Care of the Newborn Infant in the Delivery Room

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The vast majority of births in this country entail a smooth transition for newborn infants as they adjust to their extrauterine environment. Ten percent of infants born in the United States, however, require some form of assistance to make this transition. It is for this reason that it is essential there be at least one individual, and ideally a team of individuals, in the delivery room who is capable of initiating newborn resuscitation and whose primary responsibility is the care of the newborn. Having an understanding of the physiology of the neonatal transition period and training on the skills required in infant resuscitation is critical for health care workers involved in the care of the newborn infant in the delivery room.

Physiology of the Neonatal Transition Period

Inside the womb, a newborn infant is entirely dependent on his mother for the nutrients and oxygen to sustain his growth and development during the fetal period. He receives nutrient and oxygen-rich blood from the placenta through the umbilical vein and the two umbilical arteries carry the waste products and carbon dioxide from the fetus back through the placenta to the mother's circulation to be eliminated. Since the mother's body and the placenta do the work for the fetal liver and lungs, blood is shunted away from these organs through the ductus venosus, foramen ovale, and ductus arteriosus.

At birth, as the infant takes his first and then subsequent breaths, a cascade of events occurs resulting in the transition from the fetal to postnatal circulation. As the infant replaces the fluid that has filled his lungs in utero with oxygen-rich air, the expansion of his lungs and subsequent increased oxygen tension leads to a dramatic fall in pulmonary vascular resistance which in turn, results in a marked increase in blood flow from the right ventricle into the pulmonary vasculature. The rising oxygen tension, coupled with the cessation of the maternal supply of prostaglandins with the clamping of the umbilical cord, leads to vasoconstriction of the ductus venosus and ductus arteriosus. The clamping of the umbilical cord also contributes to a marked decrease in pressure in the inferior vena cava and right side of the heart, which leads to a functional closure of the foramen ovale as it snaps shut with the development of the new pressure differential between the left and right atria. If an infant is apneic at birth or if anything interferes with the effectiveness of those first breaths (meconium aspiration, surfactant deficiency, etc…), the infant does not make this transition successfully and is at risk for the development of hypoxia, severe acidosis, and possibly death.

Preparation for the Support and Resuscitation of the Newborn Infant

Preparation for the delivery and possible resuscitation of a newborn infant is twofold. The first step involves the preparation of the delivery room, which includes ensuring that the essential equipment is present and working, as well as familiarizing the staff with the location and proper use of the equipment. A list of the recommended equipment for neonatal resuscitation is provided in Table 1.

The second step involves a review of the prenatal and labor records in an effort to determine risk factors for neonatal depression requiring resuscitation. The prenatal records should provide information on any abnormalities detected on ultrasound or prenatal testing, the estimated gestational age of the infant, and any pregnancy complications. Abnormalities that can be detected by ultrasound and prenatal testing that would increase an infant's risk for needing resuscitation at birth include congenital defects such as heart defects, diaphragmatic hernia, gastroschisis/omphalocele, neural tube defects, and oligohydramnios (associated with pulmonary hypoplasia). The gestational age of the infant is important both for predicting the need for resuscitation, as well as for estimating the infant's weight so that the appropriately-sized resuscitative equipment can be obtained. The degree of prematurity can also predict an infant's need for respiratory support in the delivery room. Fetal lung maturity usually occurs around 34-35 weeks and infants born prior to this time often require some form of respiratory support in the delivery room. Mothers who develop premature labor are often given a course of steroids, which can speed up fetal lung maturation and decrease the infant's need for respiratory support. Pregnancy complications that can increase an infant's risk for neonatal depression requiring resuscitation include maternal diabetes, infection, eclampsia, and placental abruption.

Labor records should be reviewed both to identify signs of fetal distress and to note the administration of any drugs to the mother that may potentially depress the infant's respiratory effort. Signs of fetal distress during the labor process include sustained bradycardia, variable decelerations of the fetal heart rate with associated fetal bradycardia, and late decelerations with decreased beat-to-beat heart rate variability. The presence of meconium-stained fluid should also be noted since the infant may need additional resuscitative measures at birth (see **Resuscitation of Infants with Meconium-Stained Amniotic Fluid**). Drugs often used during labor that have the potential for causing neonatal respiratory depression include magnesium sulfate and opioid medications.

