OBJECTIVES

1. Describe the cardiovascular, pulmonary, thermal, and gastrointestinal adaptation of the newborn.
2. Identify indications for instituting neonatal resuscitation.
3. Identify parameters used in the Apgar scoring of a newborn.
4. Describe the importance of maintaining a neutral thermal environment for the newborn, and discuss interventions to achieve a neutral thermal environment.
5. Identify normal physical characteristics of the newborn.
6. Interpret physical and neurologic findings for gestational age classification.
7. Define sensory capabilities of the newborn.
8. Define nutritional needs of the normal newborn, and assess readiness and ability of the newborn to feed orally.
9. Distinguish sleep and wake cycles of the newborn.
10. Devise a health education plan for a particular situation.

INTRODUCTION

Transition from fetus to neonate requires profound physiologic adaptation. Surprisingly, most neonates make this transition without difficulty (Pinheiro, 2009). Key elements in the birth transition are (1) shift from maternally dependent oxygenation to continuous respiration; (2) change from fetal circulation to mature circulation with increase in pulmonary blood flow and loss of left-to-right shunting; (3) commencement of independent glucose homeostasis; (4) independent thermoregulation; and (5) oral feedings (Engle & Boyle, 2005). Close observation of the infant’s adaptation to extrauterine life is imperative to identify problems in transition and initiate interventions.

A. Transition from fetus to neonate

1. Respiratory adaptation
   a. Mechanical stimuli: Compression of the fetal chest during vaginal delivery creates negative pressure by which air is drawn into the lung fields as the thorax recoils to its original size when the fetus exits the mother’s body. Air fills the alveoli by replacing the lung fluids that have been expelled by chest compression during the vaginal delivery. The remaining lung fluids are removed through reabsorption by the lymphatics. Infant crying creates intrathoracic positive pressure, keeping the alveoli open.
   b. Chemical stimuli: With cessation of placental blood flow, the neonate’s lungs must initiate and maintain gas exchange. The stress on the fetus during delivery leads to mild hypoxia, elevated carbon dioxide, and acidosis. Aortic and carotid bodies contain chemoreceptors that stimulate the medulla to trigger respiration. Surfactant, a phospholipid coating the alveolar epithelium, reduces the surface tension of the lung mucosa and allows exhalation without lung collapse.
   c. Thermal stimuli: Sudden chilling of the moist infant after delivery stimulates skin sensory receptors to transmit impulses to the respiratory center.
   d. Sensory stimuli: Normal handling after delivery (e.g., vigorous drying of the newborn) provides strong tactile stimulation to initiate breathing.
2. Cardiovascular adaptation: The neonate’s circulatory system undergoes several physiologic changes after birth. The termination of fetal circulation and the transition to newborn circulation involve the closure of the three fetal shunts—the ductus venosus, the foramen ovale, and the ductus arteriosus.
   a. The physiologic changes associated with lung inflation after delivery cause an increase of pressure in the left heart and increase systemic resistance.
   b. With neonatal respiration, oxygenated blood enters the pulmonary musculature. This dilates the pulmonary artery and decreases the pulmonary vascular resistance.
   c. The ductus arteriosus functionally closes by 10 to 15 hours in the full-term infant due to decreasing pressure in the pulmonary vasculature and the increased pressure in the aorta (Blackburn, 2006). This stops the flow of blood through the ductus arteriosus.
   d. Vascular dilation along with the equalization and eventual overriding left atrial pressure forces functional closure of the foramen ovale. The foramen ovale, which acts like a flap valve, closes within minutes after birth with the decreased pulmonary vascular resistance and increased left heart pressure due to termination of placental blood flow (Blackburn, 2006).

3. Thermoregulation
   a. Thermoregulation (a critical component in the physiologic adaptation to extrauterine life) is the means by which the neonate’s body temperature is maintained by balancing heat generation and heat loss in a changing environment.
   b. Normal temperature range: Preferred temperatures for term infants are between 36° (96.8° F) and 36.5° C (97.7 F) (axillary) for the first few hours of life. Newborns are at an increased risk of thermoregulatory problems for several reasons (Galligan, 2006; Hackman, 2001).
      (1) The ratio of large body surface to body mass
      (2) Higher metabolic rate with limited stores of metabolic substrates
      (3) Limited subcutaneous fat with poorly developed shivering response
   c. Mechanisms of heat loss
      (1) Convection: Heat is lost to air or fluid around the infant that is cooler than infant’s temperature (e.g., air drafts on infant from open door in delivery room).
      (2) Radiation: Heat is lost to solid objects near infant that are cooler than infant’s temperature (e.g., windows to the outside not covered by draperies).
      (3) Conduction: Heat is lost to cold surfaces or to objects with which the infant has contact (e.g., x-ray plate or unheated mattress or scale).
      (4) Evaporation: Heat is lost when water evaporates from the infant’s skin surface or respiratory tract (e.g., infant not dried immediately after birth).
   d. Newborns attempt to regulate body temperature through flexed fetal positioning, which decreases body surface area; peripheral vasoconstriction; increased metabolic rate; and nonshivering heat production by brown fat metabolism (London, Wieland-Ladewig, Ball, & Bindler, 2007).
   e. Neutral thermal environment (NTE): An NTE is the temperature range in which normal body temperature can be maintained with minimal metabolic demands and oxygen consumption.
      (1) Achieving an NTE
         (a) Incubator: usually single-walled plastic boxes that warm the infant by convection
         (b) Radiant warmers: an open bed with radiant heat panels placed above the infant; convective and evaporative heat losses are increased
         (c) Open crib: Once an infant’s temperature is normalized, infant is placed in an open crib with hats and blankets, providing thermal support.

