a family trait and of no consequence.

**Reproductive System**

**Female**

At birth the ovaries contain thousands of primitive germ cells. These represent the full complement of potential ova; no oogonia form after birth in term infants. The ovarian cortex, which is made up primarily of primordial follicles, occupies a larger portion of the ovary in the female newborn than in the female adult. From birth to sexual maturity the number of ova decreases by approximately 90%.

An increase of estrogen during pregnancy followed by a decrease after birth results in a mucoid vaginal discharge and even some slight bloody spotting (pseudomenstruation). External genitals are usually edematous with increased pigmentation. In term newborn infants the labia majora and minora cover the vestibule (Fig. 18-8, A). In preterm infants, the clitoris is prominent, and the labia majora are small and widely separated. Vaginal or hymenal tags are common findings and have no clinical significance. Vernix caseosa may be present between the labia.

If the female was born in the breech position, the labia may be edematous and bruised. The edema and bruising resolve in a few days; no treatment is necessary.

**Male**

The testes descend into the scrotum by birth in 90% of newborn boys. Although this percentage decreases with prematurity birth, by 1 year of age the incidence of undescended testes in all boys is less than 1%.

A tight prepuce (foreskin) is common in newborns. The urethral opening may be completely covered by the prepuce, which may not be retractable for 3 to 4 years. Smegma, a white, cheesy substance, is commonly found under the foreskin. Small, white, firm lesions called epithelial pearls may be seen at the tip of the prepuce. By 28 to 36 weeks of gestation,
the testes can be palpated in the inguinal canal, and a few rugae appear on the scrotum. At 36 to 40 weeks of gestation, the testes are palpable in the upper scrotum, and rugae appear on the anterior portion. After 40 weeks, the testes can be palpated in the scrotum, and rugae cover the scrotal sac. The postterm neonate has deep rugae and a pendulous scrotum. The scrotum is usually more deeply pigmented than the rest of the skin (Fig. 18-8, B), particularly in darker-skinned infants. Hydroceles, caused by an accumulation of fluid around the testes, may be present. They can be easily transilluminated with a light and usually decrease in size without treatment.

If the male infant was born in a breech presentation, the scrotum may appear very edematous and bruised. The swelling and discoloration resolve within a few days.

Swelling of breast tissue
Swelling of the breast tissue in infants of both sexes is caused by the hyperestrogenism of pregnancy. In a few infants a thin discharge (witch’s milk) can be seen. This condition has no clinical significance, requires no treatment, and subsides as the maternal hormones are eliminated from the infant’s body within a few days.

The nipples should be symmetric on the chest. Breast tissue and areola size increase with gestation. The areola appears slightly elevated at 34 weeks of gestation. By 36 weeks, a breast bud of 1 to 2 mm is palpable and increases to 12 mm by 42 weeks.

Signs of risk for reproductive system problems
The infant must be closely inspected for ambiguous genitalia and other abnormalities. Normally in a female infant the urethral opening is located behind the clitoris. Any deviation from this may incorrectly suggest that the clitoris is a small penis, which can occur in conditions such as adrenal hyperplasia. Nearly all female infants are born with hymenal tags; absence of such tags could indicate vaginal agenesis. Fecal discharge from the vagina indicates a rectovaginal fistula. Any of these findings must be reported to the physician for further evaluation.

The male infant’s scrotum should always be palpated for the presence of testes. Inguinal hernias may be present and become more obvious when the infant cries. If the urinary meatus is not at the tip of the glans penis, hypospadias (urethral meatus opening on the underside of the penis) or epispidias (urethral meatus opening on the top of the penis) may be present. These problems are usually associated with other anomalies.

Skeletal System
The infant’s skeletal system undergoes rapid development during the first year of life. At birth, more cartilage is present than ossified bone. Because of cephalocaudal (head-to-rump) development, the newborn looks somewhat out of proportion.

At term the head is one fourth the total body length. The arms are slightly longer than the legs. In the newborn, the legs are one third the total body length, but only 15% of the total body weight. As growth proceeds, the midpoint in head-to-toe measurements gradually descends from the level of the umbilicus at birth to the level of the symphysis pubis at maturity.

