Chapter 21: Neonatal Resuscitation

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High-Yield Facts

The vast majority of newly born infants will respond to tactile stimulation and warming. Very few will require advanced life support.

Neonatal resuscitation is focused chiefly on respiratory support, not on cardiac support, unlike resuscitation for adults or older children.

Healthy term newborns may take 10 minutes or longer to reach normal extrauterine oxygen saturations.

The use of preductal pulse oximetry is recommended because skin color can be a poor indicator of oxygen saturation.

The use of oxygen/air blenders is recommended to decrease exposure to 100% oxygen which has been increasingly shown to have toxic effects.

When meconium-stained amniotic fluid is present, mouth and nasal suctioning after delivery of the head is not recommended. Intratracheal suctioning should only be performed after delivery if the infant has absent or depressed respirations, decreased muscle tone, or a heart rate less than 100 beats/min.

Laryngeal mask airways may be considered for assisted ventilation of term or near-term newborns in the hands of experienced providers.

Chest compressions are only initiated if there is no pulse or if the heart rate remains less than 60 beats/min after adequate positive-pressure ventilation (PPV) for 30 seconds.

The ratio of chest compressions to ventilations during resuscitation should be 3:1, with 90 compressions and 30 ventilations per minute.

The recommended technique for performing chest compressions is the two-thumb–encircling hand technique.

The best site to palpate for pulses in the newly born infant is the umbilical stump.
The umbilical vein is the best site for intravenous (IV) access.

Only isotonic crystalloid or packed red blood cells should be used for initial volume resuscitation.

Epinephrine is indicated for asystole or a heart rate less than 60 beats/min after 30 seconds of adequate ventilation and chest compressions.

The dose of epinephrine for the newly born infant is 0.1 to 0.3 mL/kg of 1:10,000 solution given intravenously. Higher doses are not recommended.

Therapeutic hypothermia instituted after resuscitation may improve neurologic outcomes for term infants with hypoxic-ischemic encephalopathy (HIE).

**Background**

Of the nearly 4 million infants that are born in the United States each year, more than 90% successfully transition from intrauterine life with little or no intervention. Roughly 10% require some assistance and 1% require more extensive resuscitation.\(^1\) Because of the large number of births, it is inevitable that the emergency medicine practitioner will be faced with a newly born infant in their emergency department and the need for neonatal resuscitation. As in any critical situation, in medicine, preparation and anticipation play a key role in neonatal resuscitation. This includes equipment (Table 21-1) and personnel to be ready as soon as a newly born infant presents to the emergency department. Current American Heart Association (AHA) guidelines recommend that at least one skilled provider should attend every birth in the delivery room and three skilled providers should be present for deliveries in the emergency department.\(^2\)
### Neonatal Resuscitation Quick Checklist

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
</table>
| Warm     | Preheat radiant warmer  
          | Warm towels or blankets |
| Clear airway | Bulb syringe  
              | 10F or 12F suction catheter attached to wall suction at 80–100 mm Hg  
               | Meconium aspirator |
| Auscultate | Stethoscope |
| Oxygenate | Method to give free-flow oxygen (mask, tubing, flow-inflating bag, or T-piece)  
            | Gases flowing just prior to birth, 5–10 L/min  
               | Oxygen blender set per protocol  
               | Pulse oximeter probe (detached from oximeter until needed)  
               | Pulse oximeter |
| Ventilate | Positive-pressure ventilation (PPV) devices with term and preterm masks  
              | PPV devices functioning  
              | Connected to air/oxygen source (blender)  
              | 8F feeding tube and 20-mL syringe |
| Intubate  | Laryngoscope  
           | Size 0 and 1 (size 00, optional) blades with bright light  
              | Endotracheal tubes, sizes 2.5, 3.0, 3.5, 4.0  
               | Stylets  
               | End-tidal CO₂ detector  
               | Laryngeal mask airway (size 1) and 5-mL syringe |
| Medicate  | Access to 1:10,000 epinephrine and normal saline  
              | Supplies for administering medicines and placing emergency umbilical venous catheter  
               | Documentation supplies |
| Thermoregulate | Plastic bag or plastic wrap  
                      | Chemically activated warming pad  
                      | Transport incubator ready |
Maternal Risk Factors

Successful neonatal resuscitation depends on anticipation, preparation, and immediate support of infants who are not successfully transitioning to extrauterine life.¹ Because births that occur outside of the delivery room are often complicated by lack of prenatal care, trauma, or prematurity, it is vital to take a focused history to guide the level of expected resuscitation. Key antepartum factors to focus on include the gestation of the pregnancy, the last menstrual period, multiple gestation, and history of previous fetal or neonatal death. Maternal diabetes, hypertension, and intrapartum fever also have been associated with increased perinatal morbidity. Other risk factors that should be addressed include prolonged rupture of membranes (>18 hours), prolonged labor (>24 hours), meconium-stained or foul-smelling amniotic fluid, bleeding, and prolapsed umbilical cord (Table 21-2).
### TABLE 21-2

**Maternal Risk Factors**

<table>
<thead>
<tr>
<th>Antepartum Factors</th>
<th>Intrapartum Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal diabetes</td>
<td>Macrosomia</td>
</tr>
<tr>
<td>Gestational hypertension or preeclampsia</td>
<td>Use of general anesthesia</td>
</tr>
<tr>
<td>Chronic hypertension</td>
<td>Narcotics administered to mother within 4 h of delivery</td>
</tr>
<tr>
<td>Fetal anemia or isoimmunization</td>
<td>Meconium-stained amniotic fluid</td>
</tr>
<tr>
<td>Previous fetal or neonatal death</td>
<td>Prolapsed cord</td>
</tr>
<tr>
<td>Bleeding in the second or third trimester</td>
<td>Abruptio placentae</td>
</tr>
<tr>
<td>Maternal infection</td>
<td>Placenta previa</td>
</tr>
<tr>
<td>Maternal cardiac, renal, pulmonary, thyroid, or</td>
<td>Significant intrapartum bleeding</td>
</tr>
<tr>
<td>neurologic disease</td>
<td></td>
</tr>
<tr>
<td>Polyhydramnios/oligohydramnios</td>
<td></td>
</tr>
<tr>
<td>Premature rupture of membranes</td>
<td></td>
</tr>
</tbody>
</table>

**Fetal hydrops**

**Postterm gestation**

**Multiple gestation**

**Size-dates discrepancy**

**Drug therapy, such as magnesium**

**Adrenergic agonists**

**Maternal substance abuse**

**Fetal malformation or anomalies**

**Diminished fetal activity**

**No prenatal care**

**Mother older than 35 yrs**

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### Newly Born Infants Requiring Resuscitation

Current AHA neonatal resuscitation guidelines include a rapid observational tool, which can be used to identify which newly born infants will not need to be resuscitated.¹ This tool consists of three questions:

- **Was the baby born after a full-term gestation?**
- **Is the baby breathing or crying?**
Temporary paper: 9/18/2018

Does the baby have good muscle tone?

If the answer to all of the questions is yes, the infant will likely not require significant resuscitation and should be allowed to stay with the mother with continued monitoring. If the answer to any of these questions is no, then resuscitation may be required. The actions undertaken during resuscitation should occur in an orderly manner as described by the AHA (Fig. 21-1). These include initial steps in stabilization, ventilation, chest compressions, and administration of epinephrine or volume expansion. The heart rate, respiratory effort, and color are monitored closely and guide the decision to escalate the level of resuscitation.

**Figure 21-1**
Assessment of Newly Born Infant

The Apgar score is a method of objectively measuring the newborn's condition and response to resuscitation. The Apgar score is normally assigned at 1 minute and again at 5 minutes, based on the infant's respirations, heart rate (best evaluated by palpating the umbilicus), color, muscle tone, and reflex irritability (Table 21-3). If the 5-minute Apgar score is less than 7, then additional scores should be made every 5 minutes up to 20 minutes. The Apgar score is not used to determine the need for resuscitation or to guide the resuscitation efforts, and the resuscitation must not be delayed for the purpose of tabulating the Apgar score. Neonates with a 1-minute Apgar score >7 require minimal resuscitation other than drying and
stimulation. Infants with persistently low Apgars (<3) at 10 minutes have been shown to have a high likelihood of death or moderate/severe disability.\(^3\)

**TABLE 21-3**

**The Apgar Score**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Score 0</th>
<th>Score 1</th>
<th>Score 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Blue, pale</td>
<td>Body pink, extremities blue</td>
<td>Totally pink</td>
</tr>
<tr>
<td>Muscle tone</td>
<td>None, limp</td>
<td>Slight flexion</td>
<td>Active, good flexion</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>0</td>
<td>&lt;100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Respiration</td>
<td>Absent</td>
<td>Slow, irregular</td>
<td>Strong, regular</td>
</tr>
<tr>
<td>Reflex irritability (response to nasal catheter)</td>
<td>None</td>
<td>Some grimace</td>
<td>Good grimace, crying</td>
</tr>
</tbody>
</table>

To calculate Apgar score, add numbers for all parameters together.


**Resuscitation**

**Positioning of the Newborn**

After delivery, the infant should be dried with warm towels and placed supine under a radiant warmer. The head should be put into a “sniffing” position which aligns the posterior pharynx, larynx, and trachea and allows for unimpeded air entry (Fig. 21-2). Oral and nasal suctioning should be performed with a bulb syringe or suction catheter, turning the infants head to the side if copious secretions are present. The mouth should be suctioned prior to suctioning the nose so that the oropharynx is clear of secretions if the infant suddenly gasps during nasal suctioning. One way to remember to suction the mouth before nose is that “M” comes before “N” in the alphabet.\(^2\) When suctioning the mouth and posterior oropharynx, it is important not to suction too vigorously or deeply, which is shown in some circumstances to cause bradycardia and apnea.\(^2\)

**Temperature Control**

Newborns are at risk for hypothermia following delivery because of their large surface area to body-mass ratio as well as evaporative heat loss. Hypothermia can lead to hypoglycemia, increased oxygen consumption and if severe, respiratory depression, and acidosis. This can be avoided by careful drying of the infant with warm towels and placing the infant under a radiant heat source. Very low-birth-weight infants (<1500 g) are particularly prone to hypothermia and may need to be placed under plastic wrapping to avoid evaporative loss. Continual monitoring of temperature is very important, because hyperthermia can have deleterious effects such as worsening ischemic brain injury.

**Stimulation**

For vigorous newborns, drying and suctioning of the mouth is usually adequate stimulation as evidenced by increased heart rate and respiratory effort. If the infant does not have adequate respirations, rubbing the infant’s trunk and flicking the soles of the feet should be initiated. If the newborn does not respond promptly to tactile stimulation, positive-pressure ventilation (PPV) should be initiated. It is important not to mistake gasping for breathing. Gasping is a series of deep, irregular or rapid respirations that are indicative of respiratory depression or hypoxia and require the same intervention that no observed respiratory effort would require.

**Oxygen**
If the infant is not breathing adequately or has a heart rate less than 100 beats/min (best evaluated by palpating the base of the umbilical cord), PPV should be initiated immediately. Administering free-flow oxygen or continuing tactile stimulation for a baby that is not breathing is not valuable and only delays appropriate treatment. The baby’s skin color, observing the lips, mouth, and torso, should be assessed, because the transition from cyanosis to pink color is an rapid indicator of oxygenation. Acrocyanosis, which is cyanosis of the hands and feet, represents peripheral vasoconstriction and is not an indication for administering oxygen. Central cyanosis may be an indicator for further intervention, but this is complicated by several factors. Skin color is often an unreliable indicator of oxygen saturation (SpO₂) and may be difficult to interpret due to skin pigmentation. Also, studies have shown that normal term infants take several minutes to transition from the intrauterine 60% oxygen saturation to the normal room air oxygen saturation of 90%. Because of this, updated AHA guidelines recommend preductal oxygen saturation (attaching oximeter probe to the right hand) to be utilized if central cyanosis is persistent. Obtaining a reliable oximeter signal may take several minutes and should not delay the resuscitation effort. Once a good oximeter signal is obtained, an oxygen/air blender (Fig. 21-3) should be utilized to titrate the administered oxygen between 21% and 100% to achieve target values at different times after birth (Table 21-4). For term infants, 21% oxygen should be used initially and the oxygen percentage should be increased as needed based on pulse oximeter. There is evidence that preterm infants should be started on a higher percentage of oxygen during resuscitation. Administration of 100% oxygen is not recommended, especially in preterm infants, due to deleterious effects. Oxygen can be weaned and then discontinued when there is no central cyanosis, oximetry saturations are above 90%, and there is no respiratory distress. If this is not the case, a trial of PPV should be initiated.
### TABLE 21-4
Targeted Preductal SpO₂ After Birth

<table>
<thead>
<tr>
<th>Time</th>
<th>SpO₂ Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 min</td>
<td>60%–65%</td>
</tr>
<tr>
<td>2 min</td>
<td>65%–70%</td>
</tr>
<tr>
<td>3 min</td>
<td>70%–75%</td>
</tr>
<tr>
<td>4 min</td>
<td>75%–80%</td>
</tr>
<tr>
<td>5 min</td>
<td>80%–85%</td>
</tr>
<tr>
<td>10 min</td>
<td>85%–95%</td>
</tr>
</tbody>
</table>


### FIGURE 21-3


**Ventilation**
The normal newborn breathes or cries spontaneously within seconds of birth and establishes regular respirations within the first minute of life. PPV is indicated if the infant remains apneic or gasping, the heart rate is <100 beats/min after 30 seconds of initial resuscitation, or has central cyanosis despite supplemental oxygen. Ventilation of the lungs is the single most important aspect of resuscitation of the compromised newborn. Ventilation is performed using a cushioned mask with either a self- or flow-inflating bag or a T-piece resuscitator (Fig. 21-4). Breaths are delivered when the operator occludes and opens the aperture on the device connected to the mask. The mask must make a tight seal over the nose and mouth and the pop-off valve may need to be bypassed because of the high peak inspiratory pressures needed for the initial breaths. Peak pressures up to 40 cm H₂O may be necessary because of the “stiff” fluid-filled lungs of newborns. After the initial breaths, the fluid will begin to be expressed from the lungs and lower pressures can be utilized. It is important to use the lowest pressure that will adequately give chest rise to avoid iatrogenic pneumothorax. Term newborns only require 10 to 25 mL of volume per ventilation, so smaller bags should be used with a volume of 200 to 750 mL. The concentration of oxygen should be titrated using an oxygen blender as described in the previous section. The best indicator of successful PPV is increasing heart rate. An acronym for improving PPV is “MRSOPA” (Table 21-5). Effective bag-mask ventilation at 40 to 60 breaths/min is continued for 30 seconds and the infant is then reassessed. Assisted ventilation can be discontinued once the heart rate is >100 beats/min, the infant is breathing spontaneously, and improvements in color and tone are seen. If the heart rate remains <100 beats/min, assisted ventilation is continued. If the heart rate remains <60 beats/min, despite assisted ventilation, chest compressions are initiated and the endotracheal intubation should be considered.
TABLE 21-5
Technique for Improving Positive-Pressure Ventilation by Mask

<table>
<thead>
<tr>
<th>Corrective Steps</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Be sure there is a good seal of the mask on the face</td>
</tr>
<tr>
<td>R</td>
<td>The head should be in a “sniffing” position</td>
</tr>
<tr>
<td>S</td>
<td>Check for secretions; suction if present</td>
</tr>
<tr>
<td>O</td>
<td>Ventilate with the baby’s mouth slightly open and lift the jaw forward</td>
</tr>
<tr>
<td>P</td>
<td>Gradually increase the pressure every few breaths, until there are bilateral breath sounds and visible chest movement with each breath</td>
</tr>
<tr>
<td>A</td>
<td>Consider endotracheal intubation or laryngeal mask airway</td>
</tr>
</tbody>
</table>


FIGURE 21-4
Endotracheal Intubation

The indications for endotracheal intubation during neonatal resuscitation include poor response to or the inability to provide adequate PPV, the need for endotracheal suctioning or chest compressions, extreme prematurity, or suspected diaphragmatic hernia.² The size of the endotracheal (ET) tube depends on the weight or gestation of the newly born infant (Table 21-6). A laryngoscope with a straight blade is utilized, using a 0 or 1 blade. Successful endotracheal intubation is evidenced by bilateral chest rise and improvement in heart rate, color, and muscle tone. The use of an end-tidal carbon dioxide monitor can assist with confirmation of proper tube placement, even in very low-birth-weight infants. Care must be made not to advance the ET tube too far, which will result in mainstem bronchus intubation. Most ET tubes have a guideline that should be placed adjacent to the vocal cords, resulting in proper intubation depth (Fig. 21-5). A rough formula for depth of intubation is as follows:

\[
\text{Depth of tube insertion at gums (in cm) = 6 + infant's weight (in kg)}^{2}
\]
### TABLE 21-6

**Endotracheal (ET) Tube Sizing**

<table>
<thead>
<tr>
<th>Tube Size (mm) (Internal Diameter)</th>
<th>Weight (g)</th>
<th>Gestational Age (wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>Below 1000</td>
<td>Below 28</td>
</tr>
<tr>
<td>3.0</td>
<td>1000–2000</td>
<td>28–34</td>
</tr>
<tr>
<td>3.5</td>
<td>2000–3000</td>
<td>34–38</td>
</tr>
<tr>
<td>3.5–4.0</td>
<td>Above 3000</td>
<td>Above 38</td>
</tr>
</tbody>
</table>


### FIGURE 21-5


![Endotracheal Tube and Vocal Cords](image)

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Intubation attempts should be completed within 30 seconds during resuscitation because the infant will not be ventilated during the procedure.\(^2\)

### Laryngeal Mask Airways

Laryngeal mask airways (LMAs) may be considered for assisted ventilation of infants, where bag-mask ventilation or intubation has been unsuccessful for term or near-term newborns. A size 1 LMA should be utilized, and although designed for use in newborns over 2 kg, they have been successfully used in newborns as small as 1.5 kg. LMAs should only be used by providers experienced in their use.\(^1\)
Chest Compressions

Chest compressions are rarely needed in the resuscitation of all but the most critical of newly born infants. They are indicated when the heart rate remains <60 beats/min, despite 30 seconds of effective PPV. There are two different techniques for administering chest compressions (Fig. 21-6). One is the two-finger technique and the more effective technique is the two-thumb-encircling hand technique. Here, two thumbs deliver the compression, with the provider's hands encircling the infant and supporting the back. This technique is recommended because it may deliver higher peak systolic and coronary perfusion pressure. Compressions should be given over the lower third of the sternum to a depth of roughly one-third the diameter of the chest cavity (Fig. 21-7). There should be a 3:1 compression to ventilation ratio with ventilation and compression coordinated to avoid simultaneous delivery. About 120 events/min (90 compressions and 30 ventilations) should be delivered resulting in an event roughly twice per second. Every 30 seconds, respiratory effort, color, pulse, and muscle tone should be reassessed. Chest compressions can be discontinued when the heart rate is >60 beats/min and effective ventilations should then be delivered at the higher rate of 40 to 60 breaths/min.

FIGURE 21-6

Intravenous Access

For infants who require volume expansion or epinephrine, intravenous (IV) access is necessary. The umbilical vein is the preferred route for IV access, because it is easily identified and large enough for rapid catheter insertion. The umbilical vein can be identified as a thin-walled structure usually in the 11- or 12-o'clock position in the umbilical cord. Conversely, the umbilical arteries are two thicker-walled vessels lying in the 4- to 8-o'clock position (rarely will a neonate have only one umbilical artery). After cleaning the umbilical cord and using aseptic technique, the cord is cut 1 to 2 cm above the skin line, perpendicular to the cord. A 3.5 or 5F umbilical catheter can be advanced 2 to 4 cm or until blood can be easily aspirated from the catheter (Fig. 21-8). Deeper advancement of the catheter should be avoided because of the risk of infusing hypertonic solution into the liver.

FIGURE 21-8
Medications

Medications are rarely needed in the resuscitation of newborn infants. One large series demonstrated that medications were required in only 0.15% of 15,000 deliveries. Bradycardia in the newly born is usually secondary to inadequate ventilation or hypoxemia and establishing effective ventilation should be the focus during resuscitation. If the heart rate remains <60 beats/min despite effective ventilation and chest compressions, then epinephrine or volume expansion may be indicated.

Epinephrine

Epinephrine is the most important drug used in infant resuscitation. It is indicated in asystole and in bradycardia with a heart rate less than 60 after 30 seconds of effective ventilation with 100% oxygen and chest compressions. The recommended IV dose is 0.1 to 0.3 mL/kg (0.01 to 0.03 mg/kg) per dose of 1:10,000 solution. Higher IV doses are not recommended based on studies in animals that showed exaggerated hypertension, decreased myocardial function, and worse neurologic function after epinephrine doses of 0.1 mg/kg or higher. The preferred route is IV, although the endotracheal route can be used if IV access has not been established. If the endotracheal route is used, a higher dose should be considered—0.5 to 0.1 mL/kg (0.05 to 0.1 mg/kg), but the safety of these higher endotracheal doses has not been well studied. Epinephrine should be given rapidly and may be repeated every 3 to 5 minutes, reassessing the patient carefully between doses.

Volume Expansion

The indication for using volume expansion in neonatal resuscitation is hypovolemia or hypovolemic shock. Some of the conditions that may lead to hypovolemic shock include placental abruption, placenta
previa, trauma, avulsed umbilical cord, or premature cord clamping. Babies in shock appear pale, have weak pulses, and delayed capillary refill. Often, they will not respond adequately to well-administered resuscitation and have persistent bradycardia. Volume expansion is given in aliquots of 10 mL/kg over 5 to 10 minutes. The acute treatment of hypovolemia is initiated with normal saline or lactated Ringer's solution, followed by packed red blood cells if there is a large-volume blood loss or a poor response to the crystalloid solution. Uncross-matched O-negative blood should be administered if a full-type and cross-match cannot be obtained in a timely fashion.

Glucose

Hypoglycemia is often seen in premature infants and infants born to diabetic mothers. Acute signs of hypoglycemia include jitteriness, seizures, and decreased level of consciousness. Infants who are symptomatic or require significant resuscitation should have their glucose levels monitored and glucose should be administered to maintain normoglycemia (>50 mg/dL). The dose of glucose is 2 to 4 mL/kg of D$_{10}$W given intravenously. Higher concentrations should be avoided because they may lead to hyperosmolality and increased risk of intraventricular hemorrhage. Until the infant is stabilized and feedings are established, glucose should be infused at a rate of 6 to 8 mg/kg/min.

Naloxone

Naloxone is a direct narcotic antagonist used to reverse respiratory depression because of narcotic exposure. This effect can be observed if maternal narcotics were administered within 4 hours of delivery. The current dosing recommendation for naloxone is 0.1 mg/kg given either intravenously or intramuscularly. Endotracheal administration of naloxone is not supported by current recommendations. Naloxone should not be given if there is maternal history of chronic narcotic abuse or methadone therapy because severe acute withdrawal syndrome and seizures can occur.

Special Situations

Meconium

Meconium-stained amniotic fluids complicates approximately 13% of live-born births. A smaller percentage (5%-12%) of these infants go on to develop meconium aspiration syndrome, which ranges in severity from mild respiratory distress to respiratory arrest and severe pulmonary hypertension. The likelihood of meconium-stained fluid is much higher in infants who are postmature or have suffered fetal distress. The management of infants born through meconium-stained fluids underwent a major paradigm shift based on a multicenter study in 2000, which demonstrated that endotracheal suction of meconium was not helpful for vigorous infants (strong respiratory effort, heart rate >100 beats/min, and good muscle tone). Recommendations no longer advise routine obstetrical suctioning of the oropharynx and
nasopharynx after delivery of the head for infants born through meconium-stained fluid. Further management following delivery is based on the activity of the infant, not the consistency of the meconium. Vigorous infants do not require endotracheal suctioning of meconium.\textsuperscript{2} This should be performed only on depressed infants (absent or depressed respirations, heart rate <100 beats/min, and poor muscle tone). The technique is to visualize the trachea using a laryngoscope, intubate the trachea, and then suction the meconium by attaching the ET tube to wall suction (Fig. 21-9). Multiple attempts and fresh ET tubes may be necessary if the meconium is especially thick or adherent. The infant's clinical status needs to be monitored very closely during these attempts and PPV should be instituted if the infant becomes severely depressed or bradycardic.\textsuperscript{2}

**FIGURE 21-9**


![Image of suctioning meconium from trachea](image)

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**Prematurity**

The premature infant (born prior to 37 weeks' gestation) represents a unique challenge in resuscitation because of multiple differences in their physiology and reactions to stress.\textsuperscript{1} Their lungs are often undeveloped and as a result of lack of surfactant may be very difficult to ventilate. The chest wall is very compliant and with less muscle mass, the premature infant will fatigue rapidly as they try to maintain their respiratory status. Often, intubation is needed to support ventilation and to provide a route to administer surfactant. Premature infants are particularly prone to hypothermia and cold stress because of their
immature skin and larger surface area to body-mass ratio. Great care must be taken to minimize heat loss with radiant heaters, warm blankets, and plastic membranes. They are also very prone to intraventricular hemorrhage because of the extremely fragile nature of the subependymal germinal matrix. Rapid changes in blood pressure, intravascular volume, and osmolality should be avoided to minimize the risk of intraventricular hemorrhage.

Medical technology has pushed the limits of viability for premature infants to never-before-seen levels. However, the decision to withhold resuscitation is a very complex issue, both medically and ethically even when all information is readily available. Unfortunately, this is often not an option for the emergency medicine practitioner. Resuscitation should be pursued when an infant is born with spontaneous heart rate and respirations. The decision to withdraw care may be considered if there are no signs of life (no heart beat or respiratory effort) after 10 minutes of continuous and adequate resuscitation.¹

**Diaphragmatic Hernia**

Diaphragmatic hernia occurs when there is a defect in the diaphragm (usually on the left side), giving rise to displacement of the lung by abdominal contents entering the chest cavity. The infant with this condition will be in respiratory distress, cyanotic, and have a scaphoid abdomen. A gastric tube should be placed immediately to decompress the stomach and oxygen should be administered. Prompt intubation and PPV is required and bag-mask ventilation should be avoided because it will lead to gastric distension and respiratory compromise.

**Pneumothorax**

Pneumothorax is reported to occur in 1% to 2% of term newborns and is often asymptomatic. In the context of neonatal resuscitation and PPV, pneumothorax can rapidly lead to tension pneumothorax and potentially lethal cardiorespiratory compromise. Premature infants and infants with meconium aspiration syndrome are at a higher risk for pneumothorax. Infants with this condition will be tachypneic, retracting, grunting, and tachycardic. As the tension pneumothorax progresses, the infant may become bradycardic and shocky. It may be difficult to localize the affected lung based on auscultation, but chest illumination may be helpful. If this condition is suspected and significant respiratory distress is present, needle decompression is indicated. This can be performed using a 20-gauge needle antiseptically advanced into the affected lung field either in the fourth intercostal space in the anterior axillary line or the second intercostal space in the midclavicular line. This will decompress the pleural cavity and should result in relief of the cardiorespiratory compromise.²

**Infant of a Diabetic Mother**

Infants born to a mother with glucose intolerance are exposed in utero to increased glucose levels, and respond accordingly with elevated insulin production. This makes the infant prone to multiple
complications including hypoglycemia, polycythemia, respiratory distress, intrapartum asphyxia, birth defects, and large for gestational age. Cesarean section is often necessary because of the infant’s macrosomia. Following delivery, these infants need to be monitored very closely for hypoglycemia and respiratory distress.

**Therapeutic Hypothermia**

For full-term infants who have suffered hypoxic-ischemic encephalopathy (HIE), there are recent studies that demonstrate the neurologic benefit of therapeutic hypothermia. Guidelines for this include gestational age more than 36 weeks, evidence of acute perinatal HIE event, ability to initiate hypothermia within 6 hours of delivery (body temperature 33.5–34.5°C). These criteria should influence the transfer to specialized neonatal centers if necessary and great care should be taken to prevent hyperthermia while awaiting transfer or transport.²

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You may find link to the AccessEmergency Medicine below:

http://catalog.lib.msu.edu/record=b9301975~S39a

If you have any questions, please let us know. We can be reached at 517-355-2345 (toll free at 800-500-1554) or at 517-432-6200 (select option 2). We can also be reached via email at reachout@msu.edu. We are open 24 hours.

Distance Learning Services