PROGENY
VOL XXVII, NO 1 April 2011

Neonatal Resuscitation: New Guidelines

In October 2010, the American Academy of Pediatrics published the revised guidelines for neonatal resuscitation in an article entitled, "Special Report Neonatal Resuscitation: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care." These guidelines apply primarily to newly born infants undergoing transition from intrauterine to extrauterine life, but they are also applicable to newborns who have completed perinatal transition and require resuscitation during the first few weeks to months following birth. The term *newly born* refers to an infant at the time of birth. About 10% of all newborns require some assistance to begin breathing at birth. So, in Iowa every year about 4,000 newly born infants require some degree of resuscitation. In this issue of Progeny we will summarize the revised guidelines and highlight the changes coming in the Neonatal Resuscitation Program.

ANTICIPATION OF NEED FOR RESUSCITATION

At every delivery there should be at least one person whose primary responsibility is the newborn. They must be capable of initiating resuscitation, including administration of positive pressure ventilation and chest compressions. That person or someone else who is "promptly available" should have the skills required for a complete resuscitation, including intubation, umbilical line placement and administration of medications. Newly born infants that do not need resuscitation can be quickly identified by answering these three questions: Term gestation? Crying or Breathing? Good muscle tone? If the answer to all three is 'yes' the baby does not need resuscitation. He should be dried, placed skin-to-skin with his mother, covered with dry linen and observed for breathing, activity and color improvement. If the answer to any of these questions is 'no' caregivers should begin the action steps of the NRP flow diagram in sequence. The steps include the following interventions: initial steps, ventilation, chest compressions and administration of Epinephrine and/or volume expansion. The action steps are outlined in Figure 1, *Newborn Resuscitation Algorithm*.[1]