The face appears small in relation to the skull, which appears large and heavy. Cranial size and shape can be distorted by molding (the shaping of the fetal head by the overlapping of cranial bones to facilitate movement through the birth canal during labor) (Fig. 18-9).

The bones in the vertebral column of the newborn form two primary curvatures—one in the thoracic region and one in the sacral region (Fig. 18-10, A). Both are forward, concave curvatures. As the infant gains head control at approximately age 3 months, a secondary curvature appears in the cervical region (Fig. 18-10, B).
In some newborns, a significant separation of the knees occurs when the ankles are held together, resulting in an appearance of bowlegs (Fig. 18-11, A). If an infant was in the frank breech position in utero, the legs may be extended and remain in this position for several weeks. The newborn is also very flat footed because no clearly apparent arch to the foot is present (Fig. 18-11, B).

The infant’s extremities should be symmetric and of equal length. Fingers and toes should be equal in number and should have nails present. Extra digits (polydactyly) are sometimes found on hands or feet. Fingers or toes may be fused (syndactyly).

The infant’s hips should be inspected for symmetry. Skin folds should be equal and symmetric. Hip integrity is assessed by using the Ortolani maneuver (Fig. 18-12). The examiner places the index and middle fingers of each hand over the greater trochanters of the hips at the same time. Downward pressure is exerted on the hips while the neonate’s knees are flexed. The hips are flexed at least 70 degrees and then abducted. The motion should be smooth without any unusual clicks. The presence of a click, unequal movement, or uneven gluteal skin folds is considered a positive response, indicating that the hip is dislocated, and the physician should be notified.

The newborn’s spine appears straight and can be easily flexed. The newborn can lift the head and turn it from side to side when prone. The vertebrae should appear straight and flat. The base of the spine should not have a dimple. If a dimple is noted, further inspection is required to determine whether a sinus is present. A pilonidal dimple, especially with a sinus and nevus pilosis (hairy nevus), is significant because it can be associated with spina bifida.
Signs of risk for skeletal problems
Skeletal deformities may be congenital or drug induced. Clubfoot (talipes equinovarus), a deformity in which the foot turns inward and is fixed in a plantar-flexion position, and any absence of a limb or digit should be recorded and reported. Signs of congenital hip dislocation, additional digits or webbing of digits, and any other abnormality should be recorded and reported to the health care provider.

Neuromuscular System
Unlike the skeletal system, the neuromuscular system is almost completely developed at birth. The term newborn is a responsive and reactive being with remarkable sensory development and an amazing ability for self-organization and social interaction.

Growth of the brain after birth follows a predictable pattern of rapid growth during infancy and early childhood, more gradual growth during the remainder of the first decade, and minimal growth during adolescence. The cerebellum ends its growth spurt, which began at about 30 gestational weeks, by the end of the first year. This may be the reason the brain is vulnerable to nutritional deficiencies and trauma in early infancy.

The brain requires glucose as a source of energy and a relatively large supply of oxygen for adequate metabolism. Such requirements signal a need for careful assessment of the infant’s respiratory status. The necessity for glucose requires attentiveness to those neonates who may have hypoglycemic episodes.

Spontaneous motor activity may be seen as transient tremors of the mouth and chin, especially during crying episodes, and of the extremities, notably the arms and hands. Transient tremors are normal and can be observed in nearly every newborn. These tremors should not be present when the infant is quiet and should not persist beyond 1 month of age. Persistent tremors or tremors involving the total body may indicate pathologic conditions. Marked tonicity, clonicity, and twitching of facial muscles are signs of seizure activity. Normal tremors, tremors of hypoglycemia, and central nervous system (CNS) disorders must be differentiated so that diagnostic workups and corrective care can be instituted as necessary.

Although it is limited, some neuromuscular control is present in the newborn. If newborns are placed face down on a firm surface, they will turn their heads to the side to maintain an airway. They attempt to hold their heads in line with their bodies if they are raised by their arms.