4. Gastrointestinal transition: Feedings initiated as soon as possible after birth help maintain normal metabolism during the transition from fetal to extrauterine life (Heird, 2007). The goal of feeding is to provide adequate nutrition to meet the infant’s metabolic requirements and ensure growth.
   a. Infants born beyond 32 to 34 weeks’ gestation have adequate suck-and-swallow coordination for oral feedings unless neurologic damage has occurred or the infant is too ill to safely handle feedings.
   b. Feeding newborn infants:
      (1) Breastfeeding: See Chapter 14 for a complete discussion of breastfeeding.
         (a) The best source of nutrition in the first 6 months of life is human milk (Eiger, 2009); provides 20 kcal/ounce (30 mL).
         (b) Should begin as soon as possible after birth, usually within the first hour and continue for at least 12 months (American Academy of Pediatrics [AAP], 2005)
(c) Unless medically contraindicated, alert, healthy infants should have their first feeding in the delivery room. Early breastfeeding in the delivery room has been shown to increase the percentage of mothers who continue breastfeeding at 2 and 4 months postpartum (Schanler, 2009).

(d) Feed every 2 to 3 hours or when infant is awake, alert, and demonstrating behavioral feeding cues (rapid eye movements under the eyelids, sucking movements of the mouth and tongue, hand-to-mouth movements, body movements, small sounds) (Walker, 2007). Each session should last 10 to 15 minutes on each breast. Burp infant between and after each breast.

(e) Do not supplement the breastfed infant with feedings of water, glucose water, or formula, which might actually discourage breastfeeding.

(f) Advantages of breast milk

[i] Lower incidence and/or severity of a many infectious diseases including diarrhea, respiratory tract infections, otitis media, bacteremia, bacterial meningitis, urinary tract infections, necrotizing enterocolitis (AAP, 2005; Schanler, 2009)

[ii] Possible protective effect against sudden infant death syndrome (SIDS), type 1 diabetes mellitus, type 2 diabetes mellitus, obesity, hypercholesterolemia, and asthma (AAP, 2005)

[iii] Economic benefit for the family and society related to reduced health care costs and reduced employee absenteeism for care related to infant illness (Krebs & Primak, 2006)

(iv) Psychological benefits related to enhanced infant and maternal bonding and attachment

(2) Bottle-feeding

(a) Commercially prepared formulas are based on cow’s milk and have been modified to closely resemble human milk. Provides 20 kcal/ounce (30 mL).

(b) The first feeding should be initiated in the nursery. Infant should be offered several sips of sterile water before formula to assess for aspiration.

(c) Bottle-fed infants should be fed 15 to 30 mL of formula every 3 to 4 hours on first day of life increasing to 75 to 90 mL by day 4 or 5.

(d) Always hold infant during feedings; this provides vital human contact. Bottle-propping can lead to aspiration and middle-ear infections.

(e) Discard all unused formula left in bottle after feeding.

(f) Advantages of formula

[i] Ability to share feedings with partner, family, and friends

[ii] Lack of physical problems (i.e., sore nipples, nipple confusion, etc.)

(g) Disadvantages of formula

[i] Is more costly, especially if purchased in ready-to-serve concentrations

[ii] Must be prepared if not purchased in ready-to-serve concentration

[iii] Is more difficult to digest and forms harder curds because of higher casein content

(3) Pacifiers

(a) Pacifier use is recommended once breastfeeding is well established (approximately 1 month of age) (AAP, 2005).

(b) Advantage: provides nonnutritive sucking and comfort for a crying infant and may increase arousability of infants during sleep reducing the risk of SIDS (Hunt & Hauck, 2007; Schwartz & Guthrie, 2008)

(c) Disadvantages: source of bacteria if not cleaned properly, potential for compulsive use, may interfere with normal teeth positioning and eruption and cause alteration in bone growth (Schwartz & Guthrie, 2008)

CLINICAL PRACTICE

A. Delivery room assessment

1. Identify the infant at risk.

   a. Review maternal history and prenatal course.

   b. Assess fetal well-being during labor and delivery.
(1) **Apgar scoring**
   (a) This scoring system, initially developed by Virginia Apgar in 1952, provides practitioners with a standardized approach for assessing the newborn infant immediately after birth to help identify those infants requiring resuscitation and predict survival in the neonatal period (Stoll, 2007).
   (b) Scoring is done at 1, 5, and sometimes 10 minutes of life; the newborn is given a score from 0 to 2 for each category, based on the elements described in Table 16-1.

(2) **Indications for positive pressure ventilation with a tightly fitted face mask using 100% supplemental oxygen (AHA & AAP, 2006)**
   (a) Apnea
   (b) Heart rate (HR) absent or less than 100 beats per minute (bpm)
   (c) Central cyanosis

(3) **Indications for chest compressions over the lower third of the sternum at a rate of 120/min**
   (a) HR absent or remains less than 100 bpm despite adequate assisted ventilation for 30 seconds.

(4) **Indications for medication**
   (a) HR <60 bpm after a minimum of 30 seconds of adequate ventilation and chest compressions. Administer epinephrine intravenously (IV) at a dose of 0.01 to 0.03 mg/kg.

(5) **Indications for endotracheal intubation**
   (a) Meconium-stained amniotic fluid
   (b) Ineffectiveness of positive-pressure ventilation with a tightly fitted face mask
   (c) Need for prolonged ventilation (e.g., for an extremely small infant)

**B. Complete newborn assessment**

1. After stabilization, a thorough and systematic assessment of the newborn is necessary to identify the state of health of the neonate and detect congenital anomalies that might cause problems with extrauterine adaptation. Physical examination of the term infant should be performed with one or both parents in attendance. This fosters discussion with parents about expected physical and behavioral characteristics of their newborn.

