SUPPLEMENTAL LESSON

13

Resuscitation Outside the Delivery Room

What you will learn

- How to apply Neonatal Resuscitation Program® (NRP®) principles to newborns who require resuscitation outside the hospital setting
- How to apply NRP principles to babies who require resuscitation beyond the immediate newborn period
- How to apply NRP principles to babies who require resuscitation in the neonatal intensive care unit
- When to consider using Pediatric Advanced Life Support guidelines

Key Points

1. Although resuscitation outside the delivery room setting presents different challenges, the physiologic principles and basic steps of the Neonatal Resuscitation Program (NRP) Algorithm remain the same throughout the neonatal period.

2. Regardless of the location of birth, ventilation of the lungs is the initial priority for resuscitating the newborn.

3. Every location where newborns receive care, including each postpartum room, should have immediate access to a bulb syringe, a self-inflating bag, and appropriately sized face masks.

4. Ventilation of the lungs is the initial priority for resuscitating most babies during the neonatal period. Once adequate ventilation is ensured, obtain additional information about the baby's history to guide interventions.

5. Many babies who require resuscitation in the neonatal intensive care unit (NICU) have underlying lung disease and may require higher ventilating pressures than recommended in the delivery room. In babies with established severe bronchopulmonary dysplasia (BPD), longer inflation times may also be required to achieve adequate ventilation.

6. In general, where differences exist between the NRP and Pediatric Advanced Life Support (PALS) recommendations, you should apply the NRP recommendations during the immediate newborn period and the initial hospitalization following birth. If a newborn has cardiopulmonary arrest in the NICU during this period, the NRP recommends using a 3:1 compression-to-ventilation ratio unless there is a reason to suspect a non-respiratory etiology such as a primary cardiac arrhythmia or an electrolyte disturbance.

The *Textbook of Neonatal Resuscitation,* 8th edition, focuses on resuscitation of the newborn in a hospital delivery room. However, not all neonatal resuscitation takes place in the delivery room. In this lesson, you will learn about strategies for resuscitating newly born babies outside the delivery room setting, babies who require resuscitation in the mother's postpartum room after the immediate transition period, and babies in the hospital nursery or neonatal intensive care unit (NICU).

Case 1: Newborn resuscitation after a home birth

At 36 weeks' gestation, a multiparous woman awakens when her membranes rupture and she has rapid onset of frequent, intense contractions. The nearest hospital is more than a 30-minute drive away, and her partner calls 911. The emergency operator advises the partner to increase the temperature in the room by turning the thermostat to 74°F and obtain towels to warm and dry the baby after birth.

Paramedics are dispatched and arrive at the home just as the baby's head is crowning. They quickly assemble supplies and equipment from their emergency childbirth kit, including personal protective equipment, warm towels and blankets, a cotton hat, umbilical cord clamps and sterile scissors, a bulb syringe, a stethoscope, a handheld Doppler ultrasound, a small self-inflating bag and neonatal face mask, a portable oxygen source, a pulse oximeter, and a size 1 laryngeal mask.

The baby is born with poor tone and does not cry. One member of the paramedic team uses a warm towel to dry and stimulate the baby by rubbing the baby's back, but the baby does not improve. The umbilical cord is clamped and cut, and the baby is moved to a covered, flat surface. The paramedic puts a hat on the baby's head, places the baby's head in the sniffing position, and clears secretions by suctioning the baby's mouth and nose. The baby remains limp and apneic. The paramedic begins positive-pressure ventilation (PPV) with a self-inflating bag and mask, using 21% oxygen, as additional emergency responders arrive. An assistant uses a stethoscope to listen to the baby's heart rate and applies a pulse oximeter sensor on the baby's right hand. Two minutes after birth, the baby's heart rate is 80 beats per minute (bpm) and increasing, but there is no respiratory effort and the oxygen saturation is below the target range. An assistant connects the self-inflating bag to a portable oxygen source. Three minutes later, the newborn's heart rate is greater than 100 bpm and the oxygen saturation is within the target range, but the baby still has poor tone and irregular, grunting spontaneous respiratory effort. The paramedic inserts a size 1 laryngeal mask and continues PPV while monitoring the baby's heart rate and oxygen saturation. The baby is wrapped in a thermal blanket and prepared for safe transport to the nearest hospital emergency department for further evaluation and treatment.

Are resuscitation techniques different for babies born outside the hospital setting?

