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Special Report—Neonatal Resuscitation: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations

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Note From the Writing Group: *Throughout this article, the reader will notice combinations of superscripted letters and numbers (eg, "Peripartum Suctioning[NRP-011A, NRP-012A]"). These callouts are hyperlinked to evidence-based worksheets, which were used in the development of this article. An appendix of worksheets, applicable to this article, is located at the end of the text. The worksheets are available in PDF format and are open access.*

Approximately 10% of newborns require some assistance to begin breathing at birth, and <1% require extensive resuscitation (LOE 4[1,2]). Although the vast majority of newborn infants do not require intervention to make the transition from intrauterine to extrauterine life, the large number of births worldwide means that many infants require some assistance to achieve cardiorespiratory stability. Newborn infants who are born at term and are breathing or crying and have good tone must be dried and kept warm. These actions can be provided with the baby lying on the mother's chest and should not require separation of mother and baby.

All others need to be assessed to determine their need for one or more of the following actions in sequence:

A. Initial steps in stabilization (dry and provide warmth, position, assess the airway, stimulate to breathe)
B. Ventilation
C. Chest compressions
D. Medications or volume expansion

Progression to the next step is initially based on simultaneous assessment of 2 vital characteristics: heart rate and respirations. Progression occurs only after successful completion of the preceding step. Approximately 30 seconds is allotted to complete each of the first 2 steps successfully, reevaluate, and decide whether to progress to the next (see Figure: Newborn Resuscitation Algorithm).

Since publication of the *2005 International Consensus on CPR and ECC Science With Treatment Recommendations*,[3,4] several controversial neonatal resuscitation issues have been identified. The literature was researched and a consensus was reached on the assessment of oxygenation and role of supplementary oxygen, peripartum management of meconium, ventilation strategies, devices to confirm placement of an advanced airway (eg, tracheal tube or laryngeal mask airway), med-

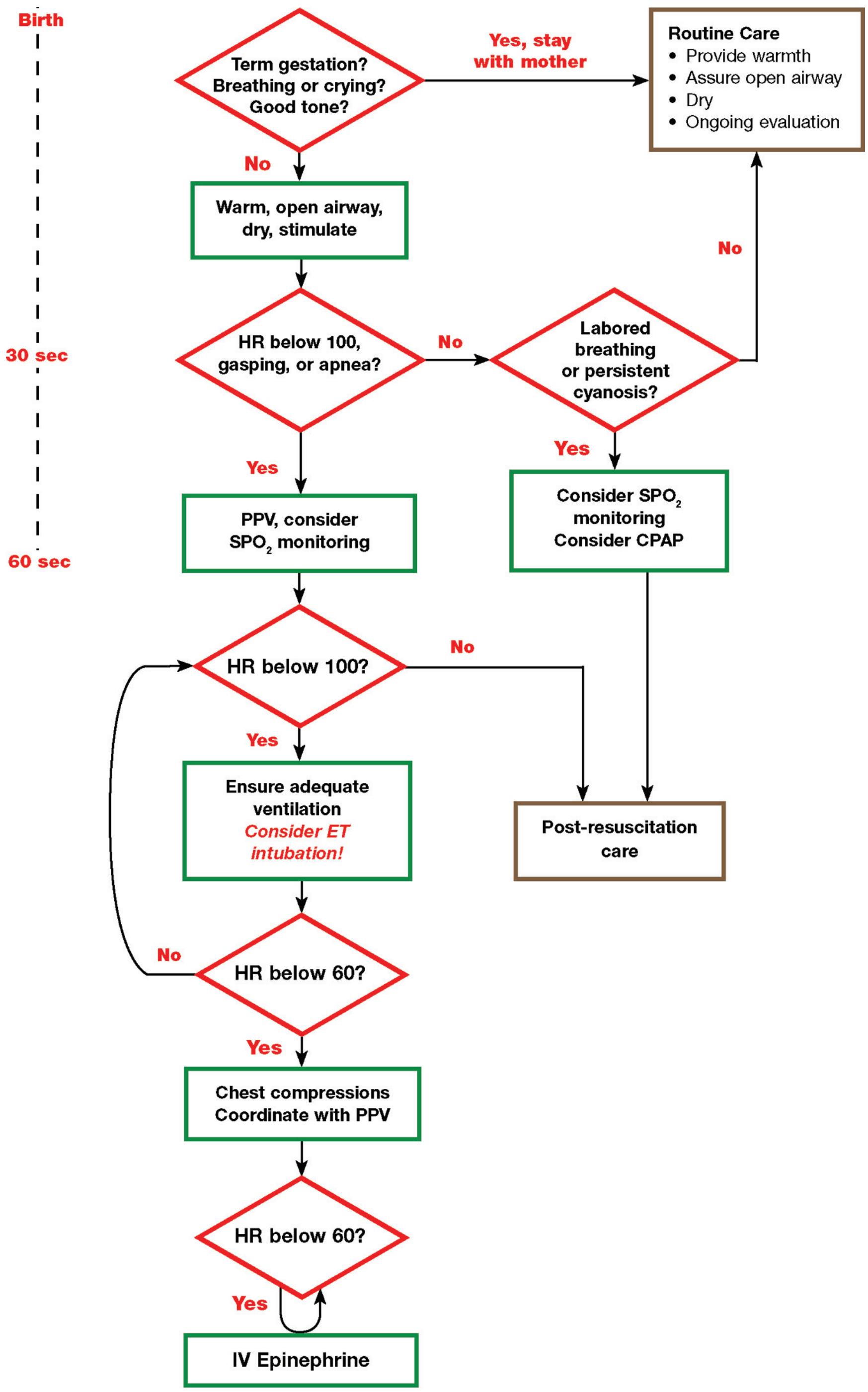

FIGURE.
Newborn Resuscitation Algorithm.

ications, maintenance of body temperature, postresuscitation management, and considerations for withholding and discontinuing resuscitation. Educational techniques for teaching, assessing, and maintaining resuscitation knowledge and skills and issues regarding the personnel needed at cesarean sections were also debated. The following are the major new recommendations:

- Progression to the next step following the initial evaluation is now defined by the simultaneous assessment of 2 vital characteristics: heart rate and respirations. Oximetry should be used for evaluation of oxygenation because assessment of color is unreliable.

- For babies born at term it is best to begin resuscitation with air rather than 100% oxygen.
- Administration of supplementary oxygen should be regulated by blending oxygen and air, and the concentration delivered should be guided by oximetry.
- The available evidence does not support or refute the routine endotracheal suctioning of infants born through meconium-stained amniotic fluid, even when the newborn is depressed.
- The chest compression-ventilation ratio should remain at 3:1 for neonates unless the arrest is known to be of cardiac etiology, in which case a higher ratio should be considered.
- Therapeutic hypothermia should be considered for infants born at term or near-term with evolving moderate to severe hypoxic-ischemic encephalopathy, with protocol and follow-up coordinated through a regional perinatal system.
- It is appropriate to consider discontinuing resuscitation if there has been no detectable heart rate for 10 minutes. Many factors contribute to the decision to continue beyond 10 minutes.
- Cord clamping should be delayed for at least 1 minute in babies who do not require resuscitation. Evidence is insufficient to recommend a time for clamping in those who require resuscitation.

INITIAL ASSESSMENT AND INTERVENTION

Assessment of Cardiorespiratory Transition and Need for Resuscitation[NRP-001A, NRP-001B, NRP-014A, NRP-014B]

Consensus on Science

A prompt increase in heart rate remains the most sensitive indicator of resuscitation efficacy (LOE 5[5]). Of the clinical assessments, auscultation of the heart is the most accurate, with palpation of the umbilical cord less so. However, both are relatively insensitive (LOE 2[6] and LOE 4[7]). Several studies have addressed the accuracy of pulse oximetry in measuring heart rate in the delivery room and have shown the feasibility of pulse oximetry during newborn resuscitation. However, none of these studies examined the impact of these measurements on resuscitation outcomes (LOE 4[7,8]). Pulse oximetry (Sp_{O_2}) and heart rate can be measured reliably after 90 seconds from birth with a pulse oximeter designed to reduce movement artifact and a neonatal probe (LOE 4[9,10]). Preductal values, obtained from the right wrist or hand, are higher than postductal values.[8,11] Applying the oximeter probe to the subject before connecting it to the instrument will produce reliable results more quickly (LOE 4[10]).

There is clear evidence that an increase in oxygenation and improvement in color may take many minutes to achieve, even in uncompromised babies. Furthermore, there is increasing evidence that exposure of the newly born to hyperoxia is detrimental to many organs at a cellular and functional level. For this reason color has been removed as an indicator of oxygenation or resuscitation efficacy. The oximeter can be used to adjust the increase in oxygenation to that of the uncompromised baby born at term.

Treatment Recommendations

Heart rate should remain the primary vital sign by which to judge the need for and efficacy of resuscitation. Auscultation of the precordium should remain the primary means of assessing heart rate. There is a high likelihood of underestimating heart rate with palpation of the umbilical pulse, but this is preferable to other palpation locations.

For babies who require ongoing resuscitation or respiratory support or both, the goal should be to use pulse oximetry. The sensor should be placed on the baby's right hand or wrist before connecting the probe to the instrument. Because of concerns about the ability to consistently obtain accurate measurements, pulse oximetry should be used in conjunction with and should not replace clinical assessment of heart rate during newborn resuscitation.

Use of Supplementary Oxygen[NRP-013A, NRP-013B, NRP-014A, NRP-014B]

Consensus on Science

In term infants receiving resuscitation with intermittent positive-pressure ventilation, 100% oxygen conferred no advantage over air in the short term and resulted in increased time to first breath or cry or both (LOE 2[12,13]). Meta-analyses of these studies showed a decrease in mortality with the group for whom resuscitation was initiated with air.[14,15]

There is evidence in newborn animal models of asphyxia that exposure to high concentrations of oxygen at resuscitation does not confer any clinical advantage and is potentially harmful at the cellular level.[16,17] Two animal models of hypoxia-ischemia and persistent bradycardia found that those resuscitated with room air rather than 100% oxygen developed untoward biochemical changes in the brain (LOE 5[18,19]).

In preterm infants at <32 weeks' gestation, if attempting to mimic the gradual rise in oxygen saturation of healthy term babies in the first 10 minutes after birth by titrating the concentration to the baby's saturation, initial use of air or 100% oxygen is more likely to result in hypoxemia or hyperoxemia, respectively, than initiation of resuscitation with 30% or 90% oxygen and titration to oxygen saturation (LOE 2[11,20]). There is insufficient evidence in babies born at 32 to 37 weeks' gestation to define the appropriate oxygen administration strategy.