2. **Growth parameters**
   a. Weight: 2500 to 4000 g (5 pounds, 8 ounces to 8 pounds, 13 ounces)
   b. Length from head to heel: 48 to 53 cm (19 to 21 inches)
   c. Chest circumference: 30.5 to 33 cm (12 to 13 inches)
   d. Head circumference: 33 to 35.5 cm (13 to 14 inches)

3. **Vital signs:**
   a. Temperatures should stabilize between 36.4° and 37° C (97.5° and 98.6° F).
   b. Respiratory patterns are irregular, with respiratory rates between 30 to 60 inspirations per minute.
   c. Heart rates are regular, with rates between 110 and 160 bpm depending on the infant’s state.
   d. Blood pressure measurements are usually not assessed as part of the newborn examination.

**TABLE 16-1**

**Components of Apgar Scoring**

<table>
<thead>
<tr>
<th>Sign</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sign</strong></td>
<td><strong>0</strong></td>
</tr>
<tr>
<td>Heart rate</td>
<td>Absent</td>
</tr>
<tr>
<td>Respiratory effort</td>
<td>Absent</td>
</tr>
<tr>
<td>Muscle tone</td>
<td>Flaccid</td>
</tr>
<tr>
<td>Reflex irritability</td>
<td>No response</td>
</tr>
<tr>
<td>(catheter in nose or slap sole of foot)</td>
<td></td>
</tr>
<tr>
<td>Skin color</td>
<td>Blue/pale</td>
</tr>
</tbody>
</table>
4. Physical examination

a. General survey: periods of alertness, symmetric features and movements, easily consolable

b. Skin: smooth, pink to reddish with possible flaking in areas of major creasing. Vernix caseosa, a cheesy white substance, can be found on the entire body but is more intense between folds. Lanugo, a fine hair, might be seen, especially on the back.
   (1) Benign skin conditions
      (a) Acrocyanosis: cyanosis of hands and feet
      (b) Cutis marmorata: transient mottling, especially when exposed to cool temperatures
      (c) Erythema toxicum: pink papular rash with vesicles on chest, abdomen, back, buttocks, and extremities
      (d) Capillary hemangioma: “stork bite” and “angel kiss” are flat, deep pink areas over eyelids, forehead, or nape of neck in infants with fair skin.
      (e) Mongolian spots: bluish black hyperpigmented areas usually located on the back and buttocks in infants with dark skin

c. Head
   (1) Molding of the head might occur as the result of the delivery and usually resolves within a few weeks. Bruising is common.
      (a) Caput succedaneum: presents at birth with pitting edema of the scalp crossing suture lines as a result of accumulation of blood or serum above the periosteum (Fuloria & Kreiter, 2002).
      (b) Cephalhematoma: occurs several hours after birth from bleeding between the periosteum and skull, causing swelling that does not cross suture lines; might take several weeks to resolve

d. Eyes
   (1) Eyelids are usually edematous immediately after birth.
   (2) Color of iris: slate gray, dark blue, or brown
   (3) Pupils reactive to light; red reflex present; focuses on objects and follows to midline
   (4) Mucoid discharge is normal with absence of tears.
   (5) Scleral hemorrhages are possible.

e. Ears
   (1) Position: Top of pinna is horizontal to outer canthus of eye.
   (2) Pinna is flexible and well formed with cartilage present.
   (3) Loud noise elicits startle reflex.

f. Nose
   (1) Obligate nose breather.
   (2) Nares are patent with no evidence of choanal atresia.

g. Mouth
   (1) Intact palate with midline uvula
   (2) Normal frenulum of tongue and lip
   (3) Minimal or absent salivation
   (4) Suck, root, and gag reflexes present

h. Neck
   (1) Full range of motion without torticollis (asymmetric shortening of the sternocleidomastoid muscle)
   (2) Tonic neck reflex present
   (3) Intact clavicles with no tenderness, swelling, or crepitation
   (4) Absence of webbing

i. Chest and lungs
   (1) Symmetric, barrel-shaped, with equal anteroposterior and lateral diameters
   (2) Slight subcostal and intercostal retractions are common.
   (3) Breast enlargement and engorgement in either sex with possible physiologic galactorrhea; resolves within several weeks
   (4) Bilateral bronchial breath sounds; fine crackles and transient hoarseness are normal (Colyar, 2003)

j. Cardiac
   (1) Apex or point of maximal impulse (PMI) at left third or fourth intercostal space
   (2) Significant and persistent murmurs should be evaluated to rule out underlying structural abnormalities (Gaylord & Yetman, 2009).
k. Abdomen
   (1) Mildly protuberant
   (2) Liver normally palpable 1 to 3 cm below costal margin in the midclavicular line
   (3) Kidneys: 1 to 2 cm above and to both sides of umbilicus and felt with deep palpation
   (4) Bowel sounds present, but might be hypoactive on first day of life
   (5) Three vessels in cord

l. Genitals
   (1) Female: labia and clitoris edematous; hymenal tag often present; labia majora larger than labia minora; urethral meatus located below clitoris; vaginal discharge whitish or blood-tinged
   (2) Male: scrotum large, edematous, and pendulous; testes palpable; urethral opening at tip of glans penis; foreskin tightly adhered (phimosis)

m. Extremities
   (1) Symmetric
   (2) Full range of motion
   (3) All 10 fingers and toes present without webbing
   (4) Brachial and femoral pulses present and equal
   (5) Pink nail beds or acrocyanosis
   (6) Creases on anterior two thirds of sole
   (7) Scarf sign present
   (8) Normal hip abduction without clicks

n. Back
   (1) Spine intact without openings, masses, curves, dimples, or hairy tufts
   (2) Patent anal opening
   (3) Even gluteal folds
   (4) Trunk incurvation reflex present

o. Neurologic
   (1) Posture: general flexed position similar to that maintained in utero
   (2) Tone: extremities have brisk recoil to flexion; infant able to hold head erect momentarily while sitting
   (3) Tremors or jitteriness: Momentary quivering or tremors might occur as a result of immature nervous system.
   (4) Newborn reflexes: Table 16-2