Although newborn resuscitation scenarios encountered outside the hospital setting present different challenges, the physiologic principles and basic steps remain the same. **Regardless of the location of birth, ventilation of the lungs is the initial priority for resuscitating the newly born baby.**

What are some strategies needed to resuscitate babies born outside the hospital?

Temperature management

When a baby is born outside the delivery room environment, maintaining the baby's axillary temperature between 36.5°C and 37.5°C may become a challenge because you may not have a radiant warmer. Some suggestions for minimizing heat loss include the following:

- Increase the room temperature to 74°F to 77°F by adjusting the room's heat source.
- Dry the baby thoroughly with bath towels, a blanket, or clean clothing.
- Use the mother's body as a heat source. Consider placing the baby skin-to-skin on the mother's chest and covering both baby and mother with a warm blanket. If the baby is preterm or the environment is cold, consider covering the baby with a clean sheet of food-grade plastic wrap and then covering the baby with a warm blanket.
- Emergency response teams should consider having polyethylene plastic wrap and portable thermal mattresses to help maintain temperature. It is important that the thermal mattress be stored and activated at room temperature. If the mattress is already warm (from being stored in a hot vehicle), it may reach a higher temperature than intended after activation and increase the risk of overheating the newborn or causing thermal injury.

Clearing secretions from the airway

If resuscitation is required outside a delivery room or nursery, vacuum suction may not be readily available. If secretions are obstructing the airway, or if you need to begin PPV, use a bulb syringe or wipe the mouth and nose with a clean handkerchief or other cloth wrapped around your index finger.

Positive-pressure ventilation

Ventilation of the baby's lungs is the single most important and effective step during neonatal resuscitation. Most babies breathe spontaneously after birth, and many of those who do not will begin spontaneous respirations after receiving stimulation. Drying the newborn and rubbing the back and extremities are acceptable methods of stimulation. Some babies born outside the hospital setting may require PPV to inflate their lungs. The NRP recommends that all personnel who may need to resuscitate a newborn outside the hospital environment carry an appropriately sized self-inflating bag-and-mask device and portable oxygen source in case PPV is needed. Similar to the method described in Lesson 4, if the baby's heart rate does not increase rapidly after starting PPV and the baby's chest is not moving, use the ventilation corrective steps (MR. SOPA) to improve the effectiveness of PPV.

Assessing heart rate

Initially, the baby's heart rate should be assessed by auscultating the chest with a stethoscope. Emergency responders who attend out-of-hospital births should also carry a pulse oximeter. An appropriately sized oximeter sensor and sensor cover should be used. If the newborn's heart rate cannot be auscultated and pulse oximetry is not functioning, a handheld Doppler ultrasound (used to auscultate fetal heart rate prior to birth) can be held against the baby's chest to assess the heart rate, or a portable cardiac monitor with appropriate chest leads may be used.

Oxygen management

For a term baby, begin PPV with 21% oxygen. A self-inflating bag that is not attached to an oxygen source will deliver 21% oxygen. For a baby less than 35 weeks' gestation, you may begin PPV with an oxygen concentration (FIO_2) between 21% and 30%. In an out-of-hospital environment, you may not have access to an oxygen blender and may only have access to 100% oxygen directly from a portable oxygen tank. If pulse oximetry is available and indicates that the oxygen saturation is below the target range, and your oxygen tank has a flowmeter that can be adjusted incrementally between 0 L/min (oxygen off) and 10 L/min, you may be able to deliver between 21% oxygen (room air) and 85% to 95% oxygen (5-10 L/min) by simply adjusting the oxygen flow into the PPV device.

If the newborn is breathing and has a heart rate greater than 100 bpm, but the oxygen saturation is below target range, you can give free-flow

oxygen through oxygen tubing or from the open reservoir (tail) of some self-inflating bags. Adjust the distance between the 100% oxygen flow and the baby's mouth and nose to maintain the oxygen saturation within the minute-specific target range.

Alternative airways

If an alternative airway is needed after an out-of-hospital birth of a baby who weighs at least 1.5 kg, this program suggests the use of a size 1 laryngeal mask, as described in Lesson 4. Endotracheal intubation is possible but may be more difficult and less successful for newborns in an out-of-hospital setting. Insertion of a laryngeal mask does not require additional instruments or visualization of the baby's vocal cords. Laryngeal masks can be inserted by appropriately trained providers with a high rate of first-attempt success, and have been shown to be an effective alternative to face-mask ventilation and endotracheal intubation. If the baby cannot be successfully ventilated with a face mask or if prolonged ventilation will be required during emergency medical transport to a hospital, a laryngeal mask may provide a successful airway.