Treatment Recommendation

In term infants receiving resuscitation at birth with positive-pressure ventilation, it is best to begin with air rather than 100% oxygen. If despite effective ventilation there is no increase in heart rate or if oxygenation (guided by oximetry) remains unacceptable, use of a higher concentration of oxygen should be considered.

Because many preterm babies of $<$32 weeks' gestation will not reach target saturations in air, blended oxygen and air may be given judiciously and ideally guided by pulse oximetry. Both hyperoxemia and hypoxemia should be avoided. If a blend of oxygen and air is not available, resuscitation should be initiated with air.

Peripartum Suctioning[NRP-011A, NRP-012A]

Peripartum suctioning was examined from 2 perspectives: (1) suctioning of the airway in depressed neonates born through clear amniotic fluid and (2) tracheal suctioning in depressed neonates born through meconium-stained amniotic fluid.

Suctioning of the Upper Airway

Consensus on Science

There is no evidence to support or refute suctioning of the mouth and nose of depressed neonates at birth when the infant is born through clear amniotic fluid. In healthy neonates suctioning of the mouth and nose is associated with cardiorespiratory complications (LOE 1[21,22]). In infants who are intubated, sedated, or paralyzed following resuscitation, endotracheal suctioning in the absence of secretions may result in a decrease in oxygenation, an increase in cerebral blood flow and intracranial pressure, and a decrease in compliance (LOE 5[23]).

Treatment Recommendation

Routine intrapartum oropharyngeal and nasopharyngeal suctioning for infants born with clear or meconium-stained amniotic fluid is no longer recommended.

Tracheal Suctioning

Consensus on Science

Depressed infants born through meconium-stained amniotic fluid are at increased risk of developing meconium aspiration syndrome (LOE 4[24,25]). Although these infants are at increased risk of developing meconium aspiration syndrome, the use of tracheal suctioning has not been associated with a reduction in the incidence of meconium aspiration syndrome or mortality (LOE 4[26]; LOE 5[27]). No randomized controlled studies have compared intubation and tracheal suctioning and no tracheal suctioning in depressed infants.

Treatment Recommendation

The available evidence does not support or refute the routine endotracheal suctioning of depressed infants born through meconium-stained amniotic fluid.

VENTILATION STRATEGIES[NRP-028A, NRP-028B]

Ventilation strategies were examined from 4 perspectives: (1) characteristics of the initial assisted breaths and the role of positive end-expiratory pressure (PEEP), (2) continuous positive airway pressure (CPAP) during or following resuscitation, (3) devices to assist ventilation, and (4) strategies when resources are limited.

Initial Breaths

Consensus on Science

Both longer and shorter inspiratory times are in clinical use for initial ventilation in term infants, but there are no randomized controlled trials comparing these 2 approaches. In a small case series in term infants, a prolonged initial inflation of 5 seconds produced a 2-fold increase in functional residual capacity compared with historic controls (LOE 4[28]). A single randomized controlled trial in preterm infants of a 10-second sustained inflation followed by nasal CPAP compared with face mask ventilation demonstrated decreased need for intubation in the first 72 hours, shorter duration of ventilatory support, and reduced bronchopulmonary dysplasia (LOE 1[29]). Two other randomized controlled trials failed to show a benefit from delivery room application of a sustained initial inflation followed by nasal CPAP (LOE 1[30,31]). Multiple variables among the 3 randomized controlled trials, including mode of intervention (nasopharyngeal tube versus face mask, T-piece versus self-inflating bag), as well as the use of CPAP in the delivery room make it difficult to determine the effect of the initial sustained inflation on establishing a functional residual capacity in very preterm infants.

Pressure

There is no evidence to support the use of inflation pressures higher than those that are necessary to achieve improvement in heart rate or chest expansion. This can usually be achieved in term infants with an inflation pressure of 30 cm H_2O (LOE 4[28,32]) and in preterm infants with pressures of 20 to 25 cm H_2O (LOE 4[33]). Occasionally higher pressures are required (LOE 4[34]). In immature animals, ventilation at birth with high tidal volumes associated with the generation of high peak inflation pressures for a few minutes causes lung injury, impaired gas exchange, and reduced lung compliance (LOE 5[35]).

Positive End-Expiratory Pressure

There is no evidence to support or refute the value of PEEP during resuscitation of term infants. In preterm infants 1 small study did not show a benefit from PEEP during initial stabilization in reducing the number of infants who required intubation in the delivery room (LOE 1[36]). In studies of intubated immature animals the use of PEEP during initial stabilization after birth improved functional residual capacity, oxygenation, and lung compliance and reduced lung injury (LOE 5[37,38]), but high levels of PEEP (8 to 12 cm H_2O) may reduce pulmonary blood flow and increase the risk of pneumothorax (LOE 5[39,40]).

Treatment Recommendation

To establish initial lung inflation in apneic newborn infants, initiation of intermittent positive-pressure ventilation at birth can be accomplished with either shorter or longer inspiratory times. Initial peak inflating pressures necessary to achieve an increase in heart rate or movement of the chest are variable and unpredictable and should be individualized with each breath. If pressure is being monitored, an initial inflation pressure of 20 cm H_2O may be effective in preterm babies, but a pressure of 30 to 40 cm H_2O may be necessary in some term babies. If pressure is not being monitored, the minimal inflation required to achieve an increase in heart rate should be used. Providers should avoid creation of excessive chest wall movement during ventilation of preterm infants immediately after birth.

Although measured peak inflation pressure does not correlate well with volume delivered in the context of changing respiratory mechanics, monitoring of inflation pressure may help provide consistent inflations and avoid unnecessarily high pressures. If positive-pressure ventilation is required, an initial inflation pressure of 20 to 25 cm H_2O is adequate for most preterm infants. If prompt improvement in heart rate or chest movement is not obtained, then higher pressures to achieve effective ventilation may be needed. PEEP is likely to be beneficial during initial stabilization of apneic preterm infants who require positive-pressure ventilation and should be used if suitable equipment is available.

Continuous Positive Airway Pressure[NRP-002A, NRP-002B]

Consensus on Science

For spontaneously breathing preterm infants at ≥25 weeks' gestation who have signs of respiratory distress, there is no significant difference between starting CPAP or intubation and mechanical ventilation in the delivery room when considering death or oxygen requirement at 36 weeks postmenstrual age. In spontaneously breathing infants at 25 to 28 weeks' gestation, CPAP compared with intubation reduced the rates of mechanical ventilation from 100% to 46% and surfactant use from 77% to 38% (LOE 1[41]). In the same trial infants on CPAP had a significantly increased rate of pneumothorax (9% versus 3%) (LOE 1[41]). There is no evidence to support or refute the use of CPAP in the term baby.

For very preterm infants, a multifaceted intervention, including PEEP, giving a sustained inflation and starting CPAP in the delivery room reduces the need for intubation and rate of mechanical ventilation within 72 hours and reduces incidence of bronchopulmonary dysplasia compared with positive-pressure ventilation with a self-inflating bag via a face mask (LOE 1[29]). When compared with historic controls, use of delivery room CPAP for very premature infants was associated with a decrease in the requirement for intubation, days on mechanical ventilation, and use of postnatal steroids (LOE 4[33]), although a small underpowered feasibility trial of delivery room CPAP/PEEP versus no CPAP/PEEP did not show a significant difference in immediate outcomes (LOE 1[36]).

Treatment Recommendation

Spontaneously breathing preterm infants who have respiratory distress may be supported with CPAP or intubation and mechanical ventilation. The most appropriate choice may be guided by local expertise and preferences.

Assisted Ventilation Devices[NRP-015A, NRP-015B, NRP-015C, NRP-017A, NRP-017B]

Consensus on Science

There are no clinical studies in newborns requiring positive pressure during resuscitation to support or refute the superiority of the T-piece resuscitator over bag-mask ventilation in improving outcome. In mechanical models target inflation pressures are delivered more consistently when using T-piece resuscitators than with self-inflating bags or flow-inflating bags (LOE 5[42,43]). In mechanical models PEEP is maintained more consistently with T-piece resuscitators compared with self-inflating bags or flow-inflating bags (LOE 5[44]). In mechanical models the ability to deliver a sustained inflation is better with either a T-piece resuscitator or flow-inflating bag than with a self-inflating bag (LOE 5[42,45]).

Treatment Recommendation

Ventilation of the newborn can be performed effectively with a flow-inflating bag, a self-inflating bag, or a pressure-limited T-piece resuscitator.

Laryngeal Mask Airway[NRP-017A, NRP-017B]

Consensus on Science

In 1 randomized controlled trial (LOE 1[46]) providers had similar success providing effective ventilation with either the laryngeal mask airway or face mask among newborns in the delivery room. In 1 retrospective cohort study (LOE 2[47]) and 3 large case series (LOE 4[48]) effective ventilation was achieved quickly using a laryngeal mask airway in newborns weighing >2000 g or delivered at ≥34 weeks' gestation. In 1 randomized controlled trial (LOE 1[49]) and 1 retrospective cohort study (LOE 2[50]) providers had similar success providing effective ventilation using either the laryngeal mask airway or endotracheal tube among newborns in the delivery room. Although a single cohort study (LOE 2[50]) suggests that newborns resuscitated with a laryngeal mask may require less respiratory support after initial resuscitation, this conclusion is subject to significant selection bias. In multiple small case reports effective ventilation was achieved with a laryngeal mask airway when both face mask ventilation and endotracheal intubation were unsuccessful. There is limited evidence to evaluate the effectiveness of the laryngeal mask airway for newborns weighing <2000 g, delivered at <34 weeks' gestation, in the setting of meconium-stained amniotic fluid, during chest compressions, or for administration of emergency intratracheal medications.

Treatment Recommendation

The laryngeal mask airway should be considered during resuscitation of the newborn if face mask ventilation is unsuccessful and tracheal intubation is unsuccessful or not feasible. The laryngeal mask airway may be considered as an alternative to a face mask for positive-pressure ventilation among newborns weighing >2000 g or delivered at ≥34 weeks' gestation. There is limited evidence, however, to evaluate its use for newborns weighing <2000 g or delivered at <34 weeks' gestation. The laryngeal mask airway may be considered as an alternative to endotracheal intubation as a secondary airway for resuscitation among newborns weighing >2000 g or delivered at ≥34 weeks' gestation. The laryngeal mask airway has not been evaluated in the setting of meconium-stained amniotic fluid, during chest compressions, or for administration of emergency intratracheal medications.