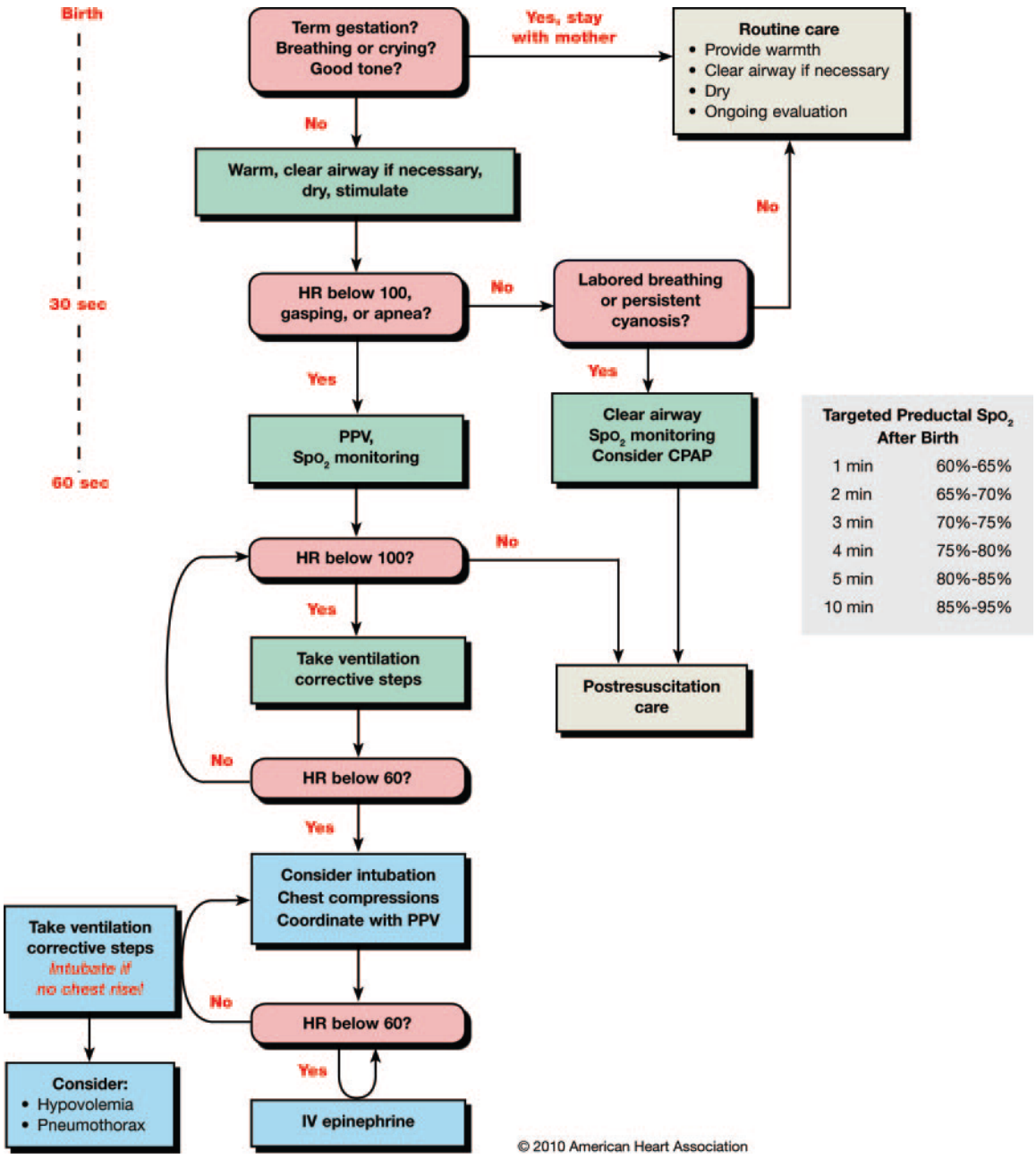

Figure 1: Newborn Resuscitation Algorithm[1]

INITIAL STEPS

The guidelines refer to the "Golden Minute" as the first 60 seconds allotted for completing the initial steps, evaluating respirations and heart rate and beginning ventilation if needed. The initial steps of resuscitation include the following interventions: provide warmth by placing the baby on a radiant warmer, position his head in the "sniffing" position, clear the airway if necessary with a bulb syringe or suction catheter, dry the baby and stimulate breathing. The current recommendations for temperature control in the delivery room include additional warming techniques for VLBW (<1500g) infants. For these infants it is recommended to pre-warm the delivery room to 26° C (78.8°F).[2] The baby should be covered in medical grade, heat-resistant plastic or polyethylene bag during resuscitation.[3,4] The baby can be placed on an exothermic mattress. However, it is necessary to monitor temperatures closely when these techniques are used in combination as there is an increased risk for iatrogenic hyperthermia.[5] Hyperthermia, an axillary or rectal temperature >37.5°C (99.5°F) should be avoided with all newly born infants, especially those at risk for hypoxic ischemic encephalopathy. The practice of routine suctioning of the oropharynx and nasopharynx after birth has recently come under scrutiny. Suctioning the nasopharynx during resuscitation can cause bradycardia, however suctioning when secretions are present can lower resistance to respiration. The revised guidelines for newborns with clear amniotic fluid recommend that suctioning immediately following birth (including suctioning with a bulb syringe) be reserved for infants who have an obvious obstruction to spontaneous breathing or who require positive pressure ventilation.[1] The guidelines for managing newborns with meconium-stained amniotic fluid have not changed. Endotracheal suctioning prior to ventilation is still recommended for *non-vigorous* babies when meconium is present. However, if intubation is prolonged and unsuccessful bag-mask ventilation should be considered.

PULSE OXIMETRY

Studies have shown that clinical assessment of skin color (cyanosis or lack of cyanosis) in uncompromised babies following birth is a poor indicator of the state of oxygenation. Pulse oximetry during resuscitation using probes designed for neonates is becoming the standard for assessing oxygenation. A pulse oximeter detects a pulse and displays the oxygen saturation as a percentage (SpO2). Pulse oximetry is recommended when resuscitation can be anticipated, when positive pressure ventilation is administered for more than a few breaths, when cyanosis is persistent or when supplementary oxygen is administered. The oximeter probe should be placed on the baby's right hand or wrist. Attach the probe to the baby first, and then plug it into the monitor. It takes approximately 1-2 minutes for the probe to acquire a signal and provide a reliable SpO_2. The oxygen saturation is generally accurate when the displayed heart rate matches the apical pulse. Extraneous light can disrupt the signal, so it may be helpful to cover the probe.

ADMINISTRATION OF SUPPLEMENTAL OXYGEN

Hypoxia and ischemia caused by insufficient oxygen before or after birth are known to be harmful to multiple organs. But, more recently experimental evidence suggests that too much oxygen delivered newborns after birth may also be harmful. Several systematic reviews and meta-analyses of trials comparing neonatal resuscitations initiated with room air versus 100% oxygen showed increased survival when resuscitation was initiated with room air.[6,7] One study in preterm infants showed that initiating resuscitation with a blend of oxygen and air resulted in

less hypoxemia and hyperoxemia than when resuscitation was started with room air or 100% oxygen.[8] They concluded that resuscitation can be safely initiated for extremely low gestation infants with a low concentration of oxygen ~30%. Then the FiO_2 should be adjusted according to the baby's need using pulse oximetry. There have been no studies with term infants comparing outcomes when resuscitation was initiated with different concentrations of oxygen. The new guidelines recommend *initiating resuscitation with air or blended oxygen*. The oxygen concentration can be titrated using pulse oximetry to achieve a pre-ductal SpO_2 in the target range as indicated in Figure 1. If blended oxygen is not available, start the resuscitation with air. If the baby is bradycardic (heart rate <60 bpm) after 90 seconds of resuscitation with air or a blended concentration of oxygen, the oxygen concentration should be increased to 100% until recovery of a normal heart rate.

