

## Care of the Newborn

### Routine Resuscitation

- When called to the delivery of a newborn, first learn the basic maternal history (time permitting), including the following:
  - The infant's gestational age (term vs preterm)
  - If prenatal care was obtained. If possible, gather laboratory information, including the ultrasound, infant weight, etc
  - Complications, if any, leading to delivery (eg, bleeding, change in fetal movements, etc)
  - Maternal medications (during pregnancy and in the last 24 hours of pregnancy)
  - Maternal health status (eg, medical conditions, immunizations, etc)
- Gather the proper equipment needed for resuscitating a newborn
  - Warm towels
  - A heat source to keep the infant warm
    - ▶ Use radiant warmers, if available
    - ▶ If a radiant warmer or other appropriate heat source is not available, skin-to-skin contact with the mother can be used to keep the baby warm
  - A bulb syringe
  - A suction device, such as wall suction, that can be used with a suction catheter
  - Oxygen source
  - Self-inflating bag or flow-inflating bag that can provide positive pressure ventilation
  - Mask, size 0 or 1, that can fit over the mouth and nose of an infant
  - A minute-second timer (though not essential, this helps mark 1 and 5 min and is useful if positive pressure ventilation is needed)
- Attempt to have a neonatal resuscitation provider available;

larger medical commands should identify people with this experience, even in the deployed environment

- Resuscitation
  - First 60 seconds following birth:
    - ▶ Ensure the obstetrical provider securely clamps the umbilical cord before passing the infant to the pediatric team; start the minute–second timer
    - ▶ All infants need to be warm, dry, suctioned, and stimulated; in the delivery room, this takes place within a period of 30 seconds
      - ▷ Dry the infant with the warm towels, discarding damp ones; it is typical to use two or three towels within the first 30 seconds
      - ▷ Rubbing the infant’s back and chest while drying is stimulating; if further stimulation is necessary, flicking or slapping the soles of the infant’s feet may help
      - ▷ Position the infant’s head at the foot of the bed or radiant warmer
      - ▷ Manage the patient’s airway and position the head in the sniffing position, allowing for slight hyperextension of the neck (this is usually done by the person closest to the patient’s head)
      - ▷ Suction the mouth and nares with the bulb syringe or suction catheter to clear amniotic fluid that could occlude the airway
    - ▶ Monitor the infant’s heart rate by gently palpating the base of the umbilical cord to feel for a pulse, or by listening to the heart with a stethoscope
      - ▷ If the newborn is active and crying, the heart rate should be above 100 beats per minute (bpm)
        - A “vigorous” infant has good muscle tone, a heart rate > 100 bpm, and is crying
        - If the baby is vigorous, stop resuscitation and allow the infant to transition (transitioning from the intrauterine environment to the outside world takes 2–4 h)
    - ▶ Further care is described in Routine Care of the Newborn

- All infants are born with a hue ranging from blue to pink; if healthy, they will transition to pink with adequate heart rate and ventilation
  - ▶ Sometimes an infant's hands and feet stay blue even when the rest of the body is pink (acrocyanosis)
    - ▷ Assess for central cyanosis by examining the color of the lips, gums, and central trunk
    - ▷ A brief period of free-flowing oxygen is beneficial to infants with adequate ventilation and heart rate who remain centrally blue
    - ▷ An infant requiring persistent oxygen needs more than typical resuscitation
- Every infant is assigned an Apgar score (activity, pulse, grimace, appearance, and respiration; Table 26-1) at 1 minute and 5 minutes of life
  - ▶ The score ranges from 0–10, with 10 being given to healthy, vigorous infants
  - ▶ Properly assigning an Apgar score requires training, but knowledge of the components will help providers unfamiliar with scoring know what is important when assessing a newborn during resuscitation, and will facilitate communication with a consulting specialist

### Special Circumstances Requiring Advanced Resuscitation

- The term infant is not vigorous after warming, drying, suctioning, and stimulating
  - If an infant is apneic, has a heart rate < 100 bpm, or has

**Table 26-1. Apgar Evaluation of Newborn Infants**

| <b>Sign</b>                      | <b>0</b>    | <b>1</b>                    | <b>2</b>        |
|----------------------------------|-------------|-----------------------------|-----------------|
| Heart rate                       | Absent      | Below 100                   | Over 100        |
| Respiratory effort               | Absent      | Slow, irregular             | Good, crying    |
| Muscle tone                      | Limp        | Some flexion of extremities | Active motion   |
| Response to catheter in nostril* | No response | Grimace                     | Cough or sneeze |
| Color                            | Blue, pale  | Body pink, extremities blue | Completely pink |