5. Behavioral state system: reflects the infant’s ability to respond to the environment (VandenBerg, 2007)

   a. Identifying infant’s behavioral state is helpful in determining the infant’s ability to perceive stimuli and interact with others. The Brazelton Neonatal Assessment Scale (BNAS) is a well-known tool for assessment of full-term neonatal states. The behavioral states described by Brazelton (1999) are as follows:

<table>
<thead>
<tr>
<th>TABLE 16-2</th>
<th>Newborn Reflexes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name of Reflex</strong></td>
<td><strong>Expected Response</strong></td>
</tr>
<tr>
<td>Sucking</td>
<td>Strong sucking movements of mouth can be elicited and might occur during sleep</td>
</tr>
<tr>
<td>Swallow</td>
<td>Follows sucking, usually at pauses, and can be seen at the neck</td>
</tr>
<tr>
<td>Rooting</td>
<td>When cheek is touched or stroked, infant turns head toward stroked side and opens mouth to receive nipple.</td>
</tr>
<tr>
<td>Moro (startle)</td>
<td>Moro (startle): general body response to sudden stimulus that is a combination of full extension and abduction of limbs</td>
</tr>
<tr>
<td>Babinski</td>
<td>Upward stroking of sole and across ball of foot causes great toes to hyperextend and foot to dorsiflex.</td>
</tr>
<tr>
<td>Palmar and plantar grasps</td>
<td>Touching palms of hands and feet causes flexion of fingers or toes.</td>
</tr>
</tbody>
</table>
(1) Sleep states
   (a) Deep sleep: sleep without movement except for sudden, jerky movements; hard to awaken from this state
   (b) Light sleep: eyes closed with some eye movement seen under lids, active body movements; sucking might be present
   (c) Drowsy: transition state as infant moves from sleep to awake or awake to asleep. Eyes open or closed, lids usually heavy; active body movements with occasional fussing

(2) Awake states
   (a) Quiet alert: alert with eyes open; attentive to close objects; little body movement; good opportunity for newborn to interact with parents (VandenBerg, 2007)
   (b) Active alert: inactivity with mild, agitated vocalizations. An organized term infant may be able to return to a quiet alert state or calm sleep state by calming him- or herself by sucking on the hands (VandenBerg, 2007).
   (c) Crying: eyes tightly closed at times with crying, thrashing, and movements of head and extremities

(3) State organization
   (a) After the delivery, newborns have a period of alertness lasting for a variable amount of time. Infants begin to demonstrate increasing ability to regulate state control as they transition more smoothly between states and develop a more predictable sleep-wake pattern (VandenBerg, 2007).
   (b) Newborns will usually sleep between 16 to 18 hours in a 24-hour period.
   (c) Crying in the newborn period is usually not specific to the type of discomfort. The newborn tends to cry in response to hunger, pain, or disturbing stimuli. During the neonatal period, crying is an important behavior for organizing the day and reducing disturbance in the central nervous system (CNS) (Brazelton, 1999).
   (d) An organized newborn can maintain breathing, digestion, smooth movements, tone, and posture and at the same time manage the sleep-wake state. In addition, the organized newborn demonstrates self-calming behavior (VandenBerg, 2007).

6. Sensory capabilities
   a. Hearing: well-developed at birth; responds to noise
   b. Vision: focuses on close-up objects (e.g., the mother's face when at breast); tracks with eyes to midline or beyond
   c. Taste: distinguishes between sweet and sour at 3 days of age
   d. Smell: distinguishes between mother's breasts and breast milk and those of another by fifth day of age and frequently sooner
   e. Touch: sensitive to pain, usually responds to tactile stimuli

7. Gestational age assessment (see Chapter 17 for a discussion of gestational age significance/risks)
   a. Reliable assessment of gestational age is based on neurologic development and physical characteristics found by direct examination of the infant.
   b. Classification of infant allows clinician to anticipate clinical problems and apply early diagnostic testing.
   c. Classifications: infant's weight and weeks of gestation are classified as follows:
      (1) Appropriate for gestational age (AGA): characterizes approximately 80% of the neonatal population
      (2) Small for gestational age (SGA): less than 2500 g (5 pounds, 8 ounces) for term neonate due to less growth in utero than expected; associated risks include hypoglycemia, asphyxia, respiratory distress syndrome, meconium aspiration, intrauterine infection, and hyperbilirubinemia
      (3) Large for gestational age (LGA): more than 4000 g (8 pounds, 13 ounces) for term neonate due to accelerated growth for length of gestation; associated risks include birth trauma, hypoglycemia, hypocalcemia, hyperbilirubinemia, meconium aspiration, intrauterine infection, and polycythemia.
The Newborn

Assessing for gestational age (see Chapter 8 for a complete discussion of antepartum fetal assessment)

(1) Guides are frequently used in the nursery to determine neuromuscular and physical maturity. Table 16-2, Table 16-3, and Box 16-1 are commonly used.

(2) A guide is frequently used to assess neurologic characteristics and maturity (see Box 16-1).

C. Transitional nursing care interventions/outcomes: Delivery room and nursery interventions have been combined in this section. See Figure 16-1 for sequential steps for resuscitative interventions in the delivery room and Table 16-4 for medications used during resuscitation.