VENTILATION

Simultaneous assessment of heart rate, respirations and the state of oxygenation should occur once administration of supplemental oxygen or positive pressure ventilation is begun. After the initial steps of resuscitation positive pressure ventilation (PPV) is indicated if the newborn remains apneic or gasping, the heart rate is <100 bpm, or the oxygen saturation remains below the target levels despite the use of supplemental oxygen. PPV can be initiated in most situations using a resuscitation bag and mask. Ventilation should be delivered at a rate of 40-60 breaths per minute to promptly achieve or maintain a heart rate of 100 bpm. An initial inflation pressure of 20 cm H_2O may be effective, but some term babies without spontaneous respiration may require $\geq$30 to 40 cm H_2O. Inflation pressures should be monitored. With effective ventilation you should see "perceptible chest expansion." The primary measure of adequate ventilation is an increase in heart rate. If the heart rate fails to rise with initial bag-mask ventilation, resuscitators should attempt to correct ventilation using the following action sequence: **M**ask adjustment, **R**eposition airway, **S**uction mouth and nose, **O**pen mouth, **P**ressure increase, **A**lternate airway (endotracheal intubation or laryngeal mask insertion). If the baby requires positive pressure ventilation for longer than several minutes, consider placing an oral gastric tube. Leave the cap open to vent air entering the stomach during ventilation.

T-piece Resuscitation Device: These devices can be used to deliver effective ventilation to newborns. With the T-piece resuscitator you can achieve target inflation pressures and longer inspiratory times more consistently than with resuscitation bags. However, these devices are not sensitive to changes in lung compliance as ventilation continues. Inflation pressures will likely need to change as compliance improves. The inspiratory time should be monitored closely by the person delivering ventilation.

Continuous Positive Airway Pressure (CPAP): Studies have shown there is some benefit to early CPAP in the delivery for spontaneously breathing preterm infants with respiratory distress.[9] Many experts recommend giving continuous positive airway pressure to infants who are breathing with difficulty after birth. According to the guidelines, "there is no evidence to support or refute the use of continuous positive airway pressure in the delivery room in the term baby with respiratory distress." However, if the baby has labored breathing or persistent cyanosis and his heart rate is greater than 100 bpm, practitioners may consider using CPAP. (See Figure 1).

Laryngeal Mask Airway (LMA): The laryngeal mask airway is considered to be effective in ventilating newborns weighing more than 2000g or ≥34 weeks gestation. LMA insertion during resuscitation should be considered if facemask ventilation is unsuccessful and endotracheal intubation is unsuccessful or not feasible. It is a soft, elliptical mask with an inflatable rim attached to an airway tube. The airway tube has a standard 15mm connector that fits on the end-tidal CO_2 detector then onto a resuscitation bag, T-piece resuscitator or ventilator. The mask is inserted with the hard part of the airway tube against the hard palate, until resistance is met. When the cuff is inflated with 2-4ml of air the device will seat itself over the laryngeal opening and ventilation can begin. A size 1 LMA is appropriate for newborns weighing up to 5Kg. These devices have not been evaluated in cases of meconium-stained fluid, during chest compressions or for administration of intratracheal medications.

Endotracheal Intubation: The timing of endotracheal intubation depends on the skill and experience of the resuscitator. Those not skilled in intubating newborns should call for help early and focus on providing positive pressure ventilation with a mask or LMA rather than spending valuable time trying to intubate. Endotracheal intubation may be indicated: for initial endotracheal suctioning of non-vigorous meconium-stained newborns; if bag-mask ventilation is ineffective or prolonged; when chest compressions are performed; or for special circumstances, such as congenital diaphragmatic hernia or extremely low birth weight. The best indicator of positive endotracheal intubation is prompt increase in the baby's heart rate. If ventilation continues beyond a few minutes, the endotracheal tube should be secured to the newborn's face using the Tip-to-Lip measurement: 6 + weight in Kg = cm marking at lip.