Upper Airway Interface Devices[NRP-003A, NRP-003B]

Consensus on Science

Within classes of interfaces, reports conflict about the ability to maintain a seal with an anatomically shaped mask compared with a soft round mask (LOE 5[51,52]). Delivery of positive-pressure ventilation via nasal prongs has been shown to be superior to delivery via a triangular face mask for outcomes of chest compressions and intubation (LOE 2[53]). It is likely that differences in clinical outcomes that have been reported in several studies may be attributable to the targeted intervention (ie, CPAP versus intermittent positive-pressure ventilation) rather than the interface. Nasal prongs may be a more effective device than face masks for providing respiratory support after birth (LOE 2[53]). There is insufficient evidence to support or refute the use of one type of mask over another for achieving clinical outcome, except that the Rendell-Baker style mask is suboptimal in achieving an adequate seal when used for newborns (LOE 5[54]).

Treatment Recommendations

Nasal prongs are an alternative way of giving respiratory support. Whichever interface is used, providers should ensure that they are skilled in using the interface devices available at the institution. Different masks must be held in different ways to appropriately reduce leak.

Exhaled Air Ventilation[NRP-004A, NRP-004B]

Consensus on Science

Mouth-to-mouth ventilation is less effective than a self-inflating bag or tube and mask in improving survival rates in newborns with birth asphyxia (LOE 3[55]). Use of mouth-to-mask ventilation at 30 insufflations per minute is as effective as self-inflating bag-mask ventilation in increasing heart rate in the first 5 minutes after birth (LOE 2[56]). Mask-to-tube ventilation may cause infection in newborn infants (LOE 5[57]). Two studies (LOE 5[58,59]) demonstrated that tube-to-mask ventilation can be easily taught and acceptable breaths delivered. However, tube-to-mask ventilation was more difficult to use (LOE 5[60]; LOE 3[55]).

Treatment Recommendation

Bag-mask ventilation is preferable to mouth-to-mask ventilation or tube-to-mask ventilation during neonatal resuscitation, but one of the latter two should be used when bag-mask devices are not available. Precautions must be taken because mouth-to-mask and mouth tube–to-mask ventilation are less comfortable and more tiring than bag-mask ventilation for the newborn at birth and may be associated with increased risk of infection in the infant and healthcare provider.

MONITORING DURING AND AFTER INTUBATION

Gas Monitoring Devices

Measurement of Tidal Volume[NRP-005A, NRP-005B, NRP-005C]

Consensus of Science

There are no studies that compare clinical outcomes in newborns after resuscitation with or without monitoring of tidal volume. In preterm animal models the tidal volume used during initial ventilation after birth may alter subsequent lung function and induce inflammation, but other factors, including the use and level of PEEP, appear to interact with tidal volume in determining specific effects (LOE 5[61,62]). It is unclear whether the absolute tidal volumes used affected outcomes. Studies in manikins and animals (LOE 5[63,64]) suggest that providers cannot maintain constant pressures or assess delivered volume during manual ventilation. The position of the mask and degree of leak may be improved by the use of a volume monitor (LOE 5[65]).

Treatment Recommendations

Ventilation during newborn resuscitation should aim to adequately inflate the lung while avoiding overinflation. There is insufficient evidence to recommend routine use of tidal volume monitoring in neonates receiving positive-pressure ventilation during resuscitation.

Use of Exhaled CO_2 Detectors to Confirm Tracheal Tube Placement[NRP-016A]

Consensus on Science

Studies (LOE 2[66–68]) suggest that detection of exhaled CO_2 confirms tracheal intubation in neonates with cardiac output more rapidly and accurately than clinical assessment alone. False-negative readings have been reported during cardiac arrest (LOE 4[69]) despite models suggesting efficacy (LOE 5[70]). False-positive readings may occur with colorimetric devices contaminated with epinephrine (adrenaline), surfactant, and atropine (LOE 5[71]). Neonatal studies have excluded infants who need extensive resuscitation. There is no comparative information to recommend any one method for detection of exhaled CO_2 in the neonatal population.

Treatment Recommendation

Detection of exhaled CO_2 in addition to clinical assessment is recommended as the most reliable method to confirm endotracheal placement in neonates with spontaneous circulation.

Colorimetric CO_2 Detection to Assess Ventilation in Nonintubated Patients[NRP-018A, NRP-018B, NRP-018C]

Consensus on Science

The use of colorimetric exhaled CO_2 detectors during face mask ventilation of small numbers of preterm infants in the intensive care unit (LOE 4[72]) and the delivery room (LOE 4[73]) has been reported and may help identify airway obstruction. It is unclear whether the use of exhaled CO_2 detectors during face mask ventilation confers additional benefit over clinical assessment alone. No risks attributed to the use of exhaled CO_2 detectors have been identified. The use of exhaled CO_2 detectors with other interfaces (eg, nasal airways, laryngeal masks) during positive-pressure ventilation in the delivery room has not been reported.

Treatment Recommendation

There is insufficient evidence to recommend routine use of colorimetric exhaled CO_2 detectors during mask ventilation of newborns in the delivery room.

CIRCULATORY SUPPORT

Chest Compressions[NRP-006A, NRP-006B, NRP-007A, NRP-007B]

Consensus on Science

In animal studies of asphyxial models of cardiac arrest, piglets resuscitated with a combination of chest compressions and ventilations had better outcomes than those resuscitated with ventilations or compressions alone (LOE 5[74,75]). A further study in piglets suggested that sustained chest compressions had a deleterious effect on myocardial and cerebral perfusion, especially during prolonged resuscitation.[76]

A physiologic mathematical modeling study suggested that using higher compression-ventilation ratios would result in underventilation of asphyxiated infants (LOE 5[77]). The model predicts that between 3 and 5 compressions to 1 ventilation should be most efficient for newborns.

Manikin studies confirm that the 3:1 compression-ventilation ratio provides more ventilations per minute when compared with higher ratios, but the resuscitation is perceived as being more physically taxing, especially when performed by a lone rescuer (LOE 5[78,79]). Adult manikin studies using 2 rescuers have shown that a 5:1 ratio provides better-quality chest compressions than a 15:2 ratio (LOE 5[80]) but can result in more missed ventilations per cycle (LOE 5[81]). A pediatric manikin study of mouth-to-mouth ventilation by a lone lay rescuer found equivalent minute ventilation for both the 15:2 and 5:1 ratios, but the 15:2 ratio produced more chest compressions per minute (LOE 5[82]). With 2-rescuer CPR provided by nursing students, however, minute ventilation and compressions per minute were increased with the 5:1 ratio compared with the 10:2 and 15:2 ratios (LOE 5[83]). When the 15:2 ratio was compared with the 30:2 ratio in a 1-rescuer model of medical personnel using adolescent, child, and infant manikins, more compression cycles could be achieved with the 30:2 ratio on all manikins with no apparent effect on quality of compressions (LOE 5[84]). Effect on ventilation, however, was not assessed. One study in children suggested that CPR with rescue breathing is preferable to CPR alone when the arrest is of noncardiac etiology (LOE 5[85]). There are no data regarding the optimum compression-ventilation ratios in neonates or neonatal models of primary cardiac versus predominantly asphyxial arrest.

Evidence from randomized studies in swine models (LOE 5[86,87]), manikin studies (LOE 5[84,88]), small case series (LOE 4[89]), and cadavers (LOE 5[90]) support the current practice of favoring the 2 thumb–encircling hands technique of chest compressions when compared with the 2-finger technique. The former method produces higher blood pressure, can sustain a consistent quality of compressions for a longer time, and is perceived as easier and less tiring for the provider. One manikin study involving a variety of medical or quasimedical personnel (LOE 5[91]) found no difference in a number of qualitative measures between the 2 techniques other than significantly fewer compressions were judged as too shallow with the 2-thumb technique. One small case series in newborns found higher systolic blood pressure generated with the 2-finger technique when compared with the 2 thumb–encircling hands technique (LOE 4[92]). Both techniques, however, generated comparable and adequate diastolic pressures, a more important determinant of coronary perfusion. Compressions should be centered over the lower third of the sternum rather than the mid-sternum (LOE 5[93,94]). Chest compression depth should favor one third the external anterior-posterior diameter of the chest rather than deeper compressions (LOE 5[95]).

Treatment Recommendation

There is no evidence from quality human, animal, manikin, or mathematical modeling studies to warrant a change from the current compression-ventilation ratio of 3:1. Strategies should be considered for optimizing the quality of compressions and ventilations with as few interruptions as possible. Because ventilation is critical to reversal of newborn asphyxial arrest, any higher ratio that decreases minute ventilation should be introduced with caution. If the arrest is known to be of cardiac etiology, a higher compression-ventilation ratio should be considered (eg, 15:2).

Chest compressions in the newborn should be delivered by the 2 thumb–encircling hands method as the preferred option. Compressions should be centered over the lower third of the sternum and should compress the chest one third the anterior-posterior diameter. Any chest compressions should be performed in combination with adequate inflation breaths.

MEDICATIONS AND FLUID ADMINISTRATION

Epinephrine

Route and Dose of Epinephrine[NRP-008A, NRP-008B, NRP-009A, NRP-009B]

Consensus on Science

Despite the widespread use of epinephrine during resuscitation, no controlled clinical trials have directly compared endotracheal and intravenous administration of epinephrine among neonates with a heart rate of <60 beats per minute despite adequate ventilation and chest compressions. Limited evidence from neonatal case series or case reports (LOE 4[96,97]) indicates that epinephrine administered by the endotracheal route using a wide range of doses (0.003 mg/kg to 0.25 mg/kg) may result in return of spontaneous circulation (ROSC) or an increase in heart rate when intravenous access is not available. These case series are limited by inconsistent standards for epinephrine administration and are subject to both selection and reporting bias.

Evidence from 1 case series using rigorously defined standards for epinephrine administration and outcomes reporting indicates that endotracheal administration of epinephrine (0.01 mg/kg) is likely to be less effective than intravenous administration of the same dose (LOE 4[2]). This is consistent with evidence extrapolated from neonatal animal models indicating that higher doses (0.05 mg/kg to 0.1 mg/kg) of endotracheal epinephrine may be required to achieve increased blood epinephrine concentrations and a hemodynamic response equivalent to intravenous administration (LOE 5[98,99]). Evidence extrapolated from adult animal models indicates that blood concentrations of epinephrine are significantly lower following endotracheal administration (LOE 5[100,101]), and endotracheal doses ranging from 0.05 mg/kg to 0.1 mg/kg may be required to achieve ROSC (LOE 5[102]).

Although it has been widely assumed that epinephrine can be administered faster by the endotracheal route than by the intravenous route, no clinical trials have evaluated this hypothesis. Two studies have reported cases of inappropriate early use of endotracheal epinephrine before airway and breathing are established (LOE 4[96,97]). One case series describing in-hospital pediatric cardiac arrest suggested that survival was higher among infants who received their first dose of epinephrine by the endotracheal route; however, the time required for first dose administration using the endotracheal and intravenous routes was not provided (LOE 5[103]).