Assessment of the Need for Resuscitation

Once the infant has been delivered, a quick survey should be performed to determine the need for resuscitative measures. This should include an observation of how vigorous the infant is (crying with good muscle tone vs. quiet and floppy), an assessment of how effective the infant's respiratory effort is, and a quick measurement of the infant's heart rate (usually done by palpating the umbilical pulse with a desirable heart rate being above 100 beats/minute).

The Apgar Score is a scoring system devised by Dr. Virginia Apgar to be a rapid method of assessing an infant in the minutes following birth. Scores are typically assigned to an infant at 1 and 5 minutes after birth and for infants requiring extended resuscitation, every 5 minutes after that time until the score is greater than 7. Guidelines from both the American Academy of Pediatrics and the Neonatal Resuscitation Program (NRP) state that the Apgar score should not be used to determine the need for resuscitation and that resuscitative efforts should not be delayed until the 1 minute Apgar is assigned. See Table 2 for a description of the Apgar scoring system.

Overview of Neonatal Resuscitation

Once an infant is born, resuscitative efforts should proceed according to the stepwise approach outlined by the American Heart Association (AHA) and the American Academy of Pediatrics (AAP) Neonatal Resuscitation Program. Term infants (37 weeks or older) who are vigorous with good muscle tone and respiratory effort should be dried and placed skin-to-skin with the mother when possible. Early skin-to-skin contact improves the infant's temperature regulation and helps facilitate early breastfeeding. Suctioning of the mouth and nose should be reserved for those infants with evidence of airway obstruction or needing resuscitation. When suctioning is deemed necessary, the mouth should be suctioned first so the infant does not aspirate secretions if he gasps with the suctioning of the nose.

Any infant who is not vigorous should be immediately placed on a radiant warmer, dried, and briefly suctioned. Prolonged suctioning of an infant can cause a vagal-induced bradycardia and/or damage to the oral mucosa and should be avoided. Usually the process of drying and suctioning stimulates the infant to breath, but the infant who has not responded may be stimulated by flicking the sole of his foot or rubbing his back. The infant's heart rate, respirations, and color should be assessed. This initial assessment period should last no longer than 30 seconds. Infants who are observed to have good respiratory effort and color and a heart rate >100 beats per minute can be given routine care. Infants who are cyanotic with good respiratory effort and heart rate should be given supplemental air/oxygen (see recommendations for the **Use of Supplemental Oxygen**). Infants who are apneic, have a heart rate <100 beats per minute, or are persistently cyanotic despite supplemental oxygen should be provided positive-pressure ventilation. It is important to check for effective ventilation by watching for chest rise and auscultating for breath sounds. If inadequate ventilation is suspected, corrective steps should be taken including suctioning the oropharynx, increasing the pressure used to deliver breaths, and attempting endotracheal intubation. Other indications for endotracheal intubation include the presence of meconium in a depressed infant, the desire to enhance the coordination of ventilation and chest compressions, the need for surfactant administration, and the case of congenital diaphragmatic hernia. The size and depth of insertion of the endotracheal tube can be estimated based on weight (see Table 3).

If an infant's heart rate remains <60 beats per minute after at least 30 seconds of effective ventilation, chest compressions should be initiated while ventilation continues. The chest should be compressed to a depth of ½ inch by placing the thumbs on the infant's midsternum while the palms extend behind the infant's back. The ratio of chest compressions to ventilations should be 3:1 with 90 compressions and 30 ventilations per minute. If the heart rate does not increase above 60 beats per minute despite 45-60 seconds of effective chest compressions, epinephrine (dose of 0.1mL/kg or 1:10,000 solution) should be administered, followed by another 30 second period of chest compressions and ventilation and then a reassessment of the heart rate. The epinephrine is ideally given via an intravenous route, but may be given through an endotracheal tube if no IV access has been obtained. The efficacy of endotracheal epinephrine, however, has not been proven and typically results in lower and unpredictable blood levels of the drug. Umbilical vein catheterization can be done fairly quickly by an individual skilled in this procedure and should be attempted if the infant is not responding to initial resuscitative efforts and the use of drugs is anticipated. Typically, a 3.5 French umbilical catheter is inserted in the umbilical vein just until the point where blood is easily withdrawn.