Newborn reflexes
The newborn has many primitive reflexes. The times at which these reflexes appear and disappear reflect the maturity and intactness of the developing nervous system. The most common reflexes found in the normal newborn are described in Table 18-3. The physical assessment includes a neurologic assessment of the newborn’s reflexes. This provides useful information about the infant’s nervous system and state of neurologic maturation. Many reflex behaviors are important for survival, for example, sucking and rooting. Other reflexes act as safety mechanisms, for instance, gagging, coughing, and sneezing. The assessment must be carried out as early as possible because abnormal signs present in the early neonatal period may disappear. They may reappear months or years later as abnormal functions.
### TABLE 18-3
Assessment of Newborn's Reflexes

<table>
<thead>
<tr>
<th>REFLEX</th>
<th>ELICITING THE REFLEX</th>
<th>CHARACTERISTIC RESPONSE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucking and rooting</td>
<td>Touch infant's lip, cheek, or corner of mouth with nipple</td>
<td>Infant turns head toward stimulus, opens mouth, takes hold, and sucks</td>
<td>Response is difficult if not impossible to elicit after infant has been fed; if response weak or absent, consider prematurity or neurologic defect</td>
</tr>
<tr>
<td>Swallowing</td>
<td>Feed infant; swallowing usually follows sucking and obtaining fluids</td>
<td>Swallowing is usually coordinated with sucking and usually occurs without gagging, coughing, or vomiting</td>
<td>If response is weak or absent, may indicate prematurity or neurologic defect</td>
</tr>
<tr>
<td>Extrusion</td>
<td>Touch or depress tip of tongue Tap over forehead, bridge of nose, or maxilla of newborn whose eyes are open</td>
<td>Newborn forces tongue outward Newborn blinks for first four or five taps</td>
<td>Sucking and swallowing are often uncoordinated in preterm infant</td>
</tr>
<tr>
<td>Glabellar (Myerson's)</td>
<td>With infant falling asleep or sleeping, turn head quickly to one side</td>
<td>With infant facing left side, arm and leg on that side extend; opposite arm and leg flex (turn head to right, and extremities assume opposite postures)</td>
<td>Responses in leg are more consistent than in arm Complete response disappears by 3 to 4 mo, incomplete response may be seen until third or fourth year After 6 wk, persistent response is sign of possible cerebral palsy</td>
</tr>
<tr>
<td>Tonic neck or &quot;fencing&quot;</td>
<td>With infant facing left side, arm and leg on that side extend; opposite arm and leg flex (turn head to right, and extremities assume opposite postures)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Classic pose in spontaneous tonic neck reflex. (Courtesy Marjorie Pyle, RNC, Lifecircle, Costa Mesa, CA.)*

*All durations for persistence of reflexes are based on time elapsed after 40 wk of gestation, that is, if this newborn was born at 36 wk of gestation, add 1 mo to all time limits given.*
### TABLE 18-3
Assessment of Newborn’s Reflexes—cont’d

<table>
<thead>
<tr>
<th>REFLEX</th>
<th>ELICITING THE REFLEX</th>
<th>CHARACTERISTIC RESPONSE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moro</td>
<td>Hold infant in semisitting position, allow head and trunk to fall backward to an angle of at least 30 degrees</td>
<td>Symmetric abduction and extension of arms are seen; fingers fan out and form a C with thumb and forefinger; slight tremor may be noted; arms are adducted in embracing motion and return to relaxed flexion and movement. Legs may follow similar pattern of response. Preterm infant does not complete “embrace”; instead, arms fall backward because of weakness.</td>
<td>Response is present at birth; complete response may be seen until 8 wk; body jerk is seen only between 8 and 18 wk; response is absent by 6 mo if neurologic maturation is not delayed; response may be incomplete if infant is deeply asleep; give parental guidance about normal response. Asymmetric response may connote injury to brachial plexus, clavicle, or humerus. Persistent response after 6 mo indicates possible brain damage.</td>
</tr>
<tr>
<td>Stepping or “walking”</td>
<td>Hold infant vertically, allowing one foot to touch table surface</td>
<td>Infant will simulate walking, alternating flexion and extension of feet; term infants walk on soles of their feet, and preterm infants walk on their toes</td>
<td>Response is normally present for 3 to 4 wk.</td>
</tr>
</tbody>
</table>