\*Tested after oropharynx is clear.

persistent central cyanosis despite free-flowing oxygen, further intervention is required

- ▶ Ventilation is the most important step in the resuscitation of infants that are not vigorous
- ▶ The two standard ways of providing ventilation are the self-inflating bag and flow-inflating bag
- ▶ Various mask sizes are needed, depending on the gestational age of the infant
  - ▷ Mask should cover the mouth and nose and provide a good seal
  - ▷ Most term newborns will use a size 1 infant mask
  - ▷ Preterm infants or infants that are small for their gestational age may need a size 0 newborn mask
- ▶ Use 100% oxygen when giving positive pressure ventilation
- ▶ Suction the mouth and nose again
- ▶ Place the mask over the infant's face
  - ▷ Hold the mask with your thumb and index finger; use your other three fingers to lift the jaw into the mask
  - ▷ Ensure there is an airtight seal
- ▶ Begin delivering breaths at a rate of 40–60 breaths per minute; use a manometer if available
- ▶ Pressures should be sufficient to provide adequate chest rise and fall
  - ▷ The first few breaths can require pressures in excess of 25 cm H<sub>2</sub>O, but it is rare to need pressures in excess of 40–60 cm H<sub>2</sub>O
  - ▷ Using excessive pressure can cause a pneumothorax
  - ▷ It takes experience to achieve the correct balance of pressure
    - Novices typically make one of two mistakes: they do not use sufficient pressure to provide adequate chest rise and fall, or they give breaths at a rate exceeding 60 breaths per minute
    - Using the minute–second timer can alleviate the frequency problem (give a breath every second)

- ▶ If positive pressure ventilation is adequate, heart rate will improve to over 100 bpm, color will improve, and the infant will start spontaneous respiration; gradually stop giving positive pressure ventilation
- ▶ If there is no improvement, check that the face mask is sealed adequately, reposition the head, and suction out the mouth
- ▶ If problems persist, reevaluate the pressure being administered; if it is adequate but there is still no improvement, the infant needs to be intubated
- The term infant needs to be intubated
  - Depending on the location and resources, intubating and ventilating a newborn infant may be impossible. When working in austere environments, it is reasonable and ethical to decide ahead of time the limits of the providers' resuscitative efforts
  - There are five main differences between the neonatal and adult airway:
    - ▶ The infant's head and tongue are proportionally larger than the adult's
    - ▶ The infant's larynx is more anterior and cephalad
    - ▶ The infant's epiglottis is long, narrow, and floppy (making it easier to use a Miller [straight] blade instead of a Macintosh blade)
    - ▶ The infant's vocal cords are slanted anteriorly
    - ▶ The cricoid cartilage is the narrowest part of an infant's larynx, not the vocal cords
  - A term infant is generally intubated with a 3.5 or 4.0 uncuffed endotracheal tube (ETT), using a Miller size 1 blade
  - Confirm ETT placement by observing one or more of the following:
    - ▶ Equal chest rise
    - ▶ Breath sounds over the lungs and not the stomach
    - ▶ Misting inside of the ETT
    - ▶ Positive color change using a pediatric-size disposable colorimetric carbon dioxide detector (fast, accurate)
    - ▶ Chest radiograph
    - ▶ Clinical improvement in ventilation and perfusion

- Upon successful intubation, continue providing positive pressure ventilation with enough pressure to ensure adequate chest rise at a rate of 40–60 breaths per minute
- In the rare case when an infant does not improve with establishing an airway and providing adequate ventilation, start chest compressions and establish intravenous access to give epinephrine and volume resuscitation, if necessary
- The infant develops a **tension** pneumothorax
  - Pneumothorax occurs in a small percentage of all newborns, rarely causing respiratory distress and need for rapid evacuation
  - There are cases when an infant develops a tension pneumothorax, especially those infants receiving excessive positive pressure ventilation
    - ▶ The infant will be in respiratory distress (with grunting or nasal flaring or retracting)
    - ▶ There are decreased breath sounds on the ipsilateral side, with tracheal deviation toward the contralateral side
    - ▶ Transilluminating the chest with a light source may show lucency over the side with the tension pneumothorax (chest radiograph confirms the presence of a pneumothorax, but is not usually available before intervention is required)
  - Treatment of a pneumothorax is accomplished using the same technique in any age group, except that a provider will use a smaller-gauge needle and the volume of air evacuated will be less in an infant
    - ▶ Use a needle attached to a three-way stopcock, with one end closed to air and the other open to a syringe
    - ▶ Insert the needle in the second intercostal space, at the mid-clavicular line
      - ▷ While inserting the needle, apply gentle retraction to the syringe
      - ▷ When the tip of the needle is in the correct place, you will hear a “whoosh” sound and will be able to rapidly pull back on the syringe
    - ▶ Draw off the air, turning the stopcock off to the patient and on to evacuate the air in the syringe, and repeat