End-Tidal CO_2 Detection: The new guidelines state that, "Exhaled CO_2 detection is the recommended method of confirmation of endotracheal tube placement." This statement has implications for all perinatal hospitals. An end-tidal CO_2 detector should be used with every neonatal intubation attempt. After several positive pressure breaths, the disposable colorimetric device changes color from purple to yellow when CO_2 is detected. This indicates positive endotracheal intubation. If the device does not change color, no CO_2 has been detected which strongly suggests that the tube is in the esophagus. A false-negative result is possible in situations where cardiac output is low and pulmonary blood flow is absent or poor. This can potentially lead to unnecessary extubation and reintubation. Resuscitators should take note of other clinical indicators of positive endotracheal intubation: condensation in the endotracheal tube, chest movement and the presence of breath sounds bilaterally.

CHEST COMPRESSIONS

If the newborn's heart rate remains <60 bpm despite adequate ventilation with supplementary oxygen for 30 seconds, chest compressions should be started. Chest compressions are recommended to be performed using the 2 thumb-encircling hands technique. With this method resuscitators can achieve a higher peak systolic pressure and a higher coronary perfusion pressure. Compressions should be coordinated with ventilation, 3 compressions to 1 breath. It is helpful for the compressor to verbally coordinate compressions with the person performing ventilation (one and two and three and breathe...). It may be necessary to switch to the 2-finger technique for performing chest compressions during umbilical line placement.

However, it is possible to perform the 2 thumb-encircling hands technique from the head of the bed. Chest compressions should be continued until the heart rate is ≥60 bpm.

ADMINISTRATION OF MEDICATIONS AND/OR VOLUME EXPANSION

Adequate ventilation is the most important step in restoring a normal heart rate during resuscitation. However, administration of Epinephrine and/or volume expansion may be indicated if the newborn's heart rate remains <60 bpm despite adequate ventilation and chest compressions. "Epinephrine is recommended to be administered intravenously." The recommended dose for intravenous Epinephrine is 0.1-0.3 ml/Kg using a 1:10,000 concentration. There is no supportive data for endotracheal Epinephrine so the IV route should be used as soon as venous access is established. To expedite venous access, the equipment for placing an umbilical venous catheter can be bundled in a large zip lock bag. It is acceptable to administer a higher dose of Epinephrine through the endotracheal tube while venous access is being obtained. The endotracheal dose of 1:10,000 Epinephrine is 0.5-1.0 ml/Kg. If there is know blood loss or you suspect blood loss based on the physical appearance of the newborn (pale skin, poor perfusion, weak pulse) volume expansion should be considered. Administering volume may also be indicated if the baby's heart rate does not respond to other resuscitative measures. An isotonic crystalloid such as normal saline or blood is recommended for volume expansion in the delivery room. The initial recommended dose is 10 ml/Kg which may be repeated.

WHAT'S NOT IN THE ALGORITHM?

Naloxone (Narcan), a narcotic antagonist, is no longer recommended to be administered in the delivery room. In the depressed newborn the focus should be on providing adequate ventilation to restore normal respiration and heart rate. Administration of Narcan may be considered in post-resuscitation care. Other medications that are not recommended to be administered in the delivery room include buffers (sodium bicarbonate) and vasopressors.

INDUCED THERAPEUTIC HYPOTHERMIA

Induced therapeutic hypothermia for newborns ≥36 weeks gestation with moderate to severe hypoxic ischemic encephalopathy has been shown to significantly lower the rates of mortality and neurodevelopmental disability at 18-month follow-up.[10,11,12] Therefore, "It is recommended that infants born at ≥36 weeks gestation with evolving moderate to severe hypoxic ischemic encephalopathy should be offered therapeutic hypothermia." +++ Treatment should be initiated within 6 hours of birth using an established study protocol in a facility that is capable of managing the adverse effects of cooling. This standard has implications for all perinatal hospitals. Practitioners in Level I and Level II centers must be able to recognize potential cooling candidates and facilitate prompt transfer to the tertiary center.