## TABLE 18-3
### Assessment of Newborn’s Reflexes—cont’d

<table>
<thead>
<tr>
<th>REFLEX</th>
<th>ELICITING THE REFLEX</th>
<th>CHARACTERISTIC RESPONSE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crawling</td>
<td>Place newborn on abdomen</td>
<td>Newborn makes crawling movements with arms and legs</td>
<td>Response should disappear about 6 wk of age</td>
</tr>
<tr>
<td>Deep tendon</td>
<td>Use finger instead of percussion hammer to elicit patellar, or knee jerk, reflex; newborn must be relaxed</td>
<td>Reflex jerk is present; even with newborn relaxed, nonselective overall reaction may occur</td>
<td></td>
</tr>
<tr>
<td>Crossed extension</td>
<td>Infant should be supine; extend one leg, press knee downward, stimulate bottom of foot; observe opposite leg</td>
<td>Opposite leg flexes, adducts, and then extends</td>
<td></td>
</tr>
<tr>
<td>Startle</td>
<td>Perform sharp hand clap; best elicited if newborn is 24 to 36 hr old or older</td>
<td>Arms abduct with flexion of elbows, hands stay clenched</td>
<td>Response should disappear by 4 mo of age</td>
</tr>
<tr>
<td>Babinski sign (plantar)</td>
<td>On sole of foot, beginning at heel, stroke upward along lateral aspect of sole, then move finger across ball of foot</td>
<td>All toes hyperextend, with dorsiflexion of big toe; recorded as a positive sign</td>
<td>Absence requires neurologic evaluation, should disappear after 1 yr of age</td>
</tr>
</tbody>
</table>

Crossed extension reflex. With the infant in supine position, examiner extends one leg of the infant and presses the knee down. Stimulation of sole of foot of fixated limb should cause free leg to flex, adduct, and extend as if attempting to push away stimulating agent. This reflex should be present during newborn period. (Courtesy Marjorie Pyle, RNC, Lifecircle, Costa Mesa, CA.)

Babinski reflex. (From Hockenberry, M. [2003]. Wong’s nursing care of infants and children [7th ed.]. St. Louis: Mosby.)
### TABLE 18-3
**Assessment of Newborn’s Reflexes—cont’d**

<table>
<thead>
<tr>
<th>REFLEX</th>
<th>ELICITING THE REFLEX</th>
<th>CHARACTERISTIC RESPONSE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull-to-sit (traction)</td>
<td>Pull infant up by wrists from supine position with head in midline</td>
<td>Head will lag until infant is in upright position, then head will be held in same plane with chest and shoulder momentarily before falling forward; infant will attempt to right head</td>
<td>Response depends on general muscle tone and maturity and condition of infant</td>
</tr>
<tr>
<td>Trunk incurvation (Galant)</td>
<td>Place infant prone on flat surface, run finger down back about 4 to 5 cm lateral to spine, first on one side and then down other</td>
<td>Trunk is flexed, pelvis is swung toward stimulated side. With transverse lesions of cord, no response below the level of the lesion is present.</td>
<td>Response disappears by fourth week. Absence suggests general depression of nervous system. Response may vary but should be obtainable in all infants, including preterm ones.</td>
</tr>
<tr>
<td>Magnet</td>
<td>Place infant in supine position, partially flex both lower extremities, and apply pressure to soles of feet</td>
<td>Both lower limbs should extend against examiner’s pressure</td>
<td>Absence suggests damage to spinal cord or malformation. Reflex may be weak or exaggerated after breech birth</td>
</tr>
<tr>
<td>Additional newborn responses: Yawn, stretch, burp, hiccup, sneeze</td>
<td>These are spontaneous behaviors</td>
<td>May be slightly depressed temporarily because of maternal analgesia or anesthesia, fetal hypoxia, or infection</td>
<td>Parental guidance: most of these behaviors are pleasurable to parents. Parents need to be assured that behaviors are normal. Sneeze is usually response to lint, etc.; in nose and not an indicator of a cold. No treatment is needed for hiccups; sucking may help.</td>
</tr>
</tbody>
</table>

(Courtesy Marjorie Pyle, RNC, Lifecircle, Costa Mesa, CA.)