- until no further air is evacuated from the lungs
- Infants with rapidly reaccumulating air require placement of a chest tube, which is beyond the scope of this chapter
- The amniotic fluid is meconium stained
  - Infants who are stressed prior to birth or are late in gestation (more than 41 weeks) are at increased risk to pass stool in the amniotic fluid prior to birth
    - ▷ When the mother's membranes rupture, the amniotic fluid is stained various shades of dark green
    - ▷ This places the infant at risk for aspiration of meconium fluid, which can lead to respiratory compromise (called meconium aspiration syndrome)
  - Obstetrical inventions reduce the risk of aspiration and include amniotic fluid infusion, bulb suctioning of the nares and mouth on presentation of the head (prior to delivery of the body), and not stimulating the infant at birth
  - The infant should not be stimulated when passed to the neonatal resuscitation team
    - ▶ If the infant is not vigorous, a provider experienced in intubating newborns should place an appropriately sized ETT, attach a meconium aspirator, and suction any meconium from below the vocal cords
    - ▶ The vigorous infant only requires routine resuscitation; if intubation and airway suctioning are impossible, the basics of resuscitation should be provided (warming, drying, stimulation, and suctioning, with the focus being on suctioning the oral pharynx)
  - Infants who develop signs of respiratory distress following delivery in meconium-stained fluid most likely aspirated meconium
    - ▶ These infants need to be cared for in a facility equipped to care for sick newborns
    - ▶ Consultation with a neonatologist is indicated
- The infant is preterm
  - An infant born at < 37 weeks is preterm (the age of viability is 24 gestational weeks; however, this may differ in other countries depending on their neonatal resuscitation resources)
  - Know the available hospital resources in the local area and

**Table 26-2. Infant Endotracheal Tube Sizes**

| Tube Size | Depth (cm) | Birth Weight (g) | Gestational Age (wk) |
|-----------|------------|------------------|----------------------|
| 2.5       | 7          | < 1,000          | 25–29                |
| 3.0       | 7–8        | 1,000–2,000      | 30–34                |
| 3.5       | 8–9        | 2,000–3,000      | 35–37                |
| 3.5–4.0   | 9–10       | > 3,000          | > 37                 |

consult a pediatrician or neonatologist when delivering and resuscitating a preterm infant

- Remember the basics
  - ▶ For infants born in the third trimester (> 28 wk), basic resuscitation (see Routine Resuscitation) may be all that is needed
  - ▶ If positive pressure ventilation is indicated, a size 0 neonatal mask is typically used
  - ▶ Intubation is achieved using 2.5–3.5 ETT to a depth of 7–10 cm, depending on the age and size of the infant (Table 26-2)
  - ▶ Intubation of the preterm infant requires prior experience in the intubation of children and newborns
- Following successful resuscitation, infants born at < 35 weeks or weighing < 2 kg will typically be admitted to a neonatal intensive care unit; infants older than this may be allowed to stay with their mothers, provided they can be watched closely
  - ▶ Resuscitated infants need to be kept warm and are easily susceptible to cold intolerance
  - ▶ Blood glucose levels should be checked shortly after birth and then every 3–5 hours before feeds until feeding is well established, especially in newborns that weigh < 10% of normal for their gestational age (Table 26-3)
    - ▷ Infants who are too young to begin oral feeds should be started on dextrose 10% in water (D<sub>10</sub>W) at 3.3–5 mL/kg/h (80–120 mL/kg/day; consult a pediatric provider to determine exact rates)
  - ▶ Vital signs should be checked at least every 4 hours (Table 26-4)