GUIDELINES FOR WITHHOLDING AND DISCONTINUING RESUSCITATION

It is reasonable to consider withholding resuscitation for newborns with conditions associated with high mortality and poor outcome, especially when the parents are in agreement. According to the guidelines, resuscitation is not indicated in cases of extreme prematurity (gestational age <23 weeks or birth weight <400g). Resuscitation is nearly always indicated for babies ≥25 weeks and those with most congenital malformations. If the prognosis is uncertain, the morbidity rate is high and the anticipated burden to the child is high, parental

desires regarding resuscitation should be supported. Non-initiation of resuscitation and discontinuing treatment during and after resuscitation are considered to be ethically equivalent. In cases where functional survival is highly unlikely practitioners should not hesitate to withdraw support.[13] If a newly born baby has no detectable heart rate after 10 minutes of resuscitative effort it is appropriate to consider stopping resuscitation. "The decision to continue resuscitation efforts beyond 10 minutes with no heart rate should take into consideration the presumed etiology of the arrest, the gestation of the baby, the presence or absence of complications, the potential role of therapeutic hypothermia, and the parents' previously expressed feelings about acceptable risk of morbidity."[1]

REFERENCES

1. Kattwinkel J, Perlman JM, Aziz K, Colby C, Fairchild K, Gallagher J, Hazinski MF, Halamek LP, Kumar P, Little G, McGowan JE, Nightengale B, Ramirez MM, Ringer S, Simon WM, Weiner GM, Wyckoff M, Zaichkin J. Part 15: neonatal resuscitation: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation.* 2010;122:S909-S919.
2. Kent AL, Williams J. Increasing ambient operating theatre temperature and wrapping in polyethylene improves admission temperature in premature infants. *J Paediatr Child Health*. 2008;44:325-331
3. Vohra S, Frent G, Campbell V, Abbott M, Whyte R. Effect of polyethylene occlusive skin wrapping on Heat loss in very low birth weight infants at delivery: a randomized trial. *J Pediatr.* 1999;134:547-551
4. Vohra S, Roberts RS, Zhang B, Janes M, Schmidt B. Heat Loss Prevention (HeLP) in the delivery room: a randomized controlled trial of polyethylene occlusive skin wrapping in very preterm infants. *J Pediatr*. 2004;145:750-753
5. Singh A, Duckett J, Newton T, Watkinson M. Improving neonatal unit admission temperatures in preterm babies; exothermic mattresses, polyethylene bags or a traditional approach? *J Perinatol*. 2010;30:45-49
6. Davis PG, Tan A, O'Donnell CP, Schulze A. Resuscitation of newborn infants with 100% oxygen or air: a systematic review and meta-analysis. *Lancet*. 2004;364:1329-1333
7. Rabi Y, Rabi D, Yee W. Room air resuscitation of the depressed newborn: a systematic review and meta-analysis. *Resuscitation*. 2007;72:353-363
8. Escrig R, Arruza L, Izquierdo I, Villar G, Saenz P, Gimeno A, Moro M, Vento M. Achievement of targeted saturation values in extremely low gestational age neonates resuscitated with low or high oxygen concentrations: a prospective, randomized trial. *Pediatrics.* 2008;121:875-881
9. Morley CJ, Davis PG, Doyle LW, Brion LP, Hascoet JM, Carlin JB. Nasal CPAP or intubation at birth for very preterm infants. *N Engl J Med*. 2008;358:700-708
10. Gluckman PD, Wyatt JS, Azzopardi D, Ballard R, Edwards AD, Ferriero DM, Polin RA, Robertson CM, Thorensen M, Whitelaw A, Gunn AJ. Selective head cooling with mild systemic hypothermia after neonatal encephalopathy: multicentre randomized trial. *Lancet*. 2005;365:663-670

11.Shankaran S, Laptook AR, Ehrenkranz RA, Tyson JE, McDonald SA, Donovan EF, Fanaroff AA, Poole WK, Wright LL, Higgins RD, Finer NN, Carlo WA, Duara S, Oh W, Cotten CM, Stevenson DK, Stoll BJ, Lemons JA, Guillet R, Jobe AH. Whole-body hypothermia for neonates with hypoxic-ischemic encephalopathy. *N Engl J Med*. 2005;353:1574-1584
12. Azzopardi DV, Strohm B, Edwards AD, Dyet L, Halliday HL, Juszczak E, Kapellou O, Levene M, Marlow N, Porter E, Thorensen M, Whitelaw A, Brocklehurst P. Moderate hypothermia to treat perinatal asphyxial encephalopathy. *N Engl J Med*. 2009;361:1349-1358
13. Paris JJ. What standards apply to resuscitation at the borderline of gestational age? *J Perinatol*. 2005;25:683-684

SEND QUESTIONS OR COMMENTS TO:
Penny Smith, RNC-NIC, BSN
Neonatal Nurse Specialist
Iowa Statewide Perinatal Care Program
Department of Pediatrics
200 Hawkins Drive, Iowa City, Iowa 52242-1083.
Call (319) 356-2637 or Email: penny-smith@uiowa.edu