1. Temperature regulation
   a. Interventions
      (1) Close door to delivery rooms and nursery and place radiant warmer away from traffic patterns and air drafts.
      (2) Upon delivery, dry infant thoroughly and quickly; remove wet linens and place the naked infant prone on the mother’s bare chest. Cover infant across the back with a warm blanket. Skin-to-skin (STS) contact between the mother and baby at birth keeps the baby warmer. Evidence suggests that this technique is an alternative to traditional rewarming interventions for full-term, low-risk infants that promotes mother-infant attachment (Beal, 2005; Galligan, 2006; Moore, Anderson, & Bergman, 2007).
      (3) Check infant’s temperature every 15 to 20 minutes until stable, then every 4 to 8 hours.
      (4) In the nursery, prewarm incubators and radiant warmers.
      (5) Initial bath is recommended only after the newborn’s temperature and vital signs have stabilized (2 to 4 hours after birth) (Association of Women’s Health, Obstetric and Neonatal Nurses [AWHONN], 2001).
      (6) During the bath, wash one area at a time; dry it, keeping the infant covered at all times. Place hat on infant’s head to decrease heat loss (Gaylord & Yetman, 2009). Dress infant in shirt, diaper, and hat or cap.
      (7) Wrap in double blanket until infant can maintain temperature without second blanket (usually about 24 hours) until stable.
      (8) To warm infant, set incubator temperature at 1.5°C (2.6°F) higher than infant’s temperature until infant’s temperature begins to stabilize.
      (9) Use warming devices, such as heat lamps, sparingly and for only 15-minute intervals to prevent overwarming the infant.
   b. Outcomes
      (1) Skin temperature is 36.4°C to 37°C (97.6°F to 98.6°F).
      (2) Temperature stabilizes within 4 hours.

2. Respiratory distress/difficulty
   a. Interventions
      (1) Upon delivery, position infant’s head in “sniff” position or slight extension.
      (2) Suction mouth, then the nose.
      (3) Assess respiratory effort and heart rate (HR).
      (4) Provide tactile stimulation (slap foot, flick heel with finger, or rub back).
      (5) Provide positive-pressure ventilation using a bag and mask with 100% oxygen for apnea, HR absent or less than 100 bpm, or central cyanosis.
   b. Outcomes
      (1) Spontaneous breathing with good respiratory effort and infant has lusty cry
      (2) Fluid in airways has been removed to allow for normal breathing.
      (3) HR is greater than 100 bpm.
      (4) Skin color is normal with or without acrocyanosis.
      (5) Improved muscle tone

3. Cardiopulmonary compromise
   a. Interventions
      (1) Assess respiratory rate and HR.
      (2) Begin positive-pressure ventilation using a bag and mask with 100% oxygen if HR absent or less than 100 bpm, or central cyanosis.
      (3) Begin chest compressions if HR absent or remains less than 60 bpm despite adequate assisted ventilation for 30 seconds. The two-thumb technique is recommended in newborn infants (American Heart Association [AHA] & AAP, 2006).
### TABLE 16-3
Scoring System of External Physical Characteristics

<table>
<thead>
<tr>
<th>External Sign</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Edema</strong></td>
<td>No edema</td>
<td>No edema of hands and feet; pitting</td>
<td>Smooth; medium thickness; rash or</td>
<td>Slight thickening; superficial cracking</td>
<td>Thick and parchment-like; superficial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>over tibia</td>
<td>superficial peeling</td>
<td>or deep cracking</td>
<td>or deep cracking</td>
</tr>
<tr>
<td><strong>Skin texture</strong></td>
<td>Very thin, gelatinous</td>
<td>Thin and smooth</td>
<td>Slight thickening; superficial</td>
<td>Thicker; parchment-like; superficial</td>
<td>Thicker; parchment-like; superficial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>cracking</td>
<td>or deep cracking</td>
<td>or deep cracking</td>
</tr>
<tr>
<td><strong>Skin color</strong></td>
<td>Dark red</td>
<td>Uniformly pink</td>
<td>Pale pink; variable over body</td>
<td>Pale; only pink over ears, lips,</td>
<td>Pale; only pink over ears, lips,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>palms, or soles</td>
<td>palms, or soles</td>
</tr>
<tr>
<td><strong>Skin opacity</strong></td>
<td>Numerous veins and venules clearly seen, especially over abdomen</td>
<td>Veins and tributaries seen</td>
<td>A few large vessels clearly seen over abdomen</td>
<td>A few large vessels seen indistinctly over abdomen</td>
<td>No blood vessels seen</td>
</tr>
<tr>
<td><strong>Lanugo (over back)</strong></td>
<td>No lanugo</td>
<td>Abundant; long and thick over whole back</td>
<td>Hair thinning, especially over lower back</td>
<td>Small amount of lanugo and bald areas</td>
<td>At least half of back devoid of lanugo</td>
</tr>
<tr>
<td><strong>Plantar creases</strong></td>
<td>No skin creases</td>
<td>Faint red marks over anterior half of sole</td>
<td>Definite red marks over &gt; anterior half; indentations over &gt; anterior third</td>
<td>Indentations over &gt; anterior third</td>
<td>Definite deep indentations over &gt; anterior third</td>
</tr>
<tr>
<td><strong>Nipple formation</strong></td>
<td>Nipple barely visible; no areola</td>
<td>Nipple well defined; areola smooth and flat, diameter &lt;0.75 cm</td>
<td>Areola stippled, edge not raised diameter &lt;0.75 cm</td>
<td>Areola stippled, edge raised, diameter &gt;0.75 cm</td>
<td>Areola stippled, edge raised, diameter &gt;0.75 cm</td>
</tr>
<tr>
<td><strong>Breast size</strong></td>
<td>No breast tissue palpable</td>
<td>Breast tissue on one or both sides, &lt;0.5 cm</td>
<td>Breast tissue on both sides, one or both 0.5 to 1 cm</td>
<td>Breast tissue on both sides, one or both &gt;1 cm</td>
<td>Breast tissue on both sides, one or both &gt;1 cm</td>
</tr>
<tr>
<td><strong>Ear form</strong></td>
<td>Pinna flat and shapeless; little or no incurving of edge</td>
<td>Incurving of part of edge of pinna</td>
<td>Partial incurving of whole of upper pinna</td>
<td>Well-defined incurving of whole of upper pinna</td>
<td>Well-defined incurving of whole of upper pinna</td>
</tr>
<tr>
<td><strong>Ear firmness</strong></td>
<td>Pinna soft, easily folded, no recoil</td>
<td>Pinna soft, easily folded, slow recoil</td>
<td>Cartilage to edge of pinna but soft in places, ready recoil</td>
<td>Pinna firm, cartilage to edge, instant recoil</td>
<td>Pinna firm, cartilage to edge, instant recoil</td>
</tr>
<tr>
<td><strong>Genitals: male</strong></td>
<td>Neither testis in scrotum</td>
<td>At least one testis high in scrotum</td>
<td>At least one testis down</td>
<td>At least one testis down</td>
<td>At least one testis down</td>
</tr>
<tr>
<td><strong>Genitals: female (with hips half abducted)</strong></td>
<td>Labia majora widely separated; labia minora protruding</td>
<td>Labia majora almost cover labia minor</td>
<td>Labia majora completely cover labia minor</td>
<td>Labia majora completely cover labia minor</td>
<td>Labia majora completely cover labia minor</td>
</tr>
</tbody>
</table>