(Courtesy Michael & Clement, M.D., Mesa, AZ.)
**Signs of risk for neuromuscular problems**

Any absence of a newborn reflex could indicate major neurorologic problems. Birth trauma may cause nerve damage that results in facial asymmetry and paralysis. CNS depression resulting from maternal medications received during labor and birth also will influence neuromuscular functioning. Observation of the neonate for any abnormalities must be documented. A thorough physical examination of the newborn assists in detecting any potential complications (see Table 19-2).

**BEHAVIORAL CHARACTERISTICS**

The healthy infant must achieve behavioral and biologic tasks to develop normally. Behavioral characteristics form the basis of the social capabilities of the infant. Normal newborns differ in their activity levels, feeding patterns, sleeping patterns, and responsiveness. Parents’ reactions to their newborns often are determined by these differences. Showing parents the unique characteristics of their infant assists parents to develop a more positive perception of the infant with increased interaction between infant and parent.

Behavioral responses, as well as physical characteristics, change during the period of transition. The Brazelton Neonatal Behavioral Assessment Scale (BNBAS) can be used to assess the infant’s behavior systematically (Brazelton, 1999; Brazelton & Nugent, 1996). The BNBAS is an interactive examination that assesses the infant’s response to 28 areas organized according to the clusters in Box 18-2. It is generally used as a research or diagnostic tool and requires special training.

In addition to use as initial and ongoing tools to assess neurologic and behavioral responses, the scales can be used to assess initial parent-infant relationships and as a guide for parents to help them focus on their infant’s individuality and to develop a deeper attachment to their child. See Chapter 17 for further discussion of attachment.

**BOX 18-2**

**Clusters of Neonatal Behaviors in the Brazelton Neonatal Behavioral Assessment Scale (BNBAS)**

| Habituation | Ability to respond to and then inhibit responding to discrete stimuli (light, rattle, bell, pin-prick) while asleep |
| Orientation | Quality of alert states and ability to attend to visual and auditory stimuli while alert |
| Motor performance | Quality of movement and tone |
| Range of state | Measure of general arousal level or arousability of infant |
| Regulation of state | How infant responds when aroused |
| Autonomic stability | Signs of stress (tremors, startles, skin color) related to homeostatic (self-regulator) adjustment of the nervous system |
| Reflexes | Assessment of several neonatal reflexes |

**Sleep-Wake States**

Variations in the state of consciousness of infants are called sleep-wake states (Brazelton, 1999). The six states form a continuum from deep sleep to extreme irritability (Fig. 18-13): two sleep states (deep sleep and light sleep) and four wake states (drowsy, quiet alert, active alert, and crying). Each state has specific characteristics and state-related behaviors. The optimal state of arousal is the quiet alert state. During this state infants smile, vocalize, move in synchrony with speech, watch their parents’ faces, and respond to people talking to them. The infants’ reactions to internal and external stimuli and ability to control their responses while in these sleep-wake states reflect their ability to organize behavior.

Infants use purposeful behavior to maintain the optimal arousal state: (1) actively withdrawing by increasing physical distance, (2) rejecting by pushing away with hands and feet, (3) decreasing sensitivity by falling asleep or breaking eye contact by turning head, or (4) using signaling behaviors, such as fussing and crying. These behaviors permit infants to quiet themselves and restate readiness to interact.

The first 6 weeks of life involve a steady decrease in the proportion of active REM sleep to total sleep. A steady increase in the proportion of quiet sleep to total sleep also occurs. Periods of wakefulness increase. For the first few weeks the wakeful periods seem dictated by hunger, but soon a need for socializing appears as well. The newborn sleeps approximately 17 hours a day, with periods of wakefulness gradually increasing. By the fourth week of life, some infants stay awake from one feeding to the next.

**Other Factors Influencing Newborn Behavior**

**Gestational age**

The gestational age of the infant and level of CNS maturity affect the observed behavior. In an infant with an immature CNS, the entire body responds to a pinprick of the foot. The mature infant withdraws only the foot. CNS immaturity is reflected in reflex development and sleep-wake cycles. Preterm infants have brief periods of alertness but have difficulty maintaining this state. Premature or sick infants show fatigue or stress sooner than do term healthy infants.