Volume expansion with an isotonic crystalloid solution such as normal saline or Ringer's lactate should be considered if an infant is not responding to resuscitative efforts and blood loss is known or suspected. The fluids are typically given at a dose of 10mL/kg and given over 5-10 minutes (slower for preterm infants due to the concern that large volumes may increase the risk for intraventricular hemorrhage). Naloxone is no longer recommended as part of the initial resuscitation efforts in the delivery room due to concern of precipitating acute withdrawal symptoms in an infant whose mother used narcotic drugs chronically during the pregnancy and because adequate support of ventilation should be sufficient resuscitation in infants depressed due to the effects of maternal narcotic analgesia during labor.

Use of Supplemental Oxygen

More recent AHA and AAP Neonatal Resuscitation Program guidelines discuss the need to avoid both hyperoxemia and hypoxemia in neonatal resuscitation. Hyperoxemia has been linked to more severe adverse outcomes following intrapartum asphyxia. As a result, pulse oximetry is recommended any time supplemental oxygen use is anticipated in a neonatal resuscitation and attention should be paid to maintaining a preductal oxygen saturation within the targeted range expected for the age of the infant. These targets take into account that a certain amount of right-to-left shunting is normal in the immediate postpartum period and so preductal oxygen saturations in the delivery room are lower than those expected for an infant a few hours later. See Table 4 for the targeted ranges for preductal oxygen saturation expected each minute after birth. The target range for oxygen saturation for term infants can usually be achieved by initiating resuscitation with air. Infants less than 32 weeks may need supplemental oxygen to achieve the goal range and in that case, the judicious use of blended oxygen and air is recommended.

Resuscitation of Infants with Meconium-Stained Amniotic Fluid

The management of a newborn with meconium-stained amniotic fluid is a special category of neonatal resuscitation that deserves its own separate discussion. It was previously recommended that every infant born with meconium-stained fluid be suctioned at the perineum after the delivery of the head and prior to the delivery of the body. Studies have since shown that this practice does not prevent or improve the course of meconium aspiration syndrome. Current recommendations state that infants born with meconium-stained fluid who are depressed (floppy, poor respiratory effort, low heart rate) should be immediately intubated and a meconium suction apparatus used to remove any meconium present beneath the vocal cords. Infants who are vigorous with good muscle tone and heart rate do not require tracheal intubation/suctioning and should be provided routine care as described in the preceding section.

Conclusion

In conclusion, it is important to have health care workers in the delivery room who are well trained in neonatal resuscitation in order to improve outcomes for the ten percent of newborns who require some form of assistance in the transition period after birth. Recent neonatal resuscitation guidelines encourage judicious use of suctioning, intravenous fluids, and supplemental oxygen and emphasize minimal intervention for vigorous infants and resuscitation for depressed infants that takes into account neonatal physiology and the potential harm of possible interventions.

References

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Table 1

Recommended Equipment for Neonatal Resuscitation
• Radiant warmer
• Oxygen source with warmer and humidifier
• Suction source with suction catheters
• Nasogastric tubes
• Meconium aspirators
• Bag-and-mask ventilation equipment
• Laryngoscopes and endotracheal tubes
• Stethoscope
• Intravenous fluids (10% dextrose, normal saline, Ringer's lactate)
• Drugs (epinephrine)
• Umbilical vessel catheterization equipment

Table 2

	0	1	2
A: Appearance	Blue or pale	Pink body with blue extremities	Completely pink
P: Pulse	Absent	Slow (<100 beats/min)	>100 beats/min
G: Grimace (reflex irritability)	No response	Grimace	Cry, active withdrawal
A: Activity (muscle tone)	Limp	Some flexion	Active movement
R: Respirations	Absent	Slow, irregular	Good, crying

The Apgar score is reported on a scale of 0-10 and is usually recorded at 1 and 5 minutes after birth.

Table 3

Weight (grams)	Endotracheal tube size (mm)	Depth of insertion from lip (cm)
<1000	2.5	6-7
1000-2000	3.0	7-8
2000-3000	3.5	8-9
>3000	3.5-4.0	9-10

Table 4

Time After Birth (Minutes)	Target Range for Preductal Oxygen Saturation
1	60-65%
2	65-70%
3	70-75%
4	75-80%
5	80-85%
10	85-95%