*To be used in conjunction with Box 16–1.
†If score differs on two sides, take the mean.
## TECHNIQUES OF NEUROLOGIC ASSESSMENT*

<table>
<thead>
<tr>
<th>POSTURE</th>
<th>With the infant supine and quiet, score as follows:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Arms and legs extended = 0</td>
</tr>
<tr>
<td></td>
<td>Slight or moderate flexion of hips and knees = 1</td>
</tr>
<tr>
<td></td>
<td>Moderate to strong flexion of hips and knees = 2</td>
</tr>
<tr>
<td></td>
<td>Legs flexed and abducted, arms slightly flexed = 3</td>
</tr>
<tr>
<td></td>
<td>Full flexion of arms and legs = 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SQUARE WINDOW</th>
<th>Flex the hand at the wrist. Exert pressure sufficient to get as much flexion as possible. The angle between the hypothenar eminence and the anterior aspect of the forearm is measured and scored. Do not rotate the wrist.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ANKLE DORSIFLEXION</th>
<th>Flex the foot at the ankle with sufficient pressure to get maximum change. The angle between the dorsum of the foot and the anterior aspect of the leg is measured and scored.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ARM RECOIL</th>
<th>With the infant supine, fully flex the forearm for 5 seconds, then fully extend by pulling the hands and release. Score the reaction as follows:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Remain extended or random movements = 0</td>
</tr>
<tr>
<td></td>
<td>Incomplete or partial flexion = 1</td>
</tr>
<tr>
<td></td>
<td>Brisk return to full flexion = 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEG RECOIL</th>
<th>With the infant supine, the hips and knees are fully flexed for 5 seconds, then extended by traction on the feet and released. Score the reaction as follows:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No response or slight flexion = 0</td>
</tr>
<tr>
<td></td>
<td>Partial flexion = 1</td>
</tr>
<tr>
<td></td>
<td>Full flexion (less than 90 degrees at knees and hips) = 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POPLITEAL ANGLE</th>
<th>With the infant supine and the pelvis flat on the examining surface, the leg is flexed on the thigh and the thigh fully flexed with the use of one hand. With the other hand the leg is then extended and the angle attained scored.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>HEEL-TO-EAR MANEUVER</th>
<th>With the infant supine, hold the infant's foot with one hand and move it as near to the head as possible without forcing it. Keep the pelvis flat on the examining surface. Score.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>SCARF SIGN</th>
<th>With the infant supine, take the infant's hand and draw it across the neck and as far across the opposite shoulder as possible. Assistance to the elbow is permissible by lifting it across the body. Score according to the location of the elbow:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elbow reaches the opposite anterior axillary line = 0</td>
</tr>
<tr>
<td></td>
<td>Elbow between opposite anterior axillary line and midline of thorax = 1</td>
</tr>
<tr>
<td></td>
<td>Elbow at midline of thorax = 2</td>
</tr>
<tr>
<td></td>
<td>Elbow does not reach midline of thorax = 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEAD LAG</th>
<th>With the infant supine, grasp each forearm just proximal to the wrist and pull gently to bring the infant to a sitting position. Score according to the relationship of the head to the trunk during the maneuver:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No evidence of head support = 0</td>
</tr>
<tr>
<td></td>
<td>Some evidence of head support = 1</td>
</tr>
<tr>
<td></td>
<td>Maintains head in the same anteroposterior plane as the body = 2</td>
</tr>
<tr>
<td></td>
<td>Tends to hold the head forward = 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VENTRAL SUSPENSION</th>
<th>With the infant prone and the chest resting on the examiner’s palm, lift the infant off the examining surface and score.</th>
</tr>
</thead>
</table>

*To be used in conjunction with Table 16-3.

Place infant under preheated radiant warmer

Dry infant

Position head

Suction mouth, then nose

Assess respiration

Breathing

Assess HR

>100 bpm

Assess color

Normal or acrocyanotic

Continue to observe; go to nursery

<100 bpm

Assess skin color

If normal, slowly withdraw O₂

If cyanotic, continue O₂

Assess respiration

Assess HR

>100 bpm

Chest compressions and bmv

Intubate

Biochemical resuscitation with epinephrine IV or ET 0.1 to 0.3 ml/kg of a 1:10,000 solution. Chest compressions with two-thumb method is preferred because it allows for better compression of the heart between the spine and sternum.

Assess skin color

Improving

Not improving

Continue support and monitoring as indicated

Intubate

Biochemical resuscitation

Assess respiration

Assess skin color

Spontaneous respiration

No spontaneous respiration

Cyanosis

If normal, continue to observe

O₂ 80%-100%

Reassess q3-5min

FIGURE 16-1  ■ Summary of resuscitation steps. *bmv*, Bag mask ventilation; *bpm*, beats per minute; *ET*, endotracheal tube; *HR*, heart rate; *IV*, intravenous; *IVP*, intravenous pressure; *LR*, lactated Ringer’s; *NS*, normal saline.
## TABLE 16-4
Medications for Neonatal Resuscitation

<table>
<thead>
<tr>
<th>Medication</th>
<th>Concentration to Administer</th>
<th>Preparation</th>
<th>Dosage/Route</th>
<th>Total Dose/Neonate</th>
<th>Rate/Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epinephrine</td>
<td>1:10,000</td>
<td>1 mL</td>
<td>0.1-0.3 mL/kg IV</td>
<td>Weight: 1 kg 0.1-0.3 mL</td>
<td>Total mL: 1 mL Give rapidly</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 kg 0.2-0.6 mL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 kg 0.3-0.9 mL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 kg 0.4-1.2 mL</td>
<td></td>
</tr>
<tr>
<td>Volume expanders</td>
<td>O-negative CBC</td>
<td>40 mL</td>
<td>10 mL/kg IV</td>
<td>Weight: 1 kg 10 mL</td>
<td>Total mL: 10 mL Give over 5-10 minutes</td>
</tr>
<tr>
<td></td>
<td>Whole blood</td>
<td></td>
<td></td>
<td>2 kg 20 mL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal saline Ringer’s lactate</td>
<td></td>
<td></td>
<td>3 kg 30 mL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 kg 40 mL</td>
<td></td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>0.5 mEq/mL (4.2% solution)</td>
<td>Two 10-mL prefilled syringes</td>
<td>2 mEq/kg IV</td>
<td>Weight: 1 kg 2 mL</td>
<td>Total mL: 2 mL Give slowly, over a rate of no more than 1 mEq/kg/min</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 kg 4 mL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 kg 6 mL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 kg 8 mL</td>
<td></td>
</tr>
<tr>
<td>Naloxone hydrochloride</td>
<td>0.4 mg/mL</td>
<td>1 mL</td>
<td>0.1 mg/kg 25 mL/kg IV, IM</td>
<td>Weight: 1 kg 0.1 mg</td>
<td>Total mL: 0.25 mL Only recommended for continued respiratory depression and history of maternal narcotic administration within the past 4 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 kg 0.2 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 kg 0.3 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 kg 0.4 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0 mg/mL</td>
<td>1 mL</td>
<td>0.1 mg/kg 1 mL/kg IV, IM</td>
<td>Weight: 1 kg 0.1 mg</td>
<td>Total mL: 0.1 mL Give as a continuous infusion using an infusion pump. Monitor heart rate and blood pressure closely Seek consultation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 kg 0.2 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 kg 0.3 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 kg 0.4 mg</td>
<td></td>
</tr>
</tbody>
</table>

(4) Obtain IV access and administer epinephrine IV at a dose of 0.01 to 0.03 mg/kg if the heart rate remains lower than 60 bpm after a minimum of 30 seconds of adequate ventilation and chest compressions. There is a lack of evidence to support use of endotracheal epinephrine (AHA & AAP, 2006).

b. Outcomes
(1) Improvement in cardiac output will be evidenced by the following:
   (a) HR improving and more than 100 bpm
   (b) Skin color improving to within normal limits

4. Prevention of infection
a. Interventions
   (1) After temperature stabilization, bathe the infant with warm water to reduce the incidence of skin colonization with pathogenic bacteria (Stoll, 2007). Removal of all vernix is not necessary because it may offer antibacterial protection (AWHONN, 2001).
   (2) Be certain that traces of maternal blood have been removed from infant’s skin surface before injections or invasive procedures.
   (3) Clean injection sites with alcohol and friction before injections.
   (4) Clean and observe any scalp monitoring sites for abscesses, redness, or drainage.
   (5) Eye care: Regardless of route of delivery, universal prophylaxis of all newborns with 1% silver nitrate drops, 0.5% erythromycin, or tetracycline is recommended (AAP, 2007; Stoll, 2007).
   (6) Umbilical cord care: Topical antibiotic therapy such as triple dye or bacitracin can be applied to the umbilical cord after the bath to prevent bacterial colonization; however, there is no evidence that applying sprays, creams, or powders is any better than keeping the baby’s cord clean and dry at birth (Zupan, Garner, & Omari, 2004). To aid in cord separation, air-drying by tucking the diaper below the cord is recommended (Lin, Tinkle, & Janniger, 2005).
   (7) Check circumcision site with every diaper change, and remove petroleum jelly-covered gauze after 4 hours. Clean site with water only for 3 to 4 days (AWHONN, 2001).

b. Outcomes
   (1) Infant has minimal exposure to pathogens.
   (2) Temperature of infant remains within normal limits.
   (3) Signs of infection are absent at any areas where skin integrity has been disturbed.
   (4) Eyes remain free of any purulent drainage.
   (5) Circumcision site remains free of swelling, excess redness, or excess drainage.

5. Prevent hemorrhagic disease in the newborn or vitamin K–deficiency bleeding (VKDB).
   a. Intervention
      (1) Vitamin K is administered intramuscularly within 1 hour of birth (AAP, 2006).
   b. Outcome
      (1) Signs of early and classic VKDB are absent

6. Glucose screening
   a. Intervention
      (1) There is no evidence that supports routine measurement of glucose in healthy term neonates (Bloomfield, Dinolfo, & Kokotos, 2009).
      (2) Glucose screening should be performed on any infant with symptoms attributable to hypoglycemia such as jitteriness, irritability, lethargy, hypotonia, poor feeding, diaphoresis, vomiting, apnea, or temperature instabilities (Bloomfield et al, 2009).
      (3) A blood glucose of level of less than 47mg/dL at 4 to 6 hours of age is accepted as being appropriate for intervention (Canadian Paediatric Society, 2004).
   b. Outcome: Infant will maintain normal blood glucose levels.

HEALTH EDUCATION

Health education centers on the preparation of parents for care of their newborn infant. Educational topics include general newborn care, nutrition, safety, and community resources to aid the family.

A. Delivery room care
   1. Providing family-centered developmental care has become the standard of care for the newborn infant. Whether an infant transitions to extrauterine life smoothly or requires
The Newborn resuscitative efforts, the goal of care must be integration of the child into the family unit (McGrath, 2006). This can only be done when the family is involved in the clinical decision making during the delivery and the entire postpartum stay.

2. It is important to discuss the normal course of events of birth and care of the newborn infant with parents before delivery so that they are not alarmed by normal delivery room events.

3. If there is a need for more in-depth resuscitation, provide parents with information as soon as possible.

B. General newborn care
1. How to bathe while conserving heat and providing for safety
2. How to take a temperature
3. How to use bulb syringe
4. How to diaper
5. How to care for circumcision site: ordinary cleaning of the diaper area and inspection for bleeding, swelling, or decreased urine output; petroleum jelly gauze applied during the procedure removed after 4 hours
6. How to clean genitalia
   a. Girls: separating the labia and cleaning from front to back
   b. Boys: wiping under scrotum and penis
7. How to care for umbilical cord: keeping clean and dry; folding diaper underneath cord
8. How to detect signs of illness and when to contact the physician or pediatric nurse practitioner

C. Newborn safety
1. Place on his or her back to sleep.
2. Never leave a newborn unattended on changing table or bed.
3. Learn first aid for choking.
4. Always use a car seat in the back seat; must be rear-facing until the infant is 1 year of age and 20 pounds.
5. Avoid bottle propping.
6. Wash hands before handling newborn; avoid exposure to others and to illness.
8. Never shake an infant; shaking can cause severe brain damage.

D. Newborn nutrition
1. Preparation and storage of formulas; collection and storage of breast milk
2. Cleaning of bottles and nipples
3. Reasons to avoid honey and corn syrup
4. Feeding schedules versus on-demand feedings
5. Expected amounts of intake
6. Color, consistency, and frequency of stools
7. Initial weight loss and subsequent gain

E. Community resources
1. Local chapters of La Leche League or other lactation support groups
2. Home health supply companies (e.g., for breast pumps)
3. Referrals to local county and state agencies for such concerns as medical insurance, nutritional support (Women, Infants, and Children [WIC]), parenting classes, and early child development and education

F. Pediatric health maintenance and follow-up
1. First health care provider visit should be 48 to 72 hours after discharge (Hernandez & Thilo, 2005).
2. Schedule and teach importance of immunizations (generally first hepatitis B vaccine given in nursery).
CASE STUDY AND STUDY QUESTIONS

1. A newborn infant should have the first bath:
   a. Immediately
   b. Just prior to discharge
   c. After the vitamin K injection
   d. After temperature stabilization

2. Standard umbilical cord care for the mother at home is:
   a. Clean cord with alcohol three times a day.
   b. Clean cord with warm water and air dry.
   c. Apply petroleum jelly-covered gauze every 4 hours.
   d. Apply triple dye after the bath.

3. A 30-year-old gravida 1, para 1 (G1, P1) mother who is attempting to nurse a 1-day-old infant is concerned that the infant is too sleepy to breastfeed. The most developmentally appropriate nursing intervention is to:
   a. Unwrap the infant.
   b. Place the infant skin-to-skin with the mother.
   c. Let the infant sleep; try nursing at a later time.
   d. Feed every 2 hours regardless of behavioral feeding cues.

4. What is the initial Apgar score?
   a. 10
   b. 9
   c. 7
   d. 6

5. The most developmentally appropriate intervention to ensure that this infant is in a neutral thermal environment in the delivery room is to:
   a. Place in an incubator.
   b. Place in a radiant warmer.
   c. Place in an open crib, double wrapped with a hat.
   d. Dry thoroughly and place prone skin-to-skin on mother’s bare chest and cover with a warm blanket.

6. What is the most frequent mechanism of heat loss in the newborn infant?
   a. Convection
   b. Conduction
   c. Radiation
   d. Evaporation

7. Which statement is not true about breast milk?
   b. Breast milk is economical.
   c. Breast milk provides protection against diarrhea.
   d. Breast milk provides protection against otitis media.

8. When should resuscitation be started in the delivery room?
   a. After the 1-minute Apgar score is obtained
   b. Immediately, if respirations are absent or ineffective
   c. Immediately, if HR is less than 80 bpm
   d. After 90 seconds of attempted tactile stimulation

9. In what sequence (1 to 5) should the activities occur for initial resuscitation of an infant?
   ___ 1. Position infant’s head.
   ___ 2. Suction mouth.
   ___ 3. Dry infant.
   ___ 4. Place infant under preheated radiant warmer.
   ___ 5. Suction nose.

ANSWERS TO STUDY QUESTIONS

1. d 2. b 3. b 4. b 5. d 6. d 7. a 8. b 9. 4, 3, 1, 2, 5
REFERENCES