Provide 30 seconds of PPV through the laryngeal mask, ensure that the chest is moving with PPV, and reassess the heart rate before beginning chest compressions. The laryngeal mask may improve the efficacy of PPV and increase the heart rate so that chest compressions are not necessary. Use the most accurate method available for assessing the baby's heart rate (such as a portable cardiac monitor or handheld Doppler ultrasound) to ensure appropriate decision-making and interventions.

Although laryngeal mask insertion is consistent with the general guidelines for nurse and respiratory therapist practice within hospitals, emergency response personnel should check with their state licensing board or regulatory agency regarding laryngeal mask insertion outside the hospital setting and their professional scope of practice.

Chest compressions

Chest compressions are indicated when the newborn's heart rate remains less than 60 bpm after at least 30 seconds of PPV that inflates the lungs, as evidenced by chest movement with ventilation, and preferably through an alternative airway. Regardless of the location of birth, this program recommends using a 3:1 compression-to-ventilation ratio with 120 events per minute (90 compressions + 30 ventilations). Chest compressions should be accompanied by coordinated ventilations using 100% oxygen, as described in Lesson 6.

Vascular access and medications

If the newborn's heart rate remains less than 60 bpm after 60 seconds of chest compressions and coordinated ventilations, epinephrine and possibly volume expansion are indicated, as described in Lesson 7. In this case, emergency vascular access is required. Emergency catheterization of the umbilical vein generally is not an option outside the hospital setting. In such cases, prompt insertion of an intraosseous needle into the flat surface of the tibia just below and medial to the tibial tuberosity (the bony bulge below the kneecap), as described in Lesson 7, is a reasonable alternative. Attempts at inserting a peripheral intravenous (IV) catheter are likely to be unsuccessful due to the baby's poor perfusion.

Emergency response personnel should check with their state licensing board or regulatory agency regarding emergency vascular access and medication administration outside the hospital setting and their professional scope of practice.

When should the newborn be transported to a medical facility for post-resuscitation care?

A newborn who requires PPV for more than 30 to 60 seconds should be transferred to a medical facility for close monitoring, post-resuscitation care, and evaluation.

In addition, any preterm newborn or newborn who has respiratory distress, persistent central cyanosis, poor tone, fever, hypothermia, difficulty feeding, or other signs of failing transition or illness should be immediately and safely transported to a medical facility.

What is the American Academy of Pediatrics position on planned home birth?

In 2020, the American Academy of Pediatrics (AAP) Committee on Fetus and Newborn published a Policy Statement, "Providing Care for Infants Born at Home."[1] The statement addressed resuscitation of the newborn after home birth, as well as initial care and follow-up. Both the AAP and the NRP believe that hospitals and accredited birth centers are the safest settings for birth in the United States because planned home births are associated with a twofold to threefold increase in perinatal mortality. Therefore, the AAP and NRP do not recommend planned home birth; however, the AAP and NRP recognize that women have the autonomy to choose the location of their baby's birth and some will choose a home birth. Women who

choose a planned home birth should be fully informed that in the event of an unanticipated emergency, it is unlikely that the personnel, supplies, and equipment necessary to perform a complex neonatal resuscitation will be immediately available in the home environment, and any delay may result in an adverse outcome for the newborn.

Case 2: Resuscitation in the postpartum unit

A baby was delivered at term in the hospital following an uncomplicated pregnancy and labor. The transitional period was uneventful, and the baby stayed with the mother to begin breastfeeding. During breastfeeding, when the baby was approximately 6 hours of age, the mother noticed that the baby was limp, not breathing, and unresponsive. She activated the nurse call button and shouted for help, and a nurse from the postpartum unit responded immediately. The nurse turned on the room light, opened the blanket, and found the baby limp and apneic. She placed the baby on a safe, flat surface, provided stimulation by rubbing the baby's back, placed the baby's head in the sniffing position, and cleared the airway with a bulb syringe. The baby did not improve after these maneuvers. To get additional help, the nurse pushed the CODE button on the wall and began PPV with the self-inflating bag and mask that was kept in the postpartum room.

