

# Part 13: Neonatal Resuscitation

## 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

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### Introduction

The following guidelines are a summary of the evidence presented in the *2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations (CoSTR)*.<sup>1,2</sup> Throughout the online version of this publication, live links are provided so the reader can connect directly to systematic reviews on the International Liaison Committee on Resuscitation (ILCOR) Scientific Evidence Evaluation and Review System (SEERS) website. These links are indicated by a combination of letters and numbers (eg, NRP 787). We encourage readers to use the links and review the evidence and appendices.

These guidelines apply primarily to newly born infants transitioning from intrauterine to extrauterine life. The recommendations are also applicable to neonates who have completed newborn transition and require resuscitation during the first weeks after birth.<sup>3</sup> Practitioners who resuscitate infants at birth or at any time during the initial hospitalization should consider following these guidelines. For purposes of these guidelines, the terms *newborn* and *neonate* apply to any infant during the initial hospitalization. The term *newly born* applies specifically to an infant at the time of birth.<sup>3</sup>

Immediately after birth, infants who are breathing and crying may undergo delayed cord clamping (see Umbilical Cord Management section). However, until more evidence is available, infants who are not breathing or crying should have the cord clamped (unless part of a delayed cord clamping research protocol), so that resuscitation measures can commence promptly.

Approximately 10% of newborns require some assistance to begin breathing at birth. Less than 1% require extensive resuscitation measures,<sup>4</sup> such as cardiac compressions and medications. Although most newly born infants successfully transition from intrauterine to extrauterine life without special help, because of the large total number of births, a significant number will require some degree of resuscitation.<sup>3</sup>

Newly born infants who do not require resuscitation can be generally identified upon delivery by rapidly assessing the answers to the following 3 questions:

- Term gestation?
- Good tone?
- Breathing or crying?

If the answer to all 3 questions is “yes,” the newly born infant may stay with the mother for routine care. Routine care means the infant is dried, placed skin to skin with the mother, and covered with dry linen to maintain a normal temperature. Observation of breathing, activity, and color must be ongoing.

If the answer to any of these assessment questions is “no,” the infant should be moved to a radiant warmer to receive 1 or more of the following 4 actions in sequence:

- A. Initial steps in stabilization (warm and maintain normal temperature, position, clear secretions only if copious and/or obstructing the airway, dry, stimulate)
- B. Ventilate and oxygenate
- C. Initiate chest compressions
- D. Administer epinephrine and/or volume

Approximately 60 seconds (“the Golden Minute”) are allotted for completing the initial steps, reevaluating, and beginning ventilation if required (Figure 1). Although the 60-second mark is not precisely defined by science, it is important to avoid unnecessary delay in initiation of ventilation, because this is *the* most important step for successful resuscitation of the newly born who has not responded to the initial steps. The decision to progress beyond the initial steps is determined by simultaneous assessment of 2 vital characteristics: respirations (apnea, gasping, or labored or unlabored breathing) and heart rate (less than 100/min). Methods to accurately assess the heart rate will be discussed in detail in the section on Assessment of Heart Rate. Once positive-pressure ventilation (PPV) or supplementary oxygen administration is started, assessment should consist of simultaneous evaluation of 3 vital characteristics: heart rate, respirations, and oxygen saturation, as determined by pulse oximetry and discussed under Assessment of Oxygen Need and Administration of Oxygen. The most sensitive indicator of a successful response to each step is an increase in heart rate.<sup>3</sup>

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### Anticipation of Resuscitation Need

Readiness for neonatal resuscitation requires assessment of perinatal risk, a system to assemble the appropriate personnel based on that risk, an organized method for ensuring immediate access to supplies and equipment, and standardization of behavioral skills that help assure effective teamwork and communication.

Every birth should be attended by at least 1 person who can perform the initial steps of newborn resuscitation and PPV, and whose only responsibility is care of the newborn. In the presence of significant perinatal risk factors that increase the likelihood of the need for resuscitation,<sup>5,6</sup> additional personnel with resuscitation skills, including chest compressions, endotracheal intubation, and umbilical vein catheter insertion, should be immediately

available. Furthermore, because a newborn without apparent risk factors may unexpectedly require resuscitation, each institution should have a procedure in place for rapidly mobilizing a team with complete newborn resuscitation skills for any birth.

The neonatal resuscitation provider and/or team is at a major disadvantage if supplies are missing or equipment is not functioning. A standardized checklist to ensure that all necessary supplies and equipment are present and functioning may be helpful. A known perinatal risk factor, such as preterm birth, requires preparation of supplies specific to thermoregulation and respiratory support for this vulnerable population.

When perinatal risk factors are identified, a team should be mobilized and a team leader identified. As time permits,