**Time**

The time elapsed since birth affects the behavior of infants as they attempt to become organized initially. Time elapsed since the previous feeding and time of day also may influence infants’ responses.

**Stimuli**

Environmental events and stimuli affect the behavioral responses of infants. The newborn responds differently to animate and inanimate stimuli. Nurses in intensive care nurseries observe that infants respond to loud noises, bright lights, monitor alarms, and tension in the unit. If a mother is tense and has a fast heart beat while feeding an infant, the infant will have an increase in heart rate that is similar to the mother’s.
Medication
Analgesic and anesthetic medications administered to the mother during labor may affect the newborn’s neurologic status and behavior. Narcotics are likely to cause CNS depression and hypotonia and may even cause apnea (Kliegman, 2002). These medications also can affect the infant’s sucking ability, at the breast or from a bottle.

Sensory Behaviors
From birth, infants possess sensory capabilities that indicate a state of readiness for social interaction. Infants effectively use behavioral responses in establishing their first dialogues. These responses, coupled with the newborns’ “baby appearance” (e.g., facial proportions of forehead and eyes larger than the lower portion of the face) and their small size and helplessness, rouse feelings of wanting to hold, protect, and interact with them.

Vision
Compared with other sensory systems, the visual system is the least mature at term gestation. Development of the visual system continues for the first 6 months. The pupils react to light, the blink reflex is easily stimulated, and the corneal reflex is activated by light touch. Infants are sensitive to light, preferring low illumination. If the room is darkened, they will open their eyes wide and look about. Newborns respond to a flash of bright light by frowning, blinking, and withdrawing the head by arching the entire body. Newborns have the ability to fixate and will track a high-contrast object horizontally and vertically. Infants seem attentive to the human face and will track their parents’ eyes. Parents often comment on how exciting this behavior is.

Visual acuity is difficult to determine, although it appears that the clearest visual distance for the newborn is approximately 19 cm, which is about the distance the infant’s face is from the mother’s face as she breastfeeds or cuddles. Newborns prefer to look at patterns rather than plain surfaces, even if the latter are brightly colored, and they prefer more complex patterns to simple ones (Brazelton, 1999; Gupta, Hamming, & Miller, 2002).

Hearing
As soon as the amniotic fluid drains from the ear, the infant’s hearing is similar to that of an adult. This may occur as early as 1 minute after birth. Loud sounds of about 90 decibels cause the infant to respond with a startle reflex. The newborn responds to low-frequency sounds such as a heartbeat or lullaby by decreasing motor activity or stopping crying. High-frequency sound elicits an alerting reaction.

The infant responds readily to the mother’s voice. Studies indicate a selective listening to maternal voice sounds and rhythms during intrauterine life that prepares newborns for recognition and interaction with their primary caregivers—their mothers. Newborns are accustomed in the uterus to hearing the regular rhythm of the mother’s heartbeat. As a result, they respond by relaxing and ceasing to
Temperament. Their style of behavioral response to stimuli mary reaction pattern of newborns and described them as Stimuli Response to Environmental or painful stimuli. taken by the mother decrease the infant's sensitivity to touch responses to touch. Birth trauma or stress and depressant drugs infant is unique, and variations can be seen in newborns' re-
sess, and therefore respond intensely. Others with a high sensory threshold seem low. They are readily up-
us and cry if a regular heartbeat simulator is placed in their cribs.

The internal and middle portions of the ear are larger at birth, but the external canal is small. The mastoid process and bony parts of the external canal have not developed; there-

Some newborns cry longer and harder than others. For some the sensory threshold seems low. They are readily up-

Classic studies identified individual variations in the pri-

is guided by the temperament affecting the newborn’s sen-

Habituation Habituation is a protective mechanism that allows the in-

Newborns vary in their ability to console themselves or to be consoled. In the crying state, most newborns initiate one of several methods for reducing their distress. Hand-to-

Cuddliness is especially important to parents because they often gauge their ability to care for the child by the child’s responses to their actions. There is variability in the degree to which newborns will mold into the contours of the per-