The neonatal resuscitation team arrived in the room, received information from the first-responder nurse, and quickly assessed the situation. One team member used a stethoscope to listen to the baby's heart rate and breath sounds. Another team member placed a pulse oximeter sensor on the baby's right hand and portable cardiac monitor leads on the baby's chest. The baby's heart rate was 80 bpm and rising, but the respiratory effort was irregular and oxygen saturation was low. The FIO_2 was adjusted to achieve an oxygen saturation greater than 90%. The baby soon developed consistent respiratory effort, the heart rate increased above 100 bpm, and PPV was gradually weaned. The baby received supplemental oxygen through the open tail reservoir of the self-inflating bag and was transferred to the nursery in a pre-warmed incubator for additional evaluation and treatment. A team member stayed with the baby's mother to obtain additional information, provide support, and answer questions. Shortly afterward, the care team conducted a debriefing to evaluate its readiness, teamwork, and communication.

Sudden unexpected postnatal collapse

The baby in the scenario experienced sudden unexpected postnatal collapse (SUPC), which is a clinical entity characterized by a need for resuscitation with PPV in an apparently healthy term newborn during the first 12 hours after birth in the hospital, and is one reason that a neonate may require resuscitation beyond the immediate newborn period. The event commonly occurs during skin-to-skin contact with the mother or during a breastfeeding session. Many newborns are in a prone position at the time of the event. Many affected newborns will require intensive care and some die. The reported incidence of SUPC ranges from 3 to 74 cases per 100,000 live births.[2] The etiology of SUPC is unknown and is likely multifactorial. Most cases are unexplained.

Are resuscitation techniques different for babies beyond the immediate newborn period?

Throughout this program, you have learned about resuscitating babies in the delivery room immediately after birth. Some babies, however, require resuscitation after the immediate newborn period. Although resuscitation scenarios encountered outside the immediate newborn period present unique challenges, the physiologic principles and basic steps remain the same. **Ventilation of the lungs is the initial priority for resuscitating most babies during the neonatal period.** Once adequate ventilation is ensured, obtain additional information about the baby's history to guide interventions.

What are some strategies to resuscitate babies outside the immediate newborn period?

Temperature management

Maintaining normal body temperature is easier in babies outside the immediate newborn period because the baby's body is not wet, and the risk of evaporative heat loss is lower. However, thermoregulation is still essential. To prevent hypothermia, resuscitate under a radiant warmer if available, use a hat, and wrap the baby in warm blankets for transport.

Clearing secretions from the airway

If you suspect that secretions are obstructing the airway and vacuum suction is not readily available, use a bulb syringe or wipe the mouth and nose with a clean handkerchief or cloth wrapped around your index finger. Suction the mouth and nose with a bulb syringe before initiating PPV.

Ventilation

A self-inflating bag and mask should be immediately available in every postpartum room and requires no compressed air for use. Ensure an open airway by placing the baby's head and neck in the sniffing position. Using the same principles taught in Lesson 4, troubleshoot ineffective PPV by using the ventilation corrective steps (MR. SOPA).

Assessing heart rate

If you are alone when you discover a limp, apneic newborn outside the delivery room, PPV is the highest priority. A resuscitation team member who arrives to help will assess the baby's heart rate. Initially, the baby's heart rate should be assessed by auscultating the chest with a stethoscope. If not immediately available in the postpartum room, the emergency resuscitation team should bring a pulse oximeter and cardiac monitor. These monitors should be applied to the baby as soon as possible so the team members have accurate data to inform their decisions.

Alternative airways

If an alternative airway is needed because face-mask ventilation is ineffective, either a laryngeal mask or endotracheal tube can be used. The laryngeal mask, described in Lesson 4, may be preferable if the baby is being resuscitated in a location that makes positioning for intubation difficult.

Chest compressions

Because most sudden cardiorespiratory events in the newborn period have an underlying respiratory etiology, this program recommends using a 3:1 compression-to-ventilation ratio with 120 events per minute (90 compressions + 30 ventilations) for newborns that require chest compressions during the initial newborn hospitalization. This recommendation may be modified by health care providers that have a reason to suspect a primary cardiac etiology. Based on current guidelines, chest compressions should be accompanied by coordinated ventilations, preferably using an endotracheal tube or laryngeal mask, with 100% oxygen.