Despite the widespread use of epinephrine during resuscitation, no controlled clinical trials have evaluated the ideal dose of epinephrine among neonates with a heart rate of <60 beats per minute despite adequate ventilation and chest compressions. Evidence extrapolated from pediatric studies that included infants <1 year of age (LOE 5[104,105]) indicate no benefit from intravenous epinephrine doses ≥0.03 mg/kg. This is in contrast to a single pediatric case series using historic controls that indicated a marked improvement in ROSC using high-dose intravenous epinephrine (0.1 mg/kg) among children who had not responded to 2 doses of standard epinephrine (0.01 mg/kg) (LOE 5[106]). Further extrapolative evidence from a meta-analysis of 5 adult clinical trials indicates that high-dose intravenous epinephrine may increase ROSC but offers no benefit in survival to hospital discharge (LOE 5[107]). Evidence from a planned secondary analysis of a pediatric randomized controlled trial suggests an increased risk of mortality among children receiving high-dose intravenous epinephrine (0.1 mg/kg) (LOE 5[104]). Additional evidence from 2 pediatric animal studies (LOE 5[108,109]) indicates that intravenous epinephrine ≥0.1 mg/kg increased risk of postresuscitation mortality and interfered with cerebral cortical blood flow and cardiac output. There are no published studies comparing standard- and high-dose endotracheal epinephrine in the neonatal population with hypoxic-hypercarbic arrest, and the ideal dose for endotracheal administration is unknown. Data from neonatal case series and animal models suggest that higher doses (0.05 mg/kg to 0.1 mg/kg) of endotracheal epinephrine may be required to achieve increased blood epinephrine concentrations and a hemodynamic response equivalent to intravenous administration (LOE 4[2,96]).

Treatment Recommendation

If adequate ventilation and chest compressions have failed to increase the heart rate to >60 beats per minute, then it is reasonable to use epinephrine despite the lack of human neonatal data. If epinephrine is indicated, a dose of 0.01 to 0.03 mg/kg should be administered *intravenously* as soon as possible. If adequate ventilation and chest compressions have failed to increase the heart rate to >60 beats per minute and intravenous access is *not* available, then it is reasonable to administer endotracheal epinephrine. If epinephrine is administered by the endotracheal route, it is likely that a larger dose (0.05 mg/kg to 0.1 mg/kg) will be required to achieve an effect similar to that of the 0.01 mg/kg intravenous dose. Higher intravenous doses cannot be recommended and may be harmful.

Volume Expansion[NRP-029A, NRP-029B, NRP-029C]

Consensus on Science

Multiple case series support the use of volume expansion in babies with a history of blood loss, including some who are unresponsive to chest compressions (LOE 4[110]). Many with pallor and tachycardia responded to volume expansion without having received chest compressions. In the absence of a history of blood loss there is limited evidence of benefit from administration of volume during resuscitation unresponsive to chest compressions/epinephrine (LOE 4[111]) and some suggestion of potential harm from animal studies (LOE 5[112,113]).

Treatment Recommendation

Early volume replacement with crystalloid or red cells is indicated for babies with blood loss who are not responding to resuscitation. There is insufficient evidence to support the routine use of volume administration in the infant with no blood loss who is refractory to ventilation, chest compressions, and epinephrine. Because blood loss may be occult, a trial of volume administration may be considered in babies who do not respond to resuscitation.

Other Drugs

Very rarely a narcotic antagonist (naloxone), sodium bicarbonate[NRP-021A, NRP-021B], or vasopressors may be useful after resuscitation.

Naloxone[NRP-022A, NRP-022B]

Consensus on Science

There are no data comparing naloxone with positive-pressure ventilation as the main intervention for opioid-exposed newborn infants who are apneic at birth. For newborns who are vigorous in the delivery room despite maternal use of opioids, naloxone subtly increases ventilation parameters (such as increased alveolar ventilation and improved CO_2 response curves) for a short time, but the clinical relevance of these observations is questionable (LOE 4[114]). Several other studies found no difference between vigorous treatment with naloxone and placebo or no drug treatment for newborns with outcomes of pH, P_{CO_2}, Apgar scores, and neurologic outcomes (LOE 5[115]). Studies examining naloxone have consistently demonstrated that it is frequently misused (LOE 4[116]). Naloxone given to a baby born to an opioid-addicted mother has been associated with seizures (LOE 5[117]). There are concerns about short- and long-term safety of naloxone in neonates (LOE 5[118]). Naloxone is absorbed more effectively when given intravenously but has a shorter half-life compared with intramuscular administration.

Treatment Recommendation

Naloxone is not recommended as part of the initial resuscitation for newborns with respiratory depression in the delivery room. For the clinical situation of a newborn with respiratory depression after maternal opiate exposure, the focus needs to remain on effective ventilation and airway support for the persistently apneic newborn.

Vascular Access[NRP-020A]

Consensus on Science

Multiple clinical series and case reports suggest that fluids and medications can be successfully delivered by the intraosseous route during resuscitation of neonates when equipment or personnel skilled in establishing venous access are not available or if other vascular access sites (especially intravenous) cannot be successfully established within several minutes (LOE 4[119,120]).

Treatment Recommendation

Temporary intraosseous access to provide fluids and medications to resuscitate critically ill neonates may be indicated following unsuccessful attempts to establish intravenous vascular access or when caregivers are more skilled at securing intraosseous access.

SUPPORTIVE THERAPY

Temperature Control

Maintenance of Body Temperature[NRP-023A]

Consensus on Science

A large body of evidence supports the wrapping of newborn infants of <28 weeks' gestation in polythene wraps or bags at birth without drying to reduce heat loss (LOE 1[121,122]). Some of these infants were hyperthermic on admission to the neonatal intensive care unit, but it is unclear whether this is because they were born hot or because they became overheated during stabilization and transfer. In the absence of polythene wrapping, use of exothermic mattresses maintained the temperature of newborn infants weighing <1500 g within the normal range (LOE 2[123]). A combination of exothermic mattresses and polythene wrapping during resuscitation is the most effective strategy to avoid hypothermia but may increase the risk of hyperthermia (LOE3[124]). Delivery room temperatures of at least 26°C for newborns at <28 weeks' gestation in combination with polythene wraps or bags maintained temperatures most effectively (LOE 4[125]; LOE 3[126]).

Treatment Recommendation

Newborn infants of <28 weeks' gestation should be completely covered in a polythene wrap or bag up to their necks without drying immediately after birth and then placed under a radiant heater and resuscitated or stabilized in a standard fashion. Infants should be kept wrapped until admission and temperature check. Hyperthermia should be avoided. Delivery room temperatures should be at least 26°C for infants of <28 weeks' gestation.

POSTRESUSCITATION MANAGEMENT

Temperature

Hyperthermia[NRP-031A, NRP-031B]

Consensus on Science

Infants born to febrile mothers have been reported to have a higher incidence of perinatal respiratory depression, neonatal seizures, cerebral palsy, and increased risk of mortality (LOE 4[127,128]). There is no evidence to determine whether the fever or the cause of the fever increases the risk to the baby. In 1 study, neonatal fever at birth resolved spontaneously within 60 minutes (LOE 4[129]). Adult animal trials show decreased central nervous system injury with antipyretic therapy for hyperthermia (LOE 5[130]). In a randomized study high-dose corticosteroids lowered maternal temperature but were associated with an increased number of cases of asymptomatic bacteremia in neonates (LOE 2[131]).

Treatment Recommendation

There is insufficient evidence to support or refute the routine use of interventions to lower maternal fever to reduce neonatal morbidity and mortality. There should be an increased awareness that the presence of maternal hyperthermia may lead to a need for neonatal resuscitation. The goal is to achieve normothermia and avoid iatrogenic hyperthermia.

Therapeutic Hypothermia[NRP-024A, NRP-024B]

Consensus on Science

A large body of evidence from 3 large randomized studies (LOE 1[132–134]) and 2 small randomized trials (LOE 1[135,136]) demonstrated that induced hypothermia (33.5° to 34.5°C) implemented within 6 hours of birth in term infants at highest risk for brain injury (as defined by specific protocols) and with further treatment in neonatal intensive care units is associated with significantly fewer deaths and less neurodevelopmental disability at 18-month follow-up. The number needed to treat is 9.[137] Both cooling methods (systemic versus selective head cooling) were shown to be effective, but none of the studies compared them directly. The randomized trials produced remarkably consistent results despite using different methods of cooling.[138]

Treatment Recommendations

Newly born infants born at or near-term with evolving moderate to severe hypoxic-ischemic encephalopathy should be offered therapeutic hypothermia. Whole body cooling and selective head cooling are both appropriate strategies. Cooling should be initiated and conducted under clearly defined protocols with treatment in neonatal intensive care facilities and with the capability for multidisciplinary care. Treatment should be consistent with the protocols used in the randomized clinical trials (ie, begin within 6 hours of birth, continue for 72 hours after birth, and rewarm over at least 4 hours). Carefully monitor for known adverse effects of cooling, eg, thrombocytopenia and hypotension. All treated infants should be followed up longitudinally.

General Supportive Care

Glucose[NRP-019A, NRP-019B]

Consensus on Science

Newborns with lower blood glucose levels have a higher incidence of brain injury and adverse outcomes after a hypoxic-ischemic insult, although no specific level associated with worse outcome has been identified (LOE 4[139]; LOE 3[140]). Increased glucose levels after hypoxia-ischemia do not appear to have adverse effects in studies of pediatric patients (LOE 5[141]) or in animal studies (LOE 5[142]) and may be protective (LOE 5[143]). However, no randomized controlled trials have examined this question. Due to the paucity of data, no specific target glucose concentration range can be identified at present.

Treatment Recommendation

Intravenous glucose infusion should be considered as soon as practical after resuscitation, with the goal of avoiding hypoglycemia.

Timing of Cord Clamping[NRP-030A, NRP-030B, NRP-030C, NRP-030D]

Consensus on Science

For the uncomplicated birth at term there is evidence of a benefit to delaying cord clamping for a minimum time ranging from 1 minute until the cord stops pulsating after delivery. Those with delayed clamping had improved iron status through early infancy but were more likely to receive phototherapy (LOE 1[144]).

For an otherwise uncomplicated preterm birth, there is evidence of a benefit to delaying cord clamping for a minimum time ranging from 30 seconds to 3 minutes after delivery. Those who experienced delayed clamping in this group had higher blood pressures during stabilization and a lower incidence of intraventricular hemorrhage (LOE 1[145]) and received fewer blood transfusions[145] but were more likely to receive phototherapy (LOE 2[144]). There are limited data on the hazards or benefits of delayed cord clamping in the nonvigorous infant.[146,147]

Treatment Recommendation

Delay in umbilical cord clamping for at least 1 minute is recommended for newborn infants not requiring resuscitation. There is insufficient evidence to support or refute a recommendation to delay cord clamping in babies requiring resuscitation.