Irritability Some newborns cry longer and harder than others. For some the sensory threshold requires a great deal more stimulation and varia-

Response to Environmental Stimuli Temperament

Classic studies identified individual variations in the pri-

UNIT SIX THE NEWBORN

UNIT SIX THE NEWBORN
Crying
Crying in an infant may signal hunger, pain, desire for attention, or fussiness. Most mothers learn to distinguish among the cries. The duration of crying is highly variable in each infant; newborns may cry for as little as 5 minutes or as much as 2 hours or more per day. The amount of crying peaks in the second month and then decreases. The diurnal rhythm of crying typically includes more crying in the evening hours. Crying does not seem to differ with different caregivers.

COMMUNITY ACTIVITY
Determine whether or not newborn classes are available in your community. Interview the instructor to determine what is included in the class content. Is there attention to normal physical characteristics of the neonate? What information do parents receive related to newborn behaviors? What suggestions would you make in including content related to physiologic and behavioral adaptations of the newborn? What is the value of providing expectant parents with this information?

Key Points
- By term the infant’s various anatomic and physiologic systems have reached a level of development and functioning that permits a physical existence apart from the mother. The infant has sensory capabilities that indicate a state of readiness for social interaction.
- Several significant differences exist between the respiratory, renal, and thermogenic systems of the newborn and those of an adult.
- At any serum bilirubin level, the appearance of jaundice during the first 24 hours of life or persistence of jaundice for more than 7 days usually indicates a pathologic process in term infants.
- Loss of heat in a newborn, even a healthy newborn, may result in acidosis and increase the level of free fatty acids, leading to cold stress.
- Many reflex behaviors are important for the newborn’s survival.
- Individual personalities and behavioral characteristics of infants play major roles in their ultimate relationships with their parents.
- Sleep-wake states and other factors influence the newborn’s behavior.
- Each newborn has a predisposed capacity to handle the multitude of stimuli in the external world.

Answer Guidelines to Critical Thinking Exercise
Near term Infant with Physiologic Jaundice
1. The nurse can assess the newborn for the presence of jaundice by blanching the skin over the baby’s forehead, chest, abdomen, and legs. At this point, the baby is over 24 hours of age and would likely be experiencing physiologic jaundice.
2. a. At 36 hours of age, the newborn is likely exhibiting physiologic jaundice. He is at risk for development of physiologic jaundice because of the bruising of his head and because he is preterm.
   b. The baby has not been feeding well thus far and has had only one stool. Because bilirubin is excreted primarily through the stool, it is important that his bowel movements increase. Because he is preterm, he may be more difficult to awaken for feedings than a full-term infant. The more he feeds, the greater his output will be.
   c. Randy noted the appearance of his son’s skin color as evidenced by his comment. The nurse can explain why the baby appears somewhat “yellow” and describe physiologic jaundice in terms that the parents can understand.
3. The infant’s level of jaundice should be assessed and the health care provider notified. The nurse may be able to determine a transcutaneous measurement of hyperbilirubinemia if equipment is available. The health care provider may order a serum bilirubin measurement to establish a baseline and reassess bilirubin levels periodically to determine if hyperbilirubinemia is increasing. It is important to closely monitor the infant and to intervene to prevent the development of kernicterus.
   Feeding is important in order for the newborn to excrete excess bilirubin. The parents may need to be encouraged to awaken the baby for feedings, and breastfeeding should be observed to determine the mother’s ability to feed and to assess for milk transfer. Assistance is given as needed. The baby’s output is closely monitored; parents may be instructed to keep a log of feedings, urination, and stooling.
   The parents will likely need some explanation about physiologic jaundice. First, the nurse will assess their knowledge and proceed to provide needed information. They are encouraged to ask questions of the nurse and the health care provider.
4. If bilirubin levels are measured, there may be evidence to support the conclusion that the baby is experiencing physiologic jaundice. If this is the case, the baby will appear more jaundiced over the next two or three days.
5. Jaundice could also be caused by blood incompatibilities or liver anomalies; however, this type of jaundice is considered pathologic and usually appears within the first 24 hours of life.


F190-192. The Cochrane Database of Systematic Reviews.


St. Louis: Mosby.

References


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