Vascular access and medications

If the baby's heart rate remains less than 60 bpm after 60 seconds of chest compressions and coordinated ventilations, epinephrine and possibly volume expansion are indicated, as described in Lesson 7. In this case, emergency vascular access is required. Emergency catheterization of the umbilical vein may be successful during the first week after birth. Beyond the first week, this is generally not an option. In such cases, prompt insertion of an intraosseous needle into the flat surface of the tibia just below and medial to the tibial tuberosity (the bony bulge below the kneecap), as described in Lesson 7, is a reasonable alternative for emergency vascular access. Attempts at inserting a peripheral IV catheter are likely to be unsuccessful due to the baby's poor perfusion.

If a baby is found unresponsive in a mother's room in the postpartum unit, should resuscitation be initiated in the mother's room or should the baby be carried to the nursery?

When faced with a compromised baby in a mother's room, the decision to "scoop and run" to the nursery may seem like a reasonable approach, but this is not the best choice for several reasons. It is not safe to run down a hallway carrying a compromised newborn in your arms. This puts you and the newborn at risk for injury from a fall or a collision with another person, equipment, or passageway door.

In general, every location where newborns receive care should have ready access to the equipment necessary to initiate resuscitation. If there is a designated resuscitation space that is only steps away from every postpartum room, it may be appropriate to carefully move the compromised newborn directly to this location for immediate care. In all cases, the correct solution prioritizes a timely and efficient response and best serves the interests of the newborn's health and safety.

- Each hospital should evaluate its readiness for resuscitating newborns in locations outside the delivery room.
- Anticipate this potential scenario and develop a plan for how an emergency call will be initiated, how the appropriate team will be assembled, what equipment will be stored in the room, and what equipment will be stored in a nearby location (eg, code cart in the hallway).
- By simulating unusual or uncommon scenarios in different locations, you can make plans to address your system's weaknesses and improve your teamwork.

Case 3: Resuscitation in the neonatal intensive care unit

A baby who was born at 24 weeks' gestational age is now 18 weeks old (42 weeks' postmenstrual age). The baby has been in the NICU since birth and has developed severe bronchopulmonary dysplasia (BPD) with tracheobronchomalacia and pulmonary hypertension. The baby has been intubated and receiving respiratory support with a ventilator since birth. The baby has frequent episodes of oxygen desaturation and bradycardia secondary to airway collapse and obstruction. The baby is receiving multiple medications and continuous tube feedings. One evening, a nurse responds to an alarm in the room and finds the baby cyanotic and apneic. The baby's oxygen saturation is 60% and the baby's heart rate is 50 beats per minute (sinus rhythm). The nurse increases the FIO_2 on the ventilator to 100%, quickly determines that the ventilator is functioning and properly attached to the baby's endotracheal tube, and immediately calls for help by pushing the Staff Assist button in the room. The baby does not improve, so the nurse disconnects the ventilator and begins PPV with a T-piece resuscitator using 100% oxygen through the endotracheal tube.

Additional staff, including a respiratory therapist, arrive in the room. They quickly receive information from the bedside nurse and assess the situation. One team member uses a stethoscope to listen to the baby's breath sounds. Another team member brings the unit's code cart to the room. Their rapid assessment determines that the endotracheal tube is inserted correctly, and it is not obstructed by secretions. The respiratory therapist notices that the baby's breath sounds are significantly decreased bilaterally. She suggests increasing the peak inflation pressure and using a longer inflation time to overcome the suspected distal airway collapse. As these ventilation corrective steps are performed, team members prepare to perform chest compressions and secure emergency vascular access with an intraosseous needle, if needed. After approximately 30 seconds of ventilation with higher pressure and a longer inflation time, the baby's heart rate and oxygen saturation begin to improve. Over the next several minutes, the baby continues to improve and spontaneous respiratory effort resumes. A short time later, the baby is placed back on the ventilator and a comprehensive assessment is performed by the medical team. After the event, a team member calls the baby's family to let them know what happened, provide support, and answer questions. Shortly afterward, the NICU team conducts a debriefing to evaluate its readiness, teamwork, and communication.

What causes babies to require resuscitation in the NICU?

Acute cardiorespiratory events (oxygen desaturation, apnea, and bradycardia) occur frequently among babies admitted to the NICU. Most of these events have a respiratory etiology and resolve with stimulation, adjustment of a continuous positive airway pressure (CPAP) interface, PPV, endotracheal tube suction, or attention to complications such as unintended extubation or equipment failure. Studies report that approximately 1% to 2% of all babies admitted to a NICU will receive intensive cardiopulmonary resuscitation (chest compressions and emergency medications). These data suggest that the incidence of intensive cardiopulmonary resuscitation in