WITHHOLDING OR DISCONTINUING RESUSCITATIVE EFFORTS[NRP-025A, NRP-025B, NRP-025C, NRP-026A, NRP-026B, NRP-026C, NRP-027A, NRP-027B]

Noninitiation of Resuscitation

Consensus on Science

For neonates at the margins of viability or those with conditions which predict a high risk of mortality or morbidity, attitudes and practice vary according to region and availability of resources (LOE 4[148]). Social science studies indicate that parents would like a larger role in the decisions to start resuscitation and continue life support of severely compromised newborns. Opinions among neonatal providers vary widely regarding the benefits and disadvantages of aggressive therapies in such newborns (LOE 4[149,150]). Some data are available to help identify conditions associated with high mortality and poor outcome (LOE 4[151,152]). Such conditions may include extreme prematurity and anomalies that predict extreme morbidity or early death. Treatment and outcome of infants at the margins of viability may be influenced by factors in addition to gestational age and birthweight.[153] Noninitiation of resuscitation and withdrawal of cardiorespiratory support are ethically equivalent.[154]

Treatment Recommendation

When gestation, birth weight, or congenital anomalies are associated with almost certain early death and an unacceptably high morbidity is likely among the rare survivors, resuscitation is not indicated. In conditions associated with a high rate of survival and acceptable morbidity, resuscitation is nearly always indicated. In conditions associated with uncertain prognosis, when there is borderline survival and a relatively high rate of morbidity and when the burden to the child is high, the parents' views on resuscitation should be supported. There should be a consistent and coordinated approach from the obstetric and neonatal teams in applying these guidelines and in communicating with the parents in developing an agreed-upon management plan when possible. Once resuscitation is initiated it may be appropriate to subsequently decide to discontinue cardiorespiratory support and offer comfort care.

Discontinuation of Resuscitation

Consensus on Science

Available evidence, albeit from relatively small numbers of babies, suggests that babies born without a heart rate that has not returned by 10 minutes of age are likely to either die or have severe neurologic disability (LOE 4[155,156]). It is not known whether there was significant selection bias in many of these studies, nor indeed that the babies included in these studies did receive "good-quality resuscitation." One study with a large contemporary cohort of infants (some randomized to postresuscitation hypothermia) indicates that in babies born without a detectable heart rate, the lack of ROSC after 10 minutes of age is associated with survival without severe neurologic deficit in a small number of the survivors (LOE 4[157]). Data are not available regarding the number of infants who were deemed too sick for study entry or who died before enrollment. These factors may have resulted in a significant overestimation of the rate of intact survival among infants with an Apgar score of 0 at 10 minutes. In all reported series the cause of the asphyxia and the efficacy of the resuscitation process were not elucidated.

The evidence from 7 LOE 5 studies[157,158] is insufficient to support or refute any recommendation regarding how much time should elapse with a heart rate of $<$60 but $>$0 beats per minute before discontinuing resuscitative efforts.

Treatment Recommendation

In a newly born baby with no detectable heart rate which remains undetectable for 10 minutes, it is appropriate to then consider stopping resuscitation. The decision to continue resuscitation efforts when the infant has a heart rate of 0 for longer than 10 minutes is often complex and may be influenced by issues such as the presumed etiology of the arrest, gestation of the baby, potential reversibility of the situation, and the parents' previously expressed feelings about acceptable risk of morbidity.

The evidence of outcome when the heart rate is $<$60 beats per minute at birth and persists after 10 or 15 minutes of continuous and adequate resuscitative efforts at delivery is insufficient to guide decisions as to whether to withhold or to continue resuscitation.

Personnel Needs at Elective Cesarean Sections[NRP-010A, NRP-010B, NRP-010C]

Consensus on Science

Retrospective studies show that delivery by cesarean section at term under regional anesthesia is associated with a small increase in risk of receiving assisted ventilation during neonatal resuscitation compared with unassisted vaginal birth. The number needed to treat equals 35 (LOE 4[159,160]). Five retrospective studies showed that delivery by cesarean section at term under regional anesthesia did not increase the risk of requirement for intubation during neonatal resuscitation compared with unassisted vaginal birth (LOE 4[161,162]). There is no evidence addressing this question in babies born at 34 to 36 weeks' gestation.

Treatment Recommendations

When an infant without antenatally identified risk factors is delivered at term by cesarean section under regional anesthesia, a provider capable of performing assisted ventilation should be present at the delivery. It is not necessary for a provider skilled in neonatal intubation to be present at that delivery.

EDUCATIONAL TECHNIQUES FOR TEACHING, ASSESSING, AND MAINTAINING RESUSCITATION KNOWLEDGE AND SKILLS

Simulation[NRP-032A, NRP-032B, NRP-032C, EIT-019A, EIT-019B]

Consensus on Science

There is a lack of uniformity in the definition of simulation as a learning methodology, determination of relevant outcomes, and use of appropriate measurement tools. Use of simulation as an adjunct to traditional education methodologies may enhance performance of healthcare professionals in actual clinical settings (LOE 1[163]; LOE 3[164]) and simulated resuscitations (LOE 1[165]; LOE 2[166]). Some studies did not show any difference in performance between standard training and simulation training in a clinical setting (LOE 1[167]) or using other means of evaluation (LOE 1[168]). No studies were found that revealed simulation-based training produced inferior results compared with traditional methodologies.

Treatment Recommendations

Simulation should be used as a methodology in resuscitation education. The most effective interventions and evaluation methodologies remain to be defined.

Briefings and Debriefings[NRP-033A, NRP-033B, EIT-001A, EIT-001B]

Consensus on Science

Evidence from 1 prospective randomized controlled study (LOE 1[169]) and 17 other studies (LOE 3 to 4) of briefings and debriefings document improvement in the acquisition of content knowledge, technical skills, or behavioral skills required for effective and safe resuscitation. Only a single study (LOE 4[170]) revealed no effect of briefing/debriefing on performance, and no studies indicated that the use of briefings and debriefings had any negative effects.

Treatment Recommendations

It is reasonable to recommend the use of briefings and debriefings during learning activities while caring for simulated patients and during clinical activities.

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DISCLOSURES

CoSTR Part 11: Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Ownership Interest	Consultant/Advisory Board	Other
Jeffrey M. Perlman	Weill Cornell Medical College—Professor of Pediatrics	†NIH funding- Co-Investigator—Improving antimicrobial prescribing practices in the NICU	None	*University of Miami, and Cook County Chicago	None	None	None
Jonathan Wyllie	South Tees Foundation NHS Trust Health Service Provider NHS UK Consultant Neonatologist and Clinical Director of Neonatology	None	None	None	None	*Volunteer ICC Newborn Life Support ERC Volunteer author European Newborn Life Support Guidelines Volunteer author UK Newborn Resuscitation Guidelines Volunteer co-author Advanced Paediatric Life support Guidelines Volunteer member Advanced Life Support Group UK. Volunteer acting chair Newborn Life Support Working Group for RC(UK) Volunteer British Association of Perinatal Medicine Neonatal Services and staffing working group	None
John Kattwinkel	University of Virginia—Professor of Pediatrics	*American Academy of Pediatrics research grant to study resuscitators detection of compliance while administering positive pressure ventilation by resuscitation bag	None	None	None	None	*Curley vs Gordon et al, Boston, MA (still active)
Dianne L. Atkins	University of Iowa; Prof. †I am a compensated worksheet editor for AHA 2010 Guidelines process. The compensation is divided: 2/3 to my institution and 1/3 directly to me. The amount paid to my institution does not alter my salary	None	None	None	None	None	None
Leon Chameides	Emeritus Director, Pediatric Cardiology; Clinical Professor, University of Connecticut	None	None	None	None	None	None
Jay P. Goldsmith	Pediatrix Medical Group: Single specialty multi-site group practice—Neonatologist	None	None	None	None	None	None
Ruth Guinsburg	Federal University of Saõ Paulo—Full Professor of Pediatrics	None	None	None	None	None	None
Mary Fran Hazinski	Vanderbilt University School of Nursing—Professor; AHA ECC Product Development—Senior Science Editor †the significant AHA compensation is designed to provide protected time for editing and writing responsibilities. I have a significant relationship with the AHA to support the mission of the AHA with the production of CoSTR and AHA Guidelines for CPR and ECC	None	None	None	None	None	None
Colin Morley	Retired Professor of Neonatal Medicine	None	None	Honoraria *Japanese Neonatal Society *Neonatal Ventilation and Resuscitation- Zagreb, Croatia *UK Middlesborough Neonatal Symposium	None	*Drager Medical about equip design *Education video on neonatal CPAP	None
Sam Richmond	UK National Health Service—Consultant Neonatologist	None	None	None	None	None	None
Wendy M. Simon	American Academy of Pediatrics—Director of Life Support Programs	None	None	None	None	None	None
Nalini Singhal	University of Calgary—Professor	*AAP grant looking at effect of PEEP with and with oxygen on resuscitation. Developing a International program for resuscitation, Helping Babies Breath	None	None	None	None	None
Edgardo Szyld	Fundasamin, Foundation for Womens̃ and Infant Health—Executive Director of a non profit institution (NGO)	None	None	None	None	None	None

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CoSTR Part 11: Writing Group Disclosures, *Continued*

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Ownership Interest	Consultant/Advisory Board	Other
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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.