### Neonatal Resuscitation Algorithm—2015 Update

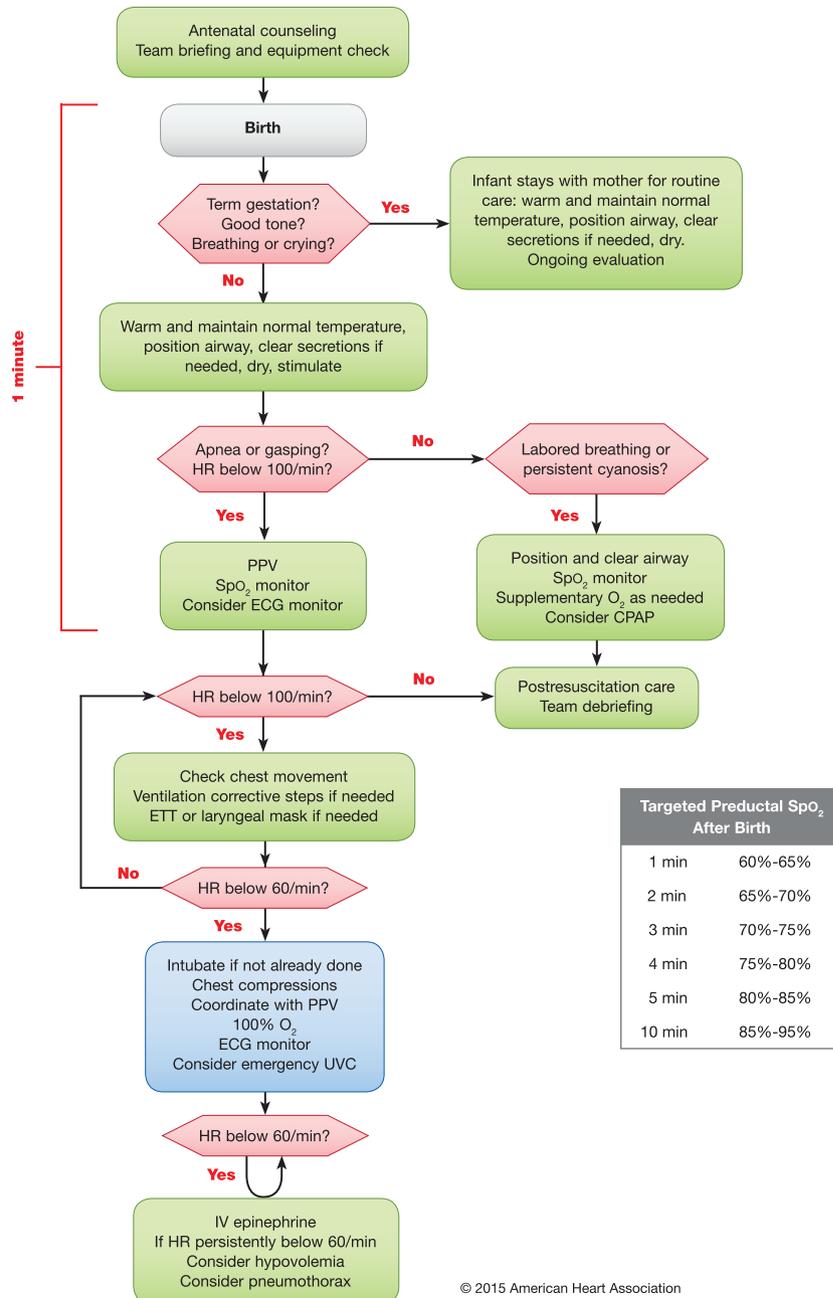


Figure 1. Neonatal Resuscitation Algorithm—2015 Update.

the leader should conduct a preresuscitation briefing, identify interventions that may be required, and assign roles and responsibilities to the team members.<sup>7,8</sup> During resuscitation, it is vital that the team demonstrates effective communication and teamwork skills to help ensure quality and patient safety.

### Umbilical Cord Management<sup>NRP 787, NRP 849</sup>

Until recent years, a common practice has been to clamp the umbilical cord soon after birth to quickly transfer the infant to the neonatal team for stabilization. This immediate clamping was deemed particularly important for infants at high risk for difficulty with transition and those most likely to require resuscitation, such as infants born preterm. During the 2010 CoSTR review, evidence began to emerge suggesting that delayed cord clamping (DCC) might be beneficial for infants who did not need immediate resuscitation at birth.<sup>7</sup>

The 2015 ILCOR systematic review<sup>NRP 787</sup> confirms that DCC is associated with less intraventricular hemorrhage (IVH) of any grade, higher blood pressure and blood volume, less need for transfusion after birth, and less necrotizing enterocolitis. There was no evidence of decreased mortality or decreased incidence of severe IVH.<sup>1,2</sup> The studies were judged to be very low quality (downgraded for imprecision and very high risk of bias). The only negative consequence appears to be a slightly increased level of bilirubin, associated with more need for phototherapy. These findings have led to national recommendations that DCC be practiced when possible.<sup>9,10</sup> A major problem with essentially all of these studies has been that infants who were thought to require resuscitation were either withdrawn from the randomized controlled trials or electively were not enrolled. Therefore, there is no evidence regarding safety or utility of DCC for infants requiring resuscitation and some concern that the delay in establishing ventilation may be harmful. Some studies have suggested that cord “milking” might accomplish goals similar to DCC,<sup>11–13</sup> but there is insufficient evidence of either its safety or utility to suggest its routine use in the newly born, particularly in extremely preterm infants.

In summary, from the evidence reviewed in the 2010 CoSTR<sup>7</sup> and subsequent review of DCC and cord milking in preterm newborns in the 2015 ILCOR systematic review,<sup>1,2</sup> DCC for longer than 30 seconds is reasonable for both term and preterm infants who do not require resuscitation at birth (Class IIa, Level of Evidence [LOE] C-LD). There is insufficient evidence to recommend an approach to cord clamping for infants who require resuscitation at birth, and more randomized trials involving such infants are encouraged. In light of the limited information regarding the safety of rapid changes in blood volume for extremely preterm infants, we suggest against the routine use of cord milking for infants born at less than 29 weeks of gestation outside of a research setting. Further study is warranted because cord milking may improve initial mean blood pressure and hematologic indices and reduce intracranial hemorrhage, but thus far there is no evidence for improvement in long-term outcomes (Class IIb, LOE C-LD).

### Initial Steps

The initial steps of newborn resuscitation are to maintain normal temperature of the infant, position the infant in a “sniffing” position to open the airway, clear secretions if needed with a bulb syringe or suction catheter, dry the infant (unless preterm and covered in plastic wrap), and stimulate the infant

to breathe. Current examination of the evidence for these practices is summarized below.

### Importance of Maintaining Normal Temperature in the Delivery Room<sup>NRP 589</sup>

It has long been recognized (since Budin’s 1907 publication of *The Nursling*)<sup>14</sup> that the admission temperature of newly born nonasphyxiated infants is a strong predictor of mortality at all gestational ages.<sup>15–49</sup> Preterm infants are especially vulnerable. Hypothermia is also associated with serious morbidities, such as increased risk of IVH,<sup>19,26,39,50–54</sup> respiratory issues,<sup>15,19,21,50,55–60</sup> hypoglycemia,<sup>15,44,60–64</sup> and late-onset sepsis.<sup>33,65</sup> Because of this, admission temperature should be recorded as a predictor of outcomes as well as a quality indicator (Class I, LOE B-NR.) It is recommended that the temperature of newly born nonasphyxiated infants be maintained between 36.5°C and 37.5°C after birth through admission and stabilization (Class I, LOE C-LD).

### Interventions to Maintain Newborn Temperature in the Delivery Room<sup>NRP 599</sup>

The use of radiant warmers and plastic wrap with a cap has improved but not eliminated the risk of hypothermia in preterm infants in the delivery room. Other strategies have been introduced, which include increased room temperature, thermal mattresses, and the use of warmed humidified resuscitation gases. Various combinations of these strategies may be reasonable to prevent hypothermia in infants born at less than 32 weeks of gestation (Class IIb, LOE B-R, B-NR, C-LD). Compared with plastic wrap and radiant warmer, the addition of a thermal mattress,<sup>66–70</sup> warmed humidified gases,<sup>71,72</sup> and increased room temperature plus cap plus thermal mattress<sup>55,57,59,73</sup> were all effective in reducing hypothermia. For all the studies, hyperthermia was a concern, but harm was not shown. Hyperthermia (greater than 38.0°C) should be avoided due to the potential associated risks (Class III: Harm, LOE C-EO).

### Warming Hypothermic Newborns to Restore Normal Temperature<sup>NRP 858</sup>

The traditional recommendation for the method of rewarming neonates who are hypothermic after resuscitation has been that slower is preferable to faster rewarming to avoid complications such as apnea and arrhythmias. However, there is insufficient current evidence to recommend a preference for either rapid (0.5°C/h or greater) or slow rewarming (less than 0.5°C/h) of unintentionally hypothermic newborns (temperature less than 36°C) at hospital admission. Either approach to rewarming may be reasonable (Class IIb, LOE C-LD).

### Effect of Maternal Hypothermia and Hyperthermia on the Neonate<sup>NRP 804</sup>

Maternal hyperthermia in labor is associated with adverse neonatal effects. These include increased mortality,<sup>74,75</sup> neonatal seizures,<sup>74–80</sup> and adverse neurologic states like encephalopathy.<sup>81–84</sup> Maternal hypothermia in labor has not been shown to be associated with clinically significant adverse neonatal outcomes at the time of birth.<sup>85–89</sup> Although maternal hyperthermia is associated with adverse neonatal outcomes, there is insufficient evidence to make a recommendation on the management of maternal hyperthermia.