**Table 26-3. Expected Newborn Weight by Gestational Age**

| Gestational Age (wk) | Mass (g) |
|----------------------|----------|
| 25                   | 650      |
| 26                   | 750      |
| 27                   | 880      |
| 28                   | 1,000    |
| 29                   | 1,150    |
| 30                   | 1,325    |
| 31                   | 1,500    |
| 32                   | 1,700    |
| 33                   | 1,900    |
| 34                   | 2,150    |
| 35                   | 2,375    |
| 36                   | 2,600    |
| 37                   | 2,860    |
| 38                   | 3,075    |
| 39                   | 3,300    |
| 40                   | 3,460    |
| 41                   | 3,600    |
| 42                   | 3,690    |

- ▷ Abnormal vital signs, temperature intolerance, hypoglycemia (blood glucose < 40), or poor feeding, regardless of gestational age, should prompt consultation with a neonatologist and transport to a hospital equipped to care for a sick neonate
- ▷ Consultation with a neonatologist regarding a pre-term newborn is always strongly encouraged
- The infant does not appear normal
  - Few abnormalities require urgent recognition and management in the delivery room (see below). In austere environ-

**Table 26-4. Normal Infant Vital Signs**

|                        |                   |
|------------------------|-------------------|
| Respiratory rate       | 30–60 breaths/min |
| Heart rate*            | 120–160 beats/min |
| Temperature (axillary) | 36.1°C–37°C       |

\*Some healthy, term infants may have a resting heart rate as low as 90 beats per minute while asleep. A heart rate that remains this low in an awake, crying infant is not normal.

ments management may be limited to recognition and supportive care without the ability to refer to a neonatal center.

- ▶ **Abdominal wall defect.** It is rare for an infant's abdominal contents to develop outside the abdomen. In gastroschisis, the abdominal wall defect is typically to the right side of the umbilical cord. In omphalocele, the defect is through the umbilical cord insertion. In either case, the same steps should be followed
  - ▶ Immediately place the infant in a clear, sterile, plastic bag up to the neck to reduce insensible water losses and minimize exposure of the open bowel; if this is impossible, consider using plastic wrap or warm saturated gauze
  - ▶ Use an oral gastric tube to decompress the intestine (a Replegle tube is preferred); if the infant requires advanced resuscitation, limit positive pressure ventilation delivered using a bag-valve mask
  - ▶ Contact a surgeon
    - Rarely, dusky blue to black bowel requires urgent reduction to prevent ischemia and bowel death
  - ▶ These patients may require initial intense fluid management and attention to acidosis status
    - Begin  $D_{10}W$  at 3.3–5 mL/kg/h (80–120 mL/kg/day)
    - Hypotension, poor perfusion, or acidosis should prompt a fluid bolus of 10 mL/kg given over 20–30 minutes
    - Transport to a tertiary care facility
- ▶ **Neural tube defect.** Protrusion of the spinal cord or the meninges outside the spinal canal is also rare
  - ▶ Place the infant prone on the infant warmer
  - ▶ Cover the protruding mass in warm, sterile gauze
  - ▶ Contact a neurosurgeon and arrange for transport to a tertiary care facility
- ▶ **Upper airway anomaly.** Infants are obligate nose breathers
  - ▶ Infants with small jaws, large tongues, and cleft lips

- may have Pierre-Robin sequence and difficulty keeping their upper airways open. These patients may benefit from being placed in the prone position, and some require placement of an oral airway. Severe cases need bag-mask ventilation and intubation
- ▷ Infants born with upper airway stenosis, such as choanal atresia, may also need an oral airway to breathe
  - ▷ Typically, infants with only cleft lips or palates do not have respiratory issues, but may have difficulty feeding, which can be addressed by a pediatric care provider
  - Most other cases of infants appearing abnormal can wait for further evaluation until after initial stabilization
- The term infant appears ill
    - When an infant appears ill, it is important to ensure that the infant is not septic. Infection in infants can present with soft signs and progress to death within hours. Maternal risk factors for neonatal infection include:
      - ▶ Intrapartum temperature 100.4°F (38.5°C)
      - ▶ Amniotic membrane rupture > 18 hours before delivery
      - ▶ Chorioamnionitis
      - ▶ Maternal group B streptococcus positive or unknown and without maternal intrapartum antibiotic prophylaxis
    - Draw a complete blood count with differential and blood culture
      - ▶ An experienced provider should perform a lumbar puncture to obtain cultures and Gram stain, cell count, and glucose and protein levels
      - ▶ For infants < 48 hours old, a urine culture is typically not helpful
    - Empiric antibiotic treatment often consists of administering ampicillin and an aminoglycoside (usually gentamicin) or ampicillin and a broad-spectrum, third-generation cephalosporin, such as cefotaxime
    - The ill-appearing infant needs transfer to a tertiary care facility

- ▶ Consult a pediatric provider
- ▶ If the term infant is < 48 hours old, start  $D_{10}W$  at 2.5 mL/kg/h (60 mL/kg/day)
- ▶ Infants > 2 days old require some electrolytes; consult a pediatric provider to determine the appropriate fluids (see recommendation in Chapter 22, Basic Fluid and Electrolytes)
- Observe vital signs
  - ▶ Warm hypothermic infants
  - ▶ Check blood glucose
  - ▶ Hypoglycemia can mimic infection; infants that appear ill and are hypoglycemic (blood glucose < 40) should receive a  $D_{10}W$  bolus (2 mL/kg), then be started on intravenous fluids (see above)
- Infants with evidence of respiratory distress or persistent cyanosis require evaluation by a specialist
  - ▶ Obtain an arterial blood gas reading by drawing blood from the radial artery
  - ▶ Place a pulse oximeter on the infant's right hand and left foot to help monitor preductal and postductal saturations
  - ▶ If possible, deliver either positive pressure ventilation via bag mask or intubation, or continuous positive pressure using 100% oxygen
  - ▶ Obtain a chest radiograph and discuss the results with a specialist
  - ▶ Begin a sepsis evaluation (see previous page)
- The infant is large or small for gestational age
  - Infants that are large or small for their gestational age are at risk for hypoglycemia
    - ▶ Check blood glucose once every few hours (for a total of three times) until patient is stable

### **Routine Care of the Newborn**

- Feeding
  - Breast-feeding is the recommended method for feeding a newborn, and may be all that is available
    - ▶ Breast-feeding should occur on demand (ie, when the infant is showing interest in feeding), 8–10 times in a

24-hour period, for 10–20 minutes on each breast

- ▶ In the stable, vigorous newborn, initiate breast-feeding immediately after birth; it takes priority over the newborn examination, delivery of vitamin K, and administration of eye drops
- ▶ Most medications are safe to use during breast-feeding
  - ▷ Exceptions include chemotherapeutic agents, radioactive isotopes, and antimetabolites
  - ▷ LactMed (<http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?LACT>) is an online Web site that can be used to determine a medication's safety during breast-feeding; it is available through the National Library of Medicine and is accessible through PubMed by selecting TOXNET, then the LactMed database
- Infants fed formula may start with only a half ounce per feed, but quickly increase to 2 ounces or more per feed over the next few days
- Newborn prophylaxis
  - After the first breast-feeding attempt has been accomplished, give 1 mg of vitamin K (phytonadione), if available, intramuscularly in the thigh to prevent hemorrhagic disease
  - Administer 1% silver nitrate eye drops or erythromycin (0.5%) and tetracycline (1.0%) sterile ophthalmic ointment, if available, for prevention of gonococcal eye infection
- General care
  - Infants should be dressed or blanketed in one or two layers more than what everyone else is wearing
    - ▶ Excessive wrapping and layering can lead to hyperthermia
    - ▶ Place wrapped infants in a crib in the supine position
  - Infants are typically given a sponge bath at birth to remove the vernix
  - Infants typically void once the first day, twice the second day, then more frequently after that
    - ▶ Most infants will stool at least once in the first 24–48 hours
    - ▶ The stool will be meconium (dark and tarry) for the first few days

- ▶ If voiding or stooling is delayed, consultation is recommended
- Most infants stay 2 days in the hospital
  - ▶ A weight loss of up to 10% of the birth weight can be expected, especially in breast-fed infants
  - ▶ Weight loss in excess of 10% should prompt further evaluation and consultation with a specialist
  - ▶ During this time, vitals should be checked at least every 8–12 hours
  - ▶ The newborn should be assessed for jaundice
    - ▷ Infants with yellowing skin should be evaluated for hyperbilirubinemia or an elevated indirect bilirubin
    - ▷ Normal values for a newborn are significantly higher than adult values and vary based on the age (in hours) of the infant (see American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. *Pediatrics*. 2004;114:297–316). An indirect bilirubin of > 10 after the first week of life in a term infant, or persistent elevation of the direct bilirubin fraction require further diagnostic investigation