CoSTR Part 11: Worksheet Collaborator Disclosures

Worksheet Collaborator	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
Khalid Aziz	University of Alberta—Associate Professor	None	None	None	None	None	None
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Steven Byrne	South Tees Hospital Foundation NHS Trust: National Health Service Trust	None	None	None	None	None	None
Peter Davis	The Royal Women's Hospital, Melbourne, Australia—Staff Neonatologist	None	None	None	None	None	None
William A. Engle	Indiana University School of Medicine Professor of Pediatrics	None	None	None	None	None	None
Marilyn Escobedo	University of Oklahoma—Professor of Pediatrics	None	None	None	None	None	None
Maria Fernanda de Almeida	Federal University of Saõ Paulo: Full time work (40 h/week) at Neonatal Division—Department of Pediatrics—Assoc. Prof; Brazilian Pediatric Society: Voluntary work at Brazilian Neonatal Resuscitation Program–NRP Steering Committee—Co-chair	None	None	None	None	None	None
David Field	University of Leicester: Higher educational institution—UK Government funded—Professor of Neonatal Medicine	None	None	None	None	None	None
Judith Finn	University of Western Australia—Professor	†Multiple National Health and Medical Research Grants (NH & MRC), National Heart Foundation Australia and State Government grants of >$10 000 since 1999. A—No money came to me—all came to my University to employ research staff and meet research expenses. No grants were directly related to any topic on which I am undertaking a Worksheet and none involved the trialing of a commercial product	None	*Less than $1000 from the Japanese Resuscitation Council to speak at their JRC Conference in Osaka in 2009	None	None	None

(*Continued*)

CoSTR Part 11: Worksheet Collaborator Disclosures, *Continued*

Worksheet Collaborator	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
Louis P. Halamek	Stanford University—Associate Professor	†Source: Laerdal Foundation I was the Principal Investigator on 3 year grant (2006–2009) funded by the Laerdal Foundation in the amount of $450 000 USD that was given to the simulation center I direct, the Center for Advanced Pediatric and Perinatal Education at Packard Children's Hospital at Stanford. This grant ended 2009-07-31. This grant was not a source of support for my salary	None	None	None	*I provide consultation services regarding simulation product design and function to Laerdal Medical, Inc., and Advanced Medical Simulation, Inc.	*I provide medicolegal consultation services to trial attorneys in the U.S., advising on questions relating to neonatal intensive care
Jane E. McGowan	St Christopher's Pediatric Associates: Practice Group for Children's Hospital—part of Tenet Healthcare—Attending Neonatologist	None	None	*Received honorarium for giving at talk for the March of Dimes on "NRP and the Preterm Infant"	None	None	None
Douglas D. McMillan	Dalhousie University and Academic Pediatrics Incorporated: University and Department of Pediatrics Financial group—Professor and Head, Division of Neonatal Perinatal medicine	None	None	†Medical Legal consulting fees for different hospitals and the Canadian Medical Protective Association (occasionally for the plaintiff)—presently "remitted" to Academic Pediatrics Incorporated *Consulting fees for program reviews related to newborn care and associated education programs—presently "remitted" to Academic Pediatrics Incorp.	None	*Consulting fees for program reviews related to newborn care and associated education programs—presently "remitted" to Academic Pediatrics Incorporated	*Medical Legal consulting fees for different hospitals and the Canadian Medical Protective Association (occasionally for the plaintiff)—presently "remitted" to Academic Pediatrics Incorporated
Lindsay Mildenhall	Counties Manukau District Health Board Auckland New Zealand: Public Health Care Provider—Consultant Neonatologist	None	None	None	None	None	None
Rintaro Mori	Osaka Medical Center and Research Institute for Maternal and Child Health: a public children's hosp. run by a local government—Division Director of Strategic Planning & Collaboration	None	None	None	None	None	None
Susan Niermeyer	University of Colorado Denver School of Medicine: professor, clinical neonatologist—Professor of Pediatrics	†Editorship, Helping Babies Breathe, American Academy of Pediatrics 2008–2009 Salary support through contract with University of Colorado Denver School of Medicine	None	None	None	None	None
Colm O'Donnell	The National Maternity Hospital, Holles Street, Dublin 2, Ireland—Consultant Neonatologist; Our Lady's Children's Hospital, Crumlin, Dublin 12, Ireland—Consultant Neonatologist; University College Dublin, Ireland: University medical school—Clinical Lecturer	None	None	*I have received honoraria from Chiesi Pharma (makers of Curosurf) for speaking at 2 educational courses and 3 scientific meetings (ie. on 5 occasions) in the last 2 years. The combined total of these honoraria is less than 1000 euros	None	None	None
Yacov Rabi	Alberta Health Services: Provide employment income for my role as a neonatologist—Physician; University of Calgary: Provides income for my role as an Assistant Professor of Medicine	None	*Supply of modified Neopuff circuits for a randomized control trial by Fisher Paykell	None	None	None	None
Steven A. Ringer	Brigham and Women's Hospital: Non-profit Hospital—Chief, Newborn Medicine	None	None	*Vermont Oxford Neonatal Network Annual Meeting	None	*Alere Healthcare Advisory Board Consulting on Clinical Care guidelines. Nothing relevant to topics with which I am involved	†Expert Witness in medical legal proceedings (Malpractice cases). A number of different attorneys/ insurance companies Money comes directly to me. Nothing relevant to questions under consideration
Jasmeet Soar	North Bristol NHS Trust: Government Hospital in UK—Consultant in Anesthetics & Intensive Care Medicine	None	None	None	None	None	None

(*Continued*)

CoSTR Part 11: Worksheet Collaborator Disclosures, *Continued*

Worksheet Collaborator	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Ownership Interest	Consultant/Advisory Board	Other
Benjamin J. Stenson	United Kingdom Public Health Service-Consultant Neonatologist	None	None	None	None	None	None
Enrique Udaeta	Medica Sur Lomas: Private Maternity Hospital—Director Department of Neonatology	None	None	None	None	None	None
Dharmapuri Vidyasagar	University of Illinois Professor emeritus Progfessor emeritus	None	None	None	None	None	None
Michael Watkinson	NHS Heart of England Foundation Trust, Birmingham, UK This is an NHS hospital in England Consultant neonatologist	None	None	None	None	None	None
Gary M. Weiner	St. Joseph Mercy Hospital—Attending Neonatologist	None	†Received equipment on-loan (3 resuscitation mannequins, 2 sets of video recording equipment) from Laerdal Medical Corporation to be used to complete a research project evaluating educational methods for teaching neonatal resuscitation. The value of the on-loan equipment is approximately $35 000	None	None	None	None
Myra H. Wyckoff	UT Southwestern Medical Center at Dallas—Associate Professor of Pediatrics	†PI, American Academy of Pediatrics. Neonatal Resuscitation Program. The ergonomics of neonatal cardiac compressions. $71 030 January 2008–2009 The funding comes to the institution *Co-Investigator (Mentor), American Academy of Pediatrics Neonatal Resuscitation Program Young Investigator Grant. Effectiveness of Plastic Head Coverings for Hypothermia Prevention in Preterm Newborns. January 2009–January 2010, $10 000 The funding comes to the institution	None	Feb 5, 2009 Pediatric Grand Rounds. University of Oklahoma Health Sciences Center. OKC, OK	None	None	None

This table represents the relationships of worksheet collaborators members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all worksheet collaborators 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

CoSTR Part 11: Worksheet Appendix

Task Force	WS ID	PICO Title	Short Title	Authors	URL
EIT	EIT-001A	For resuscitation teams (P), do briefings/debriefings (I), when compared to no briefings/debriefings (C), improve performance or outcomes (O)? (INTERVENTION)	Debriefing of CPR performance	Dana P. Edelson, Trevor Yuen	http://circ.ahajournals.org/site/c2010/eit-001a.pdf
EIT	EIT-001B	For resuscitation teams (P), do briefings/debriefings (I), when compared to no briefings/debriefings (C), improve performance or outcomes (O)? (INTERVENTION)	Debriefing of CPR performance	Jasmeet Soar	http://circ.ahajournals.org/site/c2010/eit-001b.pdf

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CoSTR Part 11: Worksheet Appendix, *Continued*

Task Force	WS ID	PICO Title	Short Title	Authors	URL
EIT	EIT-019A	In participants undergoing BLS/ALS courses (P), does the inclusion of more realistic techniques (eg. high fidelity manikins, in-situ training) (I), as opposed to standard training (eg. low fidelity, education centre) (C), improve outcomes (eg. skills performance on manikins, skills performance in real arrests, willingness to perform etc.) (O)?	High fidelity training	Jordan Duval-Arnould, Elizabeth A. Hunt	http://circ.ahajournals.org/site/c2010/eit-019a.pdf
EIT	EIT-019B	In participants undergoing BLS/ALS courses (P), does the inclusion of more realistic techniques (eg. high fidelity manikins, in-situ training) (I), as opposed to standard training (eg. low fidelity, education centre) (C), improve outcomes (eg. skills performance on manikins, skills performance in real arrests, willingness to perform etc.) (O)?	High fidelity training	Judith Finn	http://circ.ahajournals.org/site/c2010/eit-019b.pdf
NRP	NRP-001A	For neonates requiring resuscitation (P), is any adjunct measure (eg. CO_2 detection, pulse oximeter) as effective as the usual clinical findings (eg. heart rate, chest movement) effective to improve outcome (O)?	Adjuncts: CO_2 detection, pulse oximeter	John Kattwinkel	http://circ.ahajournals.org/site/c2010/nrp-001a.pdf
NRP	NRP-001B	For neonates requiring resuscitation (P), is any adjunct measure (eg. CO_2 detection, pulse oximeter) as effective as the usual clinical findings (eg. heart rate, chest movement) effective to improve outcome (O)?	Adjuncts: CO_2 detection, pulse oximeter	Yacov Rabi	http://circ.ahajournals.org/site/c2010/nrp-001b.pdf
NRP	NRP-002A	In the neonates infant (preterm and term) receiving respiratory support (P), does the use of CPAP(I) versus no-CPAP or IPPV(C) improve outcome—specify (O)?	CPAP and IPPV	Colm O'Donnell	http://circ.ahajournals.org/site/c2010/nrp-002a.pdf
NRP	NRP-002B	In the neonates infant (preterm and term) receiving respiratory support (P), does the use of CPAP(I) versus no-CPAP or IPPV(C) improve outcome—specify (O)?	CPAP and IPPV	Douglas D. McMillan	http://circ.ahajournals.org/site/c2010/nrp-002b.pdf
NRP	NRP-003A	In neonates receiving respiratory support (P) does the use of face mask interface (I) versus CPAP, NPCPAP, NC (C) (excluding intubation improve outcome) (O)?	Face mask interface vs CPAP etc	Colin Morley	http://circ.ahajournals.org/site/c2010/nrp-003a.pdf
NRP	NRP-003B	In neonates receiving respiratory support (P) does the use of face mask interface (I) versus CPAP, NPCPAP, NC (C) (excluding intubation) improve outcome (O)?	Face mask interface vs CPAP etc	Yacov Rabi	http://circ.ahajournals.org/site/c2010/nrp-003b.pdf
NRP	NRP-004A	In neonates receiving resuscitation (P) does the use of mouth-to-mouth, mouth-to-mask, mouth tube to mask (I) as compared to a self-inflating bag (C) give equivalent outcomes (stable spontaneous breathing) (O), when devices for delivering PPV are not available?	Self-inflating bag vs mouth techniques	Nalini Singhal	http://circ.ahajournals.org/site/c2010/nrp-004a.pdf
NRP	NRP-004B	In neonates receiving resuscitation (P) does the use of mouth-to-mouth, mouth-to-mask, mouth tube to mask (I) as compared to a self-inflating bag (C) give equivalent outcomes (stable spontaneous breathing) (O), when devices for delivering PPV are not available?	Self-inflating bag vs mouth techniques	Maria Fernanda de Almeida	http://circ.ahajournals.org/site/c2010/nrp-004b.pdf
NRP	NRP-005A	In neonates receiving positive pressure ventilation (P) does the use of gas volume monitoring (I) versus clinical assessment with or without pressure monitoring (C) improve clinical outcome (O)?	Ventilation volume monitoring	Steven A. Ringer	http://circ.ahajournals.org/site/c2010/nrp-005a.pdf
NRP	NRP-005B	In neonates receiving positive pressure ventilation (P) does the use of gas volume monitoring (I) versus clinical assessment with or without pressure monitoring (C) improve clinical outcome (O)?	Ventilation volume monitoring	Khalid Aziz	http://circ.ahajournals.org/site/c2010/nrp-005b.pdf
NRP	NRP-005C	In neonates receiving positive pressure ventilation (P) does the use of gas volume monitoring (I) versus clinical assessment with or without pressure monitoring (C) improve clinical outcome (O)?	Ventilation volume monitoring	Jane E. McGowan	http://circ.ahajournals.org/site/c2010/nrp-005c.pdf
NRP	NRP-006A	In neonates receiving chest compressions (P) do other ratios (5:1, 15:2) (I) versus a 3:1 (C) improve outcomes (O)?	Compression ventilation ratio	Lindsay Mildenhall	http://circ.ahajournals.org/site/c2010/nrp-006a.pdf
NRP	NRP-006B	In neonates receiving chest compressions (P) do other ratios (5:1, 15:2) (I) versus a 3:1 (C) improve outcomes (O)?	Compression ventilation ratio	Myra H. Wyckoff	http://circ.ahajournals.org/site/c2010/nrp-006b.pdf