**Maintaining Normothermia in Resource-Limited Settings**<sup>NRP 793</sup>

The ability to maintain temperature in resource-limited settings after birth is a significant problem,<sup>40</sup> with a dose-dependent increase in mortality for temperatures below 36.5°C. Premature newborns are at much higher risk than those born at term. Simple interventions to prevent hypothermia during transition (birth until 1 to 2 hours of life) reduce mortality. During transition, the use of plastic wraps<sup>90-92</sup> and the use of skin-to-skin contact<sup>93-100</sup> reduce hypothermia.

In resource-limited settings, to maintain body temperature or prevent hypothermia during transition (birth until 1 to 2 hours of life) in well newborn infants, it may be reasonable to put them in a clean food-grade plastic bag up to the level of the neck and swaddle them after drying (Class IIb, LOE C-LD). Another option that may be reasonable is to nurse such newborns with skin-to-skin contact or kangaroo mother care (Class IIb, LOE C-LD). There are no data examining the use of plastic wraps or skin-to-skin contact during resuscitation/stabilization in resource-limited settings.

**Clearing the Airway****When Amniotic Fluid Is Clear**

This topic was last reviewed in 2010.<sup>3</sup> Suctioning immediately after birth, whether with a bulb syringe or suction catheter, may be considered only if the airway appears obstructed or if PPV is required. Avoiding unnecessary suctioning helps prevent the risk of induced bradycardia due to suctioning of the nasopharynx.<sup>101,102</sup> Deterioration of pulmonary compliance, oxygenation, and cerebral blood flow velocity shown to accompany tracheal suction in intubated infants in the neonatal intensive care unit also suggests the need for caution in the use of suction immediately after birth.<sup>103-105</sup> This recommendation remains unchanged. Please refer to the 2010 CoSTR for the latest science review.<sup>7,8</sup>

**When Meconium Is Present**<sup>NRP 865</sup>

Since the mid-1970s, interventions to decrease the mortality and morbidity of meconium aspiration syndrome in infants who are born through meconium-stained amniotic fluid have been recommended. The practice of universal oropharyngeal suctioning of the fetus on the perineum followed by routine intubation and suctioning of the trachea at birth was generally practiced for many years. This practice was abandoned over a decade ago after a large multicenter, multinational randomized clinical trial provided evidence that newborns born through meconium-stained amniotic fluid who were vigorous at birth did not benefit from intervention and could avoid the risk of intubation.<sup>106</sup>

Because the presence of meconium-stained amniotic fluid may indicate fetal distress and increases the risk that the infant will require resuscitation after birth, a team that includes an individual skilled in tracheal intubation should be present at the time of birth. If the infant is vigorous with good respiratory effort and muscle tone, the infant may stay with the mother to receive the initial steps of newborn care. Gentle clearing of meconium from the mouth and nose with a bulb syringe may be done if necessary.

However, if the infant born through meconium-stained amniotic fluid presents with poor muscle tone and inadequate

breathing efforts, the initial steps of resuscitation should be completed under the radiant warmer. PPV should be initiated if the infant is not breathing or the heart rate is less than 100/min after the initial steps are completed.

Routine intubation for tracheal suction in this setting is not suggested, because there is insufficient evidence to continue recommending this practice (Class IIb, LOE C-LD). In making this suggested change, greater value has been placed on harm avoidance (ie, delays in providing bag-mask ventilation, potential harm of the procedure) over the unknown benefit of the intervention of routine tracheal intubation and suctioning. Therefore, emphasis should be made on initiating ventilation within the first minute of life in nonbreathing or ineffectively breathing infants.

Although a definitive randomized clinical trial is still needed, current published human evidence does not support a recommendation for routine intervention of intubation and suction for the nonvigorous newborn with meconium-stained amniotic fluid.<sup>107-116</sup> Appropriate intervention to support ventilation and oxygenation should be initiated as indicated for each individual infant. This may include intubation and suction if the airway is obstructed.

**Assessment of Heart Rate**<sup>NRP 898</sup>

Immediately after birth, assessment of the newborn's heart rate is used to evaluate the effectiveness of spontaneous respiratory effort and determine the need for subsequent interventions. During resuscitation, an increase in the newborn's heart rate is considered the most sensitive indicator of a successful response to each intervention. Therefore, identifying a rapid, reliable, and accurate method to measure the newborn's heart rate is critically important. In previous treatment guidelines, auscultation of the precordium was recommended as the preferred physical examination method, and pulse oximetry was recommended as an adjunct to provide a noninvasive, rapid, and continuous assessment of heart rate during resuscitation.<sup>3</sup>

The 2015 ILCOR systematic review evaluated 1 study comparing clinical assessment with electrocardiography (ECG) in the delivery room<sup>117</sup> and 5 studies comparing simultaneous pulse oximetry and ECG.<sup>118-122</sup> Clinical assessment was found to be both unreliable and inaccurate. Among healthy newborns, providers frequently could not palpate the umbilical pulse and underestimated the newborn's heart rate by auscultation or palpation.<sup>117</sup> Four studies found that 3-lead ECG displayed a reliable heart rate faster than pulse oximetry.<sup>118,120-122</sup> In 2 studies, ECG was more likely to detect the newborn's heart rate during the first minute of life.<sup>120,121</sup> Although the mean differences between the series of heart rates measured by ECG and pulse oximetry were small, pulse oximetry tended to underestimate the newborn's heart rate and would have led to potentially unnecessary interventions.<sup>118,119,122</sup> During the first 2 minutes of life, pulse oximetry frequently displayed the newborn's heart rate below either 60/min or 100/min, while a simultaneous ECG showed the heart rate greater than 100/min.<sup>122</sup>

Many of the newborns included in the studies did not require resuscitation, and very few required chest compressions. The majority of the studies did not report any difficulties with applying the leads.<sup>118-120</sup>

During resuscitation of term and preterm newborns, the use of 3-lead ECG for the rapid and accurate measurement of the newborn's heart rate may be reasonable (Class IIb, LOE C-LD). The use of ECG does not replace the need for pulse oximetry to evaluate the newborn's oxygenation.

## Assessment of Oxygen Need and Administration of Oxygen

### Use of Pulse Oximetry

This topic was last reviewed in 2010.<sup>3</sup> It is recommended that oximetry be used when resuscitation can be anticipated, when PPV is administered, when central cyanosis persists beyond the first 5 to 10 minutes of life, or when supplementary oxygen is administered.

### Administration of Oxygen

#### Term Infants

This topic was last reviewed in 2010.<sup>3</sup> It is reasonable to initiate resuscitation with air (21% oxygen at sea level). Supplementary oxygen may be administered and titrated to achieve a preductal oxygen saturation approximating the interquartile range measured in healthy term infants after vaginal birth at sea level.<sup>7,8,123</sup>

#### Preterm<sup>NRP 864</sup>

Meta-analysis of 7 randomized trials that compared initiating resuscitation of preterm newborns (less than 35 weeks of gestation) with high oxygen (65% or greater) and low oxygen (21% to 30%) showed no improvement in survival to hospital discharge with the use of high oxygen.<sup>124–130</sup> Similarly, in the subset of studies that evaluated these outcomes, no benefit was seen for the prevention of bronchopulmonary dysplasia,<sup>125,127–130</sup> IVH,<sup>125,128–130</sup> or retinopathy of prematurity.<sup>125,128,129</sup> When oxygen targeting was used as a cointervention, the oxygen concentration of resuscitation gas and the preductal oxygen saturation were similar between the high-oxygen and low-oxygen groups within the first 10 minutes of life.<sup>125,128–130</sup>

In all studies, irrespective of whether air or high oxygen (including 100%) was used to initiate resuscitation, most infants were in approximately 30% oxygen by the time of stabilization. Resuscitation of preterm newborns of less than 35 weeks of gestation should be initiated with low oxygen (21% to 30%), and the oxygen concentration should be titrated to achieve preductal oxygen saturation approximating the interquartile range measured in healthy term infants after vaginal birth at sea level<sup>123</sup> (Class I, LOE B-R). Initiating resuscitation of preterm newborns with high oxygen (65% or greater) is not recommended (Class III: No Benefit, LOE B-R). This recommendation reflects a preference for not exposing preterm newborns to additional oxygen without data demonstrating a proven benefit for important outcomes.

## Positive Pressure Ventilation

### Initial Breaths<sup>NRP 809</sup>

Several recent animal studies have suggested that a longer sustained inflation may be beneficial for establishing functional residual capacity during transition from fluid-filled to air-filled lungs after birth.<sup>131,132</sup> Some clinicians have suggested

applying this technique for transition of human newborns. Review of the literature in 2015 identified 3 randomized controlled trials<sup>133–135</sup> and 2 cohort studies<sup>136,137</sup> that demonstrated a benefit of sustained inflation for reducing need for mechanical ventilation (very low quality of evidence, downgraded for variability of interventions). However, no benefit was found for reduction of mortality, bronchopulmonary dysplasia, or air leak. One cohort study<sup>136</sup> suggested that the need for intubation was less after sustained inflation.

There are insufficient data regarding short and long-term safety and the most appropriate duration and pressure of inflation to support routine application of sustained inflation of greater than 5 seconds' duration to the transitioning newborn (Class IIb, LOE B-R). Further studies using carefully designed protocols are needed.

### End-Expiratory Pressure<sup>NRP 897</sup>

Administration of PPV is the standard recommended treatment for both preterm and term infants who are apneic. A flow-inflating or self-inflating resuscitation bag or T-piece resuscitator are appropriate devices to use for PPV. In the 2010 Guidelines<sup>3</sup> and based on experience with delivering PPV in the neonatal intensive care unit, the use of positive end-expiratory pressure (PEEP) was speculated to be beneficial when PPV is administered to the newly born, but no published evidence was available to support this recommendation. PEEP was evaluated again in 2015, and 2 randomized controlled trials<sup>138,139</sup> suggested that addition of PEEP during delivery room resuscitation of preterm newborns resulted in no improvement in mortality, no less need for cardiac drugs or chest compressions, no more rapid improvement in heart rate, no less need for intubation, no change in pulmonary air leaks, no less chronic lung disease, and no effect on Apgar scores, although the studies were underpowered to have sufficient confidence in a no-difference conclusion. However, 1 of the trials<sup>139</sup> provided low-quality evidence that the maximum amount of supplementary oxygen required to achieve target oxygen saturation may be slightly less when using PEEP. In 2015, the Neonatal Resuscitation ILCOR and Guidelines Task Forces repeated their 2010 recommendation that, when PPV is administered to preterm newborns, use of approximately 5 cm H<sub>2</sub>O PEEP is suggested (Class IIb, LOE B-R). This will require the addition of a PEEP valve for self-inflating bags.

### Assisted-Ventilation Devices and Advanced Airways<sup>NRP 870, NRP 806</sup>

PPV can be delivered effectively with a flow-inflating bag, self-inflating bag, or T-piece resuscitator<sup>138,139</sup> (Class IIa, LOE B-R). The most appropriate choice may be guided by available resources, local expertise, and preferences. The self-inflating bag remains the only device that can be used when a compressed gas source is not available. Unlike flow-inflating bags or T-piece resuscitators, self-inflating bags cannot deliver continuous positive airway pressure (CPAP) and may not be able to achieve PEEP reliably during PPV, even with a PEEP valve.<sup>140–143</sup> However, it may take more practice to use a flow-inflating bag effectively. In addition to ease of use, T-piece resuscitators can consistently provide target inflation pressures and longer inspiratory times in mechanical models,<sup>144–146</sup>

but there is insufficient evidence to suggest that these qualities result in improved clinical outcomes.<sup>138,139</sup>

Use of respiratory mechanics monitors have been reported to prevent excessive pressures and tidal volumes<sup>147</sup> and exhaled CO<sub>2</sub> monitors may help assess that actual gas exchange is occurring during face-mask PPV attempts.<sup>148</sup> Although use of such devices is feasible, thus far their effectiveness, particularly in changing important outcomes, has not been established (Class IIb, LOE C-LD).

#### **Laryngeal Mask**<sup>NRP 618</sup>

Laryngeal masks, which fit over the laryngeal inlet, can facilitate effective ventilation in term and preterm newborns at 34 weeks or more of gestation. Data are limited for their use in preterm infants delivered at less than 34 weeks of gestation or who weigh less than 2000 g. A laryngeal mask may be considered as an alternative to tracheal intubation if face-mask ventilation is unsuccessful in achieving effective ventilation<sup>149</sup> (Class IIb, LOE B-R). A laryngeal mask is recommended during resuscitation of term and preterm newborns at 34 weeks or more of gestation when tracheal intubation is unsuccessful or is not feasible (Class I, LOE C-EO). Use of the laryngeal mask has not been evaluated during chest compressions or for administration of emergency medications.

#### **Endotracheal Tube Placement**

During neonatal resuscitation, endotracheal intubation may be indicated when bag-mask ventilation is ineffective or prolonged, when chest compressions are performed, or for special circumstances such as congenital diaphragmatic hernia. When PPV is provided through an endotracheal tube, the best indicator of successful endotracheal intubation with successful inflation and aeration of the lungs is a prompt increase in heart rate. Although last reviewed in 2010,<sup>3</sup> exhaled CO<sub>2</sub> detection remains the most reliable method of confirmation of endotracheal tube placement.<sup>7,8</sup> Failure to detect exhaled CO<sub>2</sub> in neonates with adequate cardiac output strongly suggests esophageal intubation. Poor or absent pulmonary blood flow (eg, during cardiac arrest) may result in failure to detect exhaled CO<sub>2</sub> despite correct tube placement in the trachea and may result in unnecessary extubation and reintubation in these critically ill newborns.<sup>3</sup> Clinical assessment such as chest movement, presence of equal breath sounds bilaterally, and condensation in the endotracheal tube are additional indicators of correct endotracheal tube placement.

#### **Continuous Positive Airway Pressure**<sup>NRP 590</sup>

Three randomized controlled trials enrolling 2358 preterm infants born at less than 30 weeks of gestation demonstrated that starting newborns on CPAP may be beneficial when compared with endotracheal intubation and PPV.<sup>150–152</sup> Starting CPAP resulted in decreased rate of intubation in the delivery room, decreased duration of mechanical ventilation with potential benefit of reduction of death and/or bronchopulmonary dysplasia, and no significant increase in air leak or severe IVH. Based on this evidence, spontaneously breathing preterm infants with respiratory distress may be supported with CPAP initially rather than routine intubation for administering PPV (Class IIb, LOE B-R).

#### **Chest Compressions**<sup>NRP 605, NRP 895, NRP 738, NRP 862</sup>

If the heart rate is less than 60/min despite adequate ventilation (via endotracheal tube if possible), chest compressions are indicated. Because ventilation is the most effective action in neonatal resuscitation and because chest compressions are likely to compete with effective ventilation, rescuers should ensure that assisted ventilation is being delivered optimally before starting chest compressions.<sup>3</sup>

Compressions are delivered on the lower third of the sternum<sup>153–156</sup> to a depth of approximately one third of the anterior-posterior diameter of the chest (Class IIb, LOE C-LD).<sup>157</sup> Two techniques have been described: compression with 2 thumbs with the fingers encircling the chest and supporting the back (the 2-thumb technique) or compression with 2 fingers with a second hand supporting the back (the 2-finger technique). Because the 2-thumb technique generates higher blood pressure and coronary perfusion pressure with less rescuer fatigue, the 2 thumb–encircling hands technique is suggested as the preferred method<sup>158–172</sup> (Class IIb, LOE C-LD). Because the 2-thumb technique can be continued from the head of the bed while the umbilicus is accessed for insertion of an umbilical catheter, the 2-finger technique is no longer needed.

It is still suggested that compressions and ventilations be coordinated to avoid simultaneous delivery. The chest should be allowed to re-expand fully during relaxation, but the rescuer's thumbs should not leave the chest. The Neonatal Resuscitation ILCOR and Guidelines Task Forces continue to support use of a 3:1 ratio of compressions to ventilation, with 90 compressions and 30 breaths to achieve approximately 120 events per minute to maximize ventilation at an achievable rate<sup>173–178</sup> (Class IIa, LOE C-LD). Thus, each event will be allotted approximately a half of a second, with exhalation occurring during the first compression after each ventilation. A 3:1 compression-to-ventilation ratio is used for neonatal resuscitation where compromise of gas exchange is nearly always the primary cause of cardiovascular collapse, but rescuers may consider using higher ratios (eg, 15:2) if the arrest is believed to be of cardiac origin (Class IIb, LOE C-EO).

The Neonatal Guidelines Writing Group endorses increasing the oxygen concentration to 100% whenever chest compressions are provided (Class IIa, LOE C-EO). There are no available clinical studies regarding oxygen use during neonatal CPR. Animal evidence shows no advantage to 100% oxygen during CPR.<sup>179–186</sup> However, by the time resuscitation of a newborn infant has reached the stage of chest compressions, efforts to achieve return of spontaneous circulation using effective ventilation with low-concentration oxygen should have been attempted. Thus, it would appear sensible to try increasing the supplementary oxygen concentration. To reduce the risks of complications associated with hyperoxia, the supplementary oxygen concentration should be weaned as soon as the heart rate recovers (Class I, LOE C-LD).

The current measure for determining successful progress in neonatal resuscitation is to assess the heart rate response. Other devices, such as end-tidal CO<sub>2</sub> monitoring and pulse oximetry, may be useful techniques to determine when return of spontaneous circulation occurs.<sup>187–191</sup> However, in asystolic/bradycardic neonates, we suggest

against the routine use of any single feedback device such as ET $\text{CO}_2$  monitors or pulse oximeters for detection of return of spontaneous circulation, as their usefulness for this purpose in neonates has not been well established (Class IIb, LOE C-LD).

### Medications

Drugs are rarely indicated in resuscitation of the newly born infant. Bradycardia in the newborn infant is usually the result of inadequate lung inflation or profound hypoxemia, and establishing adequate ventilation is the most important step to correct it. However, if the heart rate remains less than 60/min despite adequate ventilation with 100% oxygen (preferably through an endotracheal tube) and chest compressions, administration of epinephrine or volume, or both, is indicated.<sup>3</sup>

#### Epinephrine

This topic was last reviewed in 2010.<sup>3</sup> Dosing recommendations remain unchanged from 2010.<sup>7,8</sup> Intravenous administration of epinephrine may be considered at a dose of 0.01 to 0.03 mg/kg of 1:10000 epinephrine. If endotracheal administration is attempted while intravenous access is being established, higher dosing at 0.05 to 0.1 mg/kg may be reasonable. Given the lack of supportive data for endotracheal epinephrine, it is reasonable to provide drugs by the intravenous route as soon as venous access is established.

#### Volume Expansion

This topic was last reviewed in 2010.<sup>3</sup> Dosing recommendations remain unchanged from 2010.<sup>7,8</sup> Volume expansion may be considered when blood loss is known or suspected (pale skin, poor perfusion, weak pulse) and the infant's heart rate has not responded adequately to other resuscitative measures. An isotonic crystalloid solution or blood may be considered for volume expansion in the delivery room. The recommended dose is 10 mL/kg, which may need to be repeated. When resuscitating premature infants, it is reasonable to avoid giving volume expanders rapidly, because rapid infusions of large volumes have been associated with IVH.<sup>3</sup>

#### Postresuscitation Care

Infants who require resuscitation are at risk of deterioration after their vital signs have returned to normal. Once effective ventilation and/or the circulation has been established, the infant should be maintained in or transferred to an environment where close monitoring and anticipatory care can be provided.

#### Glucose

In the 2010 Guidelines, the potential role of glucose in modulating neurologic outcome after hypoxia-ischemia was identified. Lower glucose levels were associated with an increased risk for brain injury, while increased glucose levels may be protective. However, it was not possible to recommend a specific protective target glucose concentration range. There are no new data to change this recommendation.<sup>7,8</sup>

### Induced Therapeutic Hypothermia

#### Resource-Abundant Areas

Induced therapeutic hypothermia was last reviewed in 2010; at that time it was recommended that infants born at more than 36 weeks of gestation with evolving moderate-to-severe hypoxic-ischemic encephalopathy should be offered therapeutic hypothermia under clearly defined protocols similar to those used in published clinical trials and in facilities with the capabilities for multidisciplinary care and longitudinal follow-up (Class IIa, LOE A).<sup>7,8</sup> This recommendation remains unchanged.

#### Resource-Limited Areas<sup>NRP 734</sup>

Evidence suggests that use of therapeutic hypothermia in resource-limited settings (ie, lack of qualified staff, inadequate equipment, etc) may be considered and offered under clearly defined protocols similar to those used in published clinical trials and in facilities with the capabilities for multidisciplinary care and longitudinal follow-up<sup>192-195</sup> (Class IIb, LOE B-R).

### Guidelines for Withholding and Discontinuing

Data reviewed for the 2010 Guidelines regarding management of neonates born at the margins of viability or those with conditions that predict a high risk of mortality or morbidity document wide variation in attitudes and practice by region and availability of resources. Additionally, parents desire a larger role in decisions related to initiation of resuscitation and continuation of support of severely compromised newborns. Noninitiation of resuscitation and discontinuation of life-sustaining treatment during or after resuscitation are considered ethically equivalent. The 2010 Guidelines provide suggestions for when resuscitation is not indicated, when it is nearly always indicated, and that under circumstances when outcome remains unclear, that the desires of the parents should be supported. No new data have been published that would justify a change to these guidelines as published in 2010.<sup>7,8</sup>

Antenatal assignment of prognosis for survival and/or disability of the neonate born extremely preterm has generally been made on the basis of gestational age alone. Scoring systems for including additional variables such as gender, use of maternal antenatal steroids, and multiplicity have been developed in an effort to improve prognostic accuracy. Indeed, it was suggested in the 2010 Guidelines that decisions regarding morbidity and risks of morbidity may be augmented by the use of published tools based on data from specific populations.

#### Withholding Resuscitation<sup>NRP 805</sup>

There is no evidence to support the prospective use of any particular delivery room prognostic score presently available over gestational age assessment alone, in preterm infants at less than 25 weeks of gestation. Importantly, no score has been shown to improve the clinician's ability to estimate likelihood of survival through the first 18 to 22 months after birth. However, in individual cases, when counseling a family

and constructing a prognosis for survival at gestations below 25 weeks, it is reasonable to consider variables such as perceived accuracy of gestational age assignment, the presence or absence of chorioamnionitis, and the level of care available for location of delivery. Decisions about appropriateness of resuscitation below 25 weeks of gestation will be influenced by region-specific guidelines. In making this statement, a higher value was placed on the lack of evidence for a generalized prospective approach to changing important outcomes over improved retrospective accuracy and locally validated counseling policies. The most useful data for antenatal counseling provides outcome figures for infants alive at the onset of labor, not only for those born alive or admitted to a neonatal intensive care unit<sup>196–200</sup> (Class IIB, LOE C-LD).

**Discontinuing Resuscitative Efforts**<sup>NRP 896</sup>

An Apgar score of 0 at 10 minutes is a strong predictor of mortality and morbidity in late preterm and term infants. We suggest that, in infants with an Apgar score of 0 after 10 minutes of resuscitation, if the heart rate remains undetectable, it may be reasonable to stop assisted ventilation; however, the decision to continue or discontinue resuscitative efforts must be individualized. Variables to be considered may include whether the resuscitation was considered optimal; availability of advanced neonatal care, such as therapeutic hypothermia; specific circumstances before delivery (eg, known timing of the insult); and wishes expressed by the family<sup>201–206</sup> (Class IIB, LOE C-LD).

**Briefing/Debriefing**

This topic was last reviewed in 2010.<sup>3</sup> It is still suggested that briefing and debriefing techniques be used whenever possible for neonatal resuscitation.

**Structure of Educational Programs to Teach Neonatal Resuscitation**

**Instructors**<sup>NRP 867</sup>

In studies that looked at the preparation of instructors for the training of healthcare providers, there was no association between the preparation provided and instructor or learner performance.<sup>207–214</sup> Until more research is available to clarify the optimal instructor training methodology, it is suggested that neonatal resuscitation instructors be trained using timely, objective, structured, and individually targeted verbal and/or written feedback (Class IIB, LOE C-EO).

**Resuscitation Providers**<sup>NRP 859</sup>

The 2010 Guidelines suggested that simulation should become a standard component in neonatal resuscitation training.<sup>3,6,215</sup> Studies that explored how frequently healthcare providers or healthcare students should train showed no differences in patient outcomes (LOE C-EO) but were able to show some advantages in psychomotor performance (LOE B-R) and knowledge and confidence (LOE C-LD) when focused training occurred every 6 months or more frequently.<sup>216–231</sup> It is therefore suggested that neonatal resuscitation task training occur more frequently than the current 2-year interval (Class IIB, LOE B-R).

**Disclosures**

**Part 13: Neonatal Resuscitation: 2015 Guidelines Update Writing Group Disclosures**

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This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives \$10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns \$10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

\*Modest.

†Significant.

## Appendix

## 2015 Guidelines Update: Part 13 Recommendations

Year Last Reviewed	Topic	Recommendation	Comments
2015	Umbilical Cord Management	In summary, from the evidence reviewed in the 2010 CoSTR and subsequent review of DCC and cord milking in preterm newborns in the 2015 ILCOR systematic review, DCC for longer than 30 seconds is reasonable for both term and preterm infants who do not require resuscitation at birth (Class IIa, LOE C-LD).	new for 2015
2015	Umbilical Cord Management	There is insufficient evidence to recommend an approach to cord clamping for infants who require resuscitation at birth and more randomized trials involving such infants are encouraged. In light of the limited information regarding the safety of rapid changes in blood volume for extremely preterm infants, we suggest against the routine use of cord milking for infants born at less than 29 weeks of gestation outside of a research setting. Further study is warranted because cord milking may improve initial mean blood pressure, hematologic indices, and reduce intracranial hemorrhage, but thus far there is no evidence for improvement in long-term outcomes (Class IIb, LOE C-LD).	new for 2015
2015	Importance of Maintaining Normal Temperature in the Delivery Room	Preterm infants are especially vulnerable. Hypothermia is also associated with serious morbidities, such as increased respiratory issues, hypoglycemia, and late-onset sepsis. Because of this, admission temperature should be recorded as a predictor of outcomes as well as a quality indicator (Class I, LOE B-NR).	new for 2015
2015	Importance of Maintaining Normal Temperature in the Delivery Room	It is recommended that the temperature of newly born nonasphyxiated infants be maintained between 36.5°C and 37.5°C after birth through admission and stabilization (Class I, LOE C-LD).	new for 2015
2015	Interventions to Maintain Newborn Temperature in the Delivery Room	The use of radiant warmers and plastic wrap with a cap has improved but not eliminated the risk of hypothermia in preterms in the delivery room. Other strategies have been introduced, which include increased room temperature, thermal mattresses, and the use of warmed humidified resuscitation gases. Various combinations of these strategies may be reasonable to prevent hypothermia in infants born at less than 32 weeks of gestation (Class IIb, LOE B-R, B-NR, C-LD).	updated for 2015
2015	Interventions to Maintain Newborn Temperature in the Delivery Room	Compared with plastic wrap and radiant warmer, the addition of a thermal mattress, warmed humidified gases and increased room temperature plus cap plus thermal mattress were all effective in reducing hypothermia. For all the studies, hyperthermia was a concern, but harm was not shown. Hyperthermia (greater than 38.0°C) should be avoided due to the potential associated risks (Class III: Harm, LOE C-EO).	updated for 2015
2015	Warming Hypothermic Newborns to Restore Normal Temperature	The traditional recommendation for the method of rewarming neonates who are hypothermic after resuscitation has been that slower is preferable to faster rewarming to avoid complications such as apnea and arrhythmias. However, there is insufficient current evidence to recommend a preference for either rapid (0.5°C/h or greater) or slow rewarming (less than 0.5°C/h) of unintentionally hypothermic newborns (temperature less than 36°C) at hospital admission. Either approach to rewarming may be reasonable (Class IIb, LOE C-LD).	new for 2015
2015	Maintaining Normothermia in Resource-Limited Settings	In resource-limited settings, to maintain body temperature or prevent hypothermia during transition (birth until 1 to 2 hours of life) in well newborn infants, it may be reasonable to put them in a clean food-grade plastic bag up to the level of the neck and swaddle them after drying (Class IIb, LOE C-LD).	new for 2015
2015	Maintaining Normothermia in Resource-Limited Settings	Another option that may be reasonable is to nurse such newborns with skin-to-skin contact or kangaroo mother care (Class IIb, LOE C-LD).	new for 2015
2015	Clearing the Airway When Meconium Is Present	However, if the infant born through meconium-stained amniotic fluid presents with poor muscle tone and inadequate breathing efforts, the initial steps of resuscitation should be completed under the radiant warmer. PPV should be initiated if the infant is not breathing or the heart rate is less than 100/min after the initial steps are completed. Routine intubation for tracheal suction in this setting is not suggested, because there is insufficient evidence to continue recommending this practice (Class IIb, LOE C-LD).	updated for 2015
2015	Assessment of Heart Rate	During resuscitation of term and preterm newborns, the use of 3-lead ECG for the rapid and accurate measurement of the newborn's heart rate may be reasonable (Class IIb, LOE C-LD).	new for 2015
2015	Administration of Oxygen in Preterm Infants	In all studies, irrespective of whether air or high oxygen (including 100%) was used to initiate resuscitation, most infants were in approximately 30% oxygen by the time of stabilization. Resuscitation of preterm newborns of less than 35 weeks of gestation should be initiated with low oxygen (21% to 30%), and the oxygen concentration should be titrated to achieve preductal oxygen saturation approximating the interquartile range measured in healthy term infants after vaginal birth at sea level (Class I, LOE B-R).	new for 2015

(Continued)

**2015 Guidelines Update: Part 13 Recommendations, *Continued***

Year Last Reviewed	Topic	Recommendation	Comments
2015	Administration of Oxygen	Initiating resuscitation of preterm newborns with high oxygen (65% or greater) is not recommended (Class III: No Benefit, LOE B-R).	new for 2015
2015	Positive Pressure Ventilation (PPV)	There is insufficient data regarding short and long-term safety and the most appropriate duration and pressure of inflation to support routine application of sustained inflation of greater than 5 seconds' duration to the transitioning newborn (Class IIb, LOE B-R).	new for 2015
2015	Positive Pressure Ventilation (PPV)	In 2015, the Neonatal Resuscitation ILCOR and Guidelines Task Forces repeated their 2010 recommendation that, when PPV is administered to preterm newborns, approximately 5 cm H <sub>2</sub> O PEEP is suggested (Class IIb, LOE B-R).	updated for 2015
2015	Positive Pressure Ventilation (PPV)	PPV can be delivered effectively with a flow-inflating bag, self-inflating bag, or T-piece resuscitator (Class IIa, LOE B-R).	updated for 2015
2015	Positive Pressure Ventilation (PPV)	Use of respiratory mechanics monitors have been reported to prevent excessive pressures and tidal volumes and exhaled CO <sub>2</sub> monitors may help assess that actual gas exchange is occurring during face-mask PPV attempts. Although use of such devices is feasible, thus far their effectiveness, particularly in changing important outcomes, has not been established (Class IIb, LOE C-LD).	new for 2015
2015	Positive Pressure Ventilation (PPV)	Laryngeal masks, which fit over the laryngeal inlet, can achieve effective ventilation in term and preterm newborns at 34 weeks or more of gestation. Data are limited for their use in preterm infants delivered at less than 34 weeks of gestation or who weigh less than 2000 g. A laryngeal mask may be considered as an alternative to tracheal intubation if face-mask ventilation is unsuccessful in achieving effective ventilation (Class IIb, LOE B-R).	updated for 2015
2015	Positive Pressure Ventilation (PPV)	A laryngeal mask is recommended during resuscitation of term and preterm newborns at 34 weeks or more of gestation when tracheal intubation is unsuccessful or is not feasible (Class I, LOE C-EO).	updated for 2015
2015	CPAP	Based on this evidence, spontaneously breathing preterm infants with respiratory distress may be supported with CPAP initially rather than routine intubation for administering PPV (Class IIb, LOE B-R).	updated for 2015
2015	Chest Compressions	Compressions are delivered on the lower third of the sternum to a depth of approximately one third of the anterior-posterior diameter of the chest (Class IIb, LOE C-LD).	updated for 2015
2015	Chest Compressions	Because the 2-thumb technique generates higher blood pressures and coronary perfusion pressure with less rescuer fatigue, the 2 thumb-encircling hands technique is suggested as the preferred method (Class IIb, LOE C-LD).	updated for 2015
2015	Chest Compressions	It is still suggested that compressions and ventilations be coordinated to avoid simultaneous delivery. The chest should be allowed to re-expand fully during relaxation, but the rescuer's thumbs should not leave the chest. The Neonatal Resuscitation ILCOR and Guidelines Task Forces continue to support use of a 3:1 ratio of compressions to ventilation, with 90 compressions and 30 breaths to achieve approximately 120 events per minute to maximize ventilation at an achievable rate (Class IIa, LOE C-LD).	updated for 2015
2015	Chest Compressions	A 3:1 compression-to-ventilation ratio is used for neonatal resuscitation where compromise of gas exchange is nearly always the primary cause of cardiovascular collapse, but rescuers may consider using higher ratios (eg, 15:2) if the arrest is believed to be of cardiac origin (Class IIb, LOE C-EO).	updated for 2015
2015	Chest Compressions	The Neonatal Guidelines Writing Group endorses increasing the oxygen concentration to 100% whenever chest compressions are provided (Class IIa, LOE C-EO).	new for 2015
2015	Chest Compressions	To reduce the risks of complications associated with hyperoxia the supplementary oxygen concentration should be weaned as soon as the heart rate recovers (Class I, LOE C-LD).	new for 2015
2015	Chest Compressions	The current measure for determining successful progress in neonatal resuscitation is to assess the heart rate response. Other devices, such as end-tidal CO <sub>2</sub> monitoring and pulse oximetry, may be useful techniques to determine when return of spontaneous circulation occurs. However, in asystolic/bradycardic neonates, we suggest against the routine use of any single feedback device such as ETCO <sub>2</sub> monitors or pulse oximeters for detection of return of spontaneous circulation, as their usefulness for this purpose in neonates has not been well established (Class IIb, LOE C-LD).	new for 2015
2015	Induced Therapeutic Hypothermia Resource-Limited Areas	Evidence suggests that use of therapeutic hypothermia in resource-limited settings (ie, lack of qualified staff, inadequate equipment, etc) may be considered and offered under clearly defined protocols similar to those used in published clinical trials and in facilities with the capabilities for multidisciplinary care and longitudinal follow-up (Class IIb, LOE B-R).	new for 2015

*(Continued)*

2015 Guidelines Update: Part 13 Recommendations, *Continued*

Year Last Reviewed	Topic	Recommendation	Comments
2015	Guidelines for Withholding and Discontinuing	However, in individual cases, when counseling a family and constructing a prognosis for survival at gestations below 25 weeks, it is reasonable to consider variables such as perceived accuracy of gestational age assignment, the presence or absence of chorioamnionitis, and the level of care available for location of delivery. It is also recognized that decisions about appropriateness of resuscitation below 25 weeks of gestation will be influenced by region-specific guidelines. In making this statement, a higher value was placed on the lack of evidence for a generalized prospective approach to changing important outcomes over improved retrospective accuracy and locally validated counseling policies. The most useful data for antenatal counseling provides outcome figures for infants alive at the onset of labor, not only for those born alive or admitted to a neonatal intensive care unit (Class IIb, LOE C-LD).	new for 2015
2015	Guidelines for Withholding and Discontinuing	We suggest that, in infants with an Apgar score of 0 after 10 minutes of resuscitation, if the heart rate remain undetectable, it may be reasonable to stop assisted ventilations; however, the decision to continue or discontinue resuscitative efforts must be individualized. Variables to be considered may include whether the resuscitation was considered optimal; availability of advanced neonatal care, such as therapeutic hypothermia; specific circumstances before delivery (eg, known timing of the insult); and wishes expressed by the family (Class IIb, LOE C-LD).	updated for 2015
2015	Structure of Educational Programs to Teach Neonatal Resuscitation: Instructors	Until more research is available to clarify the optimal instructor training methodology, it is suggested that neonatal resuscitation instructors be trained using timely, objective, structured, and individually targeted verbal and/or written feedback (Class IIb, LOE C-EO).	new for 2015
2015	Structure of Educational Programs to Teach Neonatal Resuscitation: Providers	Studies that explored how frequently healthcare providers or healthcare students should train showed no differences in patient outcomes (LOE C-EO) but were able to show some advantages in psychomotor performance (LOE B-R) and knowledge and confidence (LOE C-LD) when focused training occurred every 6 months or more frequently. It is therefore suggested that neonatal resuscitation task training occur more frequently than the current 2-year interval (Class IIb, LOE B-R, LOE C-EO, LOE C-LD).	new for 2015
The following recommendations were not reviewed in 2015. For more information, see the <i>2010 AHA Guidelines for CPR and ECC</i> , "Part 15: Neonatal Resuscitation."			
2010	Temperature Control	All resuscitation procedures, including endotracheal intubation, chest compression, and insertion of intravenous lines, can be performed with these temperature-controlling interventions in place (Class IIb, LOE C).	not reviewed in 2015
2010	Clearing the Airway When Amniotic Fluid Is Clear	Suctioning immediately after birth, whether with a bulb syringe or suction catheter, may be considered only if the airway appears obstructed or if PPV is required (Class IIb, LOE C).	not reviewed in 2015
2010	Assessment of Oxygen Need and Administration of Oxygen	It is recommended that oximetry be used when resuscitation can be anticipated, when PPV is administered, when central cyanosis persists beyond the first 5 to 10 minutes of life, or when supplementary oxygen is administered (Class I, LOE B).	not reviewed in 2015
2010	Administration of Oxygen in Term Infants	It is reasonable to initiate resuscitation with air (21% oxygen at sea level; Class IIb, LOE C).	not reviewed in 2015
2010	Administration of Oxygen in Term Infants	Supplementary oxygen may be administered and titrated to achieve a preductal oxygen saturation approximating the interquartile range measured in healthy term infants after vaginal birth at sea level (Class IIb, LOE B).	not reviewed in 2015
2010	Initial Breaths and Assisted Ventilation	Inflation pressure should be monitored; an initial inflation pressure of 20 cm H <sub>2</sub> O may be effective, but $\geq 30$ to 40 cm H <sub>2</sub> O may be required in some term babies without spontaneous ventilation (Class IIb, LOE C).	not reviewed in 2015
2010	Initial Breaths and Assisted Ventilation	In summary, assisted ventilation should be delivered at a rate of 40 to 60 breaths per minute to promptly achieve or maintain a heart rate of 100 per minute (Class IIb, LOE C).	not reviewed in 2015
2010	Assisted-Ventilation Devices	Target inflation pressures and long inspiratory times are more consistently achieved in mechanical models when T-piece devices are used rather than bags, although the clinical implications of these findings are not clear (Class IIb, LOE C).	not reviewed in 2015
2010	Assisted-Ventilation Devices	Resuscitators are insensitive to changes in lung compliance, regardless of the device being used (Class IIb, LOE C).	not reviewed in 2015
2010	Endotracheal Tube Placement	Although last reviewed in 2010, exhaled CO <sub>2</sub> detection remains the most reliable method of confirmation of endotracheal tube placement (Class IIa, LOE B).	not reviewed in 2015
2010	Chest Compressions	Respirations, heart rate, and oxygenation should be reassessed periodically, and coordinated chest compressions and ventilations should continue until the spontaneous heart rate is $< 60$ per minute (Class IIb, LOE C).	not reviewed in 2015

(Continued)

2015 Guidelines Update: Part 13 Recommendations, *Continued*

Year Last Reviewed	Topic	Recommendation	Comments
2010	Epinephrine	Dosing recommendations remain unchanged from 2010. Intravenous administration of epinephrine may be considered at a dose of 0.01 to 0.03 mg/kg of 1:10 000 epinephrine. If an endotracheal administration route is attempted while intravenous access is being established, higher dosing will be needed at 0.05 to 0.1 mg/kg (Class IIb, LOE C).	not reviewed in 2015
2010	Epinephrine	Given the lack of supportive data for endotracheal epinephrine, it is reasonable to provide drugs by the intravenous route as soon as venous access is established (Class IIb, LOE C).	not reviewed in 2015
2010	Volume Expansion	Volume expansion may be considered when blood loss is known or suspected (pale skin, poor perfusion, weak pulse) and the infant's heart rate has not responded adequately to other resuscitative measures (Class IIb, LOE C).	not reviewed in 2015
2010	Volume Expansion	An isotonic crystalloid solution or blood may be useful for volume expansion in the delivery room (Class IIb, LOE C).	not reviewed in 2015
2010	Volume Expansion	The recommended dose is 10 mL/kg, which may need to be repeated. When resuscitating premature infants, care should be taken to avoid giving volume expanders rapidly, because rapid infusions of large volumes have been associated with IVH (Class IIb, LOE C).	not reviewed in 2015
2010	Induced Therapeutic Hypothermia Resource-Abundant Areas	Induced therapeutic hypothermia was last reviewed in 2010; at that time it was recommended that infants born at more than 36 weeks of gestation with evolving moderate-to-severe hypoxic-ischemic encephalopathy should be offered therapeutic hypothermia under clearly defined protocols similar to those used in published clinical trials and in facilities with the capabilities for multidisciplinary care and longitudinal follow-up (Class IIa, LOE A).	not reviewed in 2015
2010	Guidelines for Withholding and Discontinuing	The 2010 Guidelines provide suggestions for when resuscitation is not indicated, when it is nearly always indicated, and that under circumstances when outcome remains unclear, that the desires of the parents should be supported (Class IIb, LOE C).	not reviewed in 2015
2010	Briefing/Debriefing	It is still suggested that briefing and debriefing techniques be used whenever possible for neonatal resuscitation (Class IIb, LOE C).	not reviewed in 2015

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KEY WORDS: cardiopulmonary resuscitation

## Part 13: Neonatal Resuscitation: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

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