(*Continued*)

CoSTR Part 11: Worksheet Appendix, *Continued*

Task Force	WS ID	PICO Title	Short Title	Authors	URL
NRP	NRP-007A	In neonates (P) receiving chest compressions does the two thumb (I) versus two finger (C) method of administration improve outcome (O)?	Two thumb vs two finger	Lindsay Mildenhall	http://circ.ahajournals.org/site/c2010/nrp-007a.pdf
NRP	NRP-007B	In neonates (P) receiving chest compressions does the two thumb (I) versus two finger (C) method of administration improve outcome (O)?	Two thumb vs two finger	Myra H. Wyckoff	http://circ.ahajournals.org/site/c2010/nrp-007b.pdf
NRP	NRP-008A	Among neonates (≤28 days) with a HR <60 bpm despite adequate ventilation and chest compressions, does the IV route compared with the ET route of epinephrine administration: 1. Increase heart rate >100 bpm faster, 2. Increase ROSC, or 3. Increase survival to discharge?	IV vs ET epinephrine	Jonathan Wyllie	http://circ.ahajournals.org/site/c2010/nrp-008a.pdf
NRP	NRP-008B	Among neonates (≤28 days) with a HR <60 bpm despite adequate ventilation and chest compressions, does the IV route compared with the ET route of epinephrine administration: 1. Increase heart rate >100 bpm faster, 2. Increase ROSC, or 3. Increase survival to discharge?	IV vs ET epinephrine	Gary M. Weiner	http://circ.ahajournals.org/site/c2010/nrp-008b.pdf
NRP	NRP-009A	Among neonates (≤28 days) with HR <60 bpm does HDE (IV >0.03 mg/kg or ET >0.1 mg/kg) compared with SDE: 1. Increase HR >100 bpm faster 2. Increase ROSC, or 3. Increase survival to discharge?	Epinephrine dose	Jonathan Wyllie	http://circ.ahajournals.org/site/c2010/nrp-009a.pdf
NRP	NRP-009B	Among neonates (≤28 days) with HR <60 bpm does HDE (IV >0.03 mg/kg or ET >0.1 mg/kg) compared with SDE: 1. Increase HR >100 bpm faster 2. Increase ROSC, or 3. Increase survival to discharge?	Epinephrine dose	Gary M. Weiner	http://circ.ahajournals.org/site/c2010/nrp-009b.pdf
NRP	NRP-010A	For infants delivered at ≥34 weeks gestation (P), is delivery by elective c-section under regional anesthesia (I) in comparison with unassisted vertex vaginal deliveries (C) associated with an increased risk of requirement for intubation during resuscitation (O)?	Prenatal prediction of respiratory compromise	Marilyn B. Escobedo	http://circ.ahajournals.org/site/c2010/nrp-010a.pdf
NRP	NRP-010B	For infants delivered at ≥34 weeks gestation (P), is delivery by elective c-section under regional anesthesia (I) in comparison with unassisted vertex vaginal deliveries (C) associated with an increased risk of requirement for intubation during resuscitation (O)?	Prenatal prediction of respiratory compromise	Benjamin J. Stenson	http://circ.ahajournals.org/site/c2010/nrp-010b.pdf
NRP	NRP-010C	For infants delivered at ≥34 weeks gestation (P), is delivery by elective c-section under regional anesthesia (I) in comparison with unassisted vertex vaginal deliveries (C) associated with an increased risk of requirement for intubation during resuscitation (O)?	Prenatal prediction of respiratory compromise	Dianne L. Atkins, Edgardo Szyld	http://circ.ahajournals.org/site/c2010/nrp-010c.pdf
NRP	NRP-011A	In depressed neonates with clear amniotic fluid (P) does suctioning of the mouth and nose (I) versus none (C) improve outcome (O).	Clear amniotic fluid	Sithembiso Velaphi, Dharmapuri Vidyasagar	http://circ.ahajournals.org/site/c2010/nrp-011a.pdf
NRP	NRP-012A	In depressed neonates born through meconium stained amniotic fluid (P), does endotracheal suctioning (I) versus no suctioning (C) improve outcome (O)?	Stained amniotic fluid	Sithembiso Velaphi, Dharmapuri Vidyasagar	http://circ.ahajournals.org/site/c2010/nrp-012a.pdf
NRP	NRP-013A	When resuscitating or stabilizing newborns at birth (P), is there an oxygen administration strategy (I) that is superior to any other (C) in improving outcome (O)?	Oxygen administration	Jay Goldsmith	http://circ.ahajournals.org/site/c2010/nrp-013a.pdf
NRP	NRP-013B	When resuscitating or stabilizing newborns at birth (P), is there an oxygen administration strategy (I) that is superior to any other (C) in improving outcome (O)?	Oxygen administration	Sam Richmond	http://circ.ahajournals.org/site/c2010/nrp-013b.pdf
NRP	NRP-014A	In neonates receiving resuscitation or stabilization (P), is the saturation demonstrated during normal birth (I) preferable to some other target (C), when considering outcome for premature and term neonates (O)?	Oxygen saturation target	John Kattwinkel	http://circ.ahajournals.org/site/c2010/nrp-014a.pdf
NRP	NRP-014B	In neonates receiving resuscitation or stabilization (P), is the saturation demonstrated during normal birth (I) preferable to some other target (C), when considering outcome for premature and term neonates (O)?	Oxygen saturation target	Colin Morley	http://circ.ahajournals.org/site/c2010/nrp-014b.pdf

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Task Force	WS ID	PICO Title	Short Title	Authors	URL
NRP	NRP-015A	In neonates (P) receiving positive pressure during resuscitation, is positive pressure ventilation by T-piece resuscitator (I) superior to bag ventilation (C) for improving outcome—specify (O)?	T-piece resuscitator	David Boyle	http://circ.ahajournals.org/site/c2010/nrp-015a.pdf
NRP	NRP-015B	In neonates (P) receiving positive pressure during resuscitation, is positive pressure ventilation by T-piece resuscitator (I) superior to bag ventilation (C) for improving outcome—specify (O)?	T-piece resuscitator	Benjamin J. Stenson	http://circ.ahajournals.org/site/c2010/nrp-015b.pdf
NRP	NRP-015C	In neonates(P) receiving positive pressure during resuscitation, is positive pressure ventilation by T-piece resuscitator (I) superior to bag ventilation (C) for improving outcome—specify (O)?	T-piece resuscitator	David Field	http://circ.ahajournals.org/site/c2010/nrp-015c.pdf
NRP	NRP-016A	For neonates (P) following attempted endotracheal intubation, is CO_2 detection (I) superior to clinical assessment (C) for confirming endotracheal location (O)?	CO_2 detection	Jonathan Wyllie	http://circ.ahajournals.org/site/c2010/nrp-016a.pdf
NRP	NRP-017A	For neonates requiring positive pressure ventilation (P), is LMA (I) an effective alternative to mask or endotracheal ventilation (C) for improving outcome (O)? (achieving stable vital signs and reducing the need for subsequent endotracheal intubation)?	LMA	Gary M. Weiner	http://circ.ahajournals.org/site/c2010/nrp-017a.pdf
NRP	NRP-017B	For neonates requiring positive pressure ventilation (P), is LMA (I) an effective alternative to mask or endotracheal ventilation (C) for improving outcome (O)? (achieving stable vital signs and reducing the need for subsequent endotracheal intubation)?	LMA	Enrique Udaeta	http://circ.ahajournals.org/site/c2010/nrp-017b.pdf
NRP	NRP-018A	For non intubated bradycardic neonates (P) requiring positive pressure ventilation, is the CO_2 monitoring device (I) more effective than chest rise, color (C) for assessing adequate ventilation (O)?	Bradycardia and CO_2 monitoring	Colm O'Donnell	http://circ.ahajournals.org/site/c2010/nrp-018a.pdf
NRP	NRP-018B	For non intubated bradycardic neonates (P) requiring positive pressure ventilation, is the CO_2 monitoring device (I) more effective than chest rise, color (C) for assessing adequate ventilation (O)?	Bradycardia and CO_2 monitoring	Masanori Tamura	http://circ.ahajournals.org/site/c2010/nrp-018b.pdf
NRP	NRP-018C	For non intubated bradycardic neonates (P) requiring positive pressure ventilation, is the CO_2 monitoring device (I) more effective than chest rise, color (C) for assessing adequate ventilation (O)?	Bradycardia and CO_2 monitoring	Steven A. Ringer	http://circ.ahajournals.org/site/c2010/nrp-018c.pdf
NRP	NRP-019A	In neonates requiring resuscitation, (P) will the early use of supplemental glucose (I) during and/or following delivery room resuscitation, versus none (C) improve outcome (i.e. avoidance of hypoglycemia, reduced long-term neurologic morbidity) (O)?	Supplemental glucose	Jane E. McGowan	http://circ.ahajournals.org/site/c2010/nrp-019a.pdf
NRP	NRP-019B	In neonates requiring resuscitation, (P) will the early use of supplemental glucose (I) during and/or following delivery room resuscitation, versus none (C) improve outcome (i.e. avoidance of hypoglycemia, reduced long-term neurologic morbidity) (O)?	Supplemental glucose	Jeffrey Perlman	http://circ.ahajournals.org/site/c2010/nrp-019b.pdf
NRP	NRP-020A	In neonates requiring resuscitation, does the administration of emergency medications (P) by intraosseous infusion (I) versus the intravenous route improve outcome (O)?	IO vs IV	William A. Engle	http://circ.ahajournals.org/site/c2010/nrp-020a.pdf
NRP	NRP-021A	In neonates requiring resuscitation and not responding to CPR (P), does the administration of sodium bicarbonate (I) versus no bicarbonate (C) improve outcome (O)?	Sodium bicarbonate	Jeffrey Perlman	http://circ.ahajournals.org/site/c2010/nrp-021a.pdf
NRP	NRP-021B	In neonates requiring resuscitation and not responding to CPR (P), does the administration of sodium bicarbonate (I) versus no bicarbonate (C) improve outcome (O)?	Sodium bicarbonate	Dianne L. Atkins, Sam Richmond	http://circ.ahajournals.org/site/c2010/nrp-021b.pdf
NRP	NRP-022A	In apneic neonates suspected of narcotic depression (P), does naloxone (I) when compared to effective ventilation without naloxone (C) improve outcome (O)?	Nalaxone	Ruth Guinsburg	http://circ.ahajournals.org/site/c2010/nrp-022a.pdf
NRP	NRP-022B	In apneic neonates suspected of narcotic depression (P), does naloxone (I) when compared to effective ventilation without naloxone (C) improve outcome (O)?	Nalaxone	Myra H. Wyckoff	http://circ.ahajournals.org/site/c2010/nrp-022b.pdf

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CoSTR Part 11: Worksheet Appendix, *Continued*

Task Force	WS ID	PICO Title	Short Title	Authors	URL
NRP	NRP-023A	In preterm neonates under radiant warmers (P), does increased room temperature, thermal mattress, or other intervention (I) as compared to plastic wraps alone (C) improve outcome (O)?	Warming adjuncts	Marilyn B. Escobedo, Michael Watkinson	http://circ.ahajournals.org/site/c2010/nrp-023a.pdf
NRP	NRP-024A	In term neonates at risk for hypoxic-ischemic encephalopathy secondary to intra-partum hypoxia (P) does selective/whole body cooling (I) versus standard therapy (C), result in improved outcome (O)?	Hypothermia (induced)	Jeffrey Perlman	http://circ.ahajournals.org/site/c2010/nrp-024a.pdf
NRP	NRP-024B	In term neonates at risk for hypoxic-ischemic encephalopathy secondary to intra-partum hypoxia (P) does selective/whole body cooling (I) versus standard therapy (C), result in improved outcome (O)?	Hypothermia (induced)	Peter Davis	http://circ.ahajournals.org/site/c2010/nrp-024b.pdf
NRP	NRP-025A	In term neonates without a detectable heart rate and no other signs of life (P) is ten minutes (I) as opposed to 15 minutes or longer (C) of effective resuscitation a reliable measure of outcome (abnormal neurologic examination and/or death) (O)?	Duration of CPR with asystole and outcome	Steve Byrne	http://circ.ahajournals.org/site/c2010/nrp-025a.pdf
NRP	NRP-025B	In term neonates without a detectable heart rate and no other signs of life (P) is ten minutes (I) as opposed to 15 minutes or longer (C) of effective resuscitation a reliable measure of outcome (abnormal neurologic examination and/or death) (O)?	Duration of CPR with asystole and outcome	Jay Goldsmith	http://circ.ahajournals.org/site/c2010/nrp-025b.pdf
NRP	NRP-025C	In term neonates without a detectable heart rate and no other signs of life (P) is ten minutes (I) as opposed to 15 minutes or longer (C) of effective resuscitation a reliable measure of outcome (abnormal neurologic examination and/or death) (O)?	Duration of CPR with asystole and outcome	Ruth Guinsburg	http://circ.ahajournals.org/site/c2010/nrp-025c.pdf
NRP	NRP-026A	In term neonates with a heart rate <60 and no other signs of life (P), is ten minutes (I) as opposed to 15 minutes or longer (C) of effective resuscitation a reliable measure of outcome (abnormal neurologic examination and/or death) (O)?	Duration of CPR with bradycardia and outcome	Steve Byrne	http://circ.ahajournals.org/site/c2010/nrp-026a.pdf
NRP	NRP-026B	In term neonates with a heart rate <60 and no other signs of life (P), is ten minutes (I) as opposed to 15 minutes or longer (C) of effective resuscitation a reliable measure of outcome (abnormal neurologic examination and/or death) (O)?	Duration of CPR with bradycardia and outcome	Jay Goldsmith	http://circ.ahajournals.org/site/c2010/nrp-026b.pdf
NRP	NRP-026C	In term neonates with a heart rate <60 and no other signs of life (P), is ten minutes (I) as opposed to 15 minutes or longer (C) of effective resuscitation a reliable measure of outcome (abnormal neurologic examination and/or death) (O)?	Duration of CPR with bradycardia and outcome	Ruth Guinsburg	http://circ.ahajournals.org/site/c2010/nrp-026c.pdf
NRP	NRP-027A	In neonates at the limits of viability or anomalies associated with lethal outcomes (P) does the non initiation (I) versus initiation (C) of resuscitation result in an outcome that is ethically justified (O).	Futile resuscitation rules	Steve Byrne	http://circ.ahajournals.org/site/c2010/nrp-027a.pdf
NRP	NRP-027B	In neonates at the limits of viability or anomalies associated with lethal outcomes (P) does the non initiation (I) versus initiation (C) of resuscitation result in an outcome that is ethically justified (O).	Futile resuscitation rules	Jay Goldsmith	http://circ.ahajournals.org/site/c2010/nrp-027b.pdf
NRP	NRP-028A	In depressed neonates requiring positive pressure ventilation (P) does the administration of longer inspiratory times, higher inflation pressures, use of PEEP (I) as compared to standard management (C) improve outcome (O)?	Ventilation times and pressures	David Boyle	http://circ.ahajournals.org/site/c2010/nrp-028a.pdf
NRP	NRP-028B	In depressed neonates requiring positive pressure ventilation (P) does the administration of longer inspiratory times, higher inflation pressures, use of PEEP (I) as compared to standard management (C) improve outcome (O)?	Ventilation times and pressures	Benjamin J. Stenson	http://circ.ahajournals.org/site/c2010/nrp-028b.pdf
NRP	NRP-029A	In neonates requiring resuscitation and unresponsive to chest compressions/epinephrine (P) does the administration of volume (I) versus no volume (C) improve outcome (O).	Volume resuscitation with CPR	Susan Niermeyer	http://circ.ahajournals.org/site/c2010/nrp-029a.pdf
NRP	NRP-029B	In neonates requiring resuscitation and unresponsive to chest compressions/epinephrine (P) does the administration of volume (I) versus no volume (C) improve outcome (O).	Volume resuscitation with CPR	Douglas D. McMillan	http://circ.ahajournals.org/site/c2010/nrp-029b.pdf

(*Continued*)

CoSTR Part 11: Worksheet Appendix, *Continued*

Task Force	WS ID	PICO Title	Short Title	Authors	URL
NRP	NRP-029C	In neonates requiring resuscitation and unresponsive to chest compressions/epinephrine (P) does the administration of volume (I) versus no volume (C) improve outcome (O).	Volume resuscitation with CPR	Masanori Tamura	http://circ.ahajournals.org/site/c2010/nrp-029c.pdf
NRP	NRP-030A	In neonates (P), does delayed cord clamping cord or milking of the cord (I) versus standard management (C), improve outcome (O).	Umbilical cord clamping and milking	Susan Niermeyer	http://circ.ahajournals.org/site/c2010/nrp-030a.pdf
NRP	NRP-030B	In neonates (P), does delayed cord clamping cord or milking of the cord (I) versus standard management (C), improve outcome (O).	Umbilical cord clamping and milking	Dianne L. Atkins, Nalini Singhal	http://circ.ahajournals.org/site/c2010/nrp-030b.pdf
NRP	NRP-030C	In neonates (P), does delayed cord clamping cord or milking of the cord (I) versus standard management (C), improve outcome (O) (milking of the cord).	Umbilical cord clamping and milking	Gary M. Weiner	http://circ.ahajournals.org/site/c2010/nrp-030c.pdf
NRP	NRP-030D	In neonates (P), does delayed cord clamping cord or milking of the cord (I) versus standard management (C), improve outcome (O)?	Umbilical cord clamping and milking	Rintaro Mori	http://circ.ahajournals.org/site/c2010/nrp-030d.pdf
NRP	NRP-031A	In neonates born to febrile mothers (P) does intervention to normalize temperature (I), compared to standard care (C) improve outcome (O)?	Maternal fever	Jeffrey Perlman	http://circ.ahajournals.org/site/c2010/nrp-031a.pdf
NRP	NRP-031B	In neonates born to febrile mothers (P) does intervention to normalize temperature (I), compared to standard care (C) improve outcome (O).	Maternal fever	Steven A. Ringer	http://circ.ahajournals.org/site/c2010/nrp-031b.pdf
NRP	NRP-032A	In participants undergoing resuscitation courses (P), does the inclusion of more realistic techniques (eg. high fidelity manikins, in-situ training) (I), as opposed to standard training (eg. low fidelity, education centre) (C), improve outcomes (eg. skills performance) (O).	Impact of realistic training on skills performance	Jane E. McGowan	http://circ.ahajournals.org/site/c2010/nrp-032a.pdf
NRP	NRP-032B	In participants undergoing resuscitation courses (P), does the inclusion of more realistic techniques (eg. high fidelity manikins, in-situ training) (I), as opposed to standard training (eg. low fidelity, education centre) (C), improve outcomes (eg. skills performance) (O).	Impact of realistic training on skills performance	Louis P. Halamek	http://circ.ahajournals.org/site/c2010/nrp-032b.pdf
NRP	NRP-032C	In participants undergoing resuscitation courses (P), does the inclusion of more realistic techniques (eg. high fidelity manikins, in-situ training) (I), as opposed to standard training (eg. low fidelity, education centre) (C), improve outcomes (eg. skills performance) (O).	Impact of realistic training on skills performance	Khalid Aziz	http://circ.ahajournals.org/site/c2010/nrp-032c.pdf
NRP	NRP-033A	For hospital resuscitation teams (P), do team briefings/debriefings (I), when compared to no briefings/debriefings (C), improve team performance (O)? (INTERVENTION)	Impact of debriefing on team performance	Dianne L. Atkins, Nalini Singhal	http://circ.ahajournals.org/site/c2010/nrp-033a.pdf
NRP	NRP-033B	For hospital resuscitation teams (P), do team briefings/debriefings (I), when compared to no briefings/debriefings (C), improve team performance (O)? (INTERVENTION)	Impact of debriefing on team performance	Louis P. Halamek	http://circ.ahajournals.org/site/c2010/nrp-033b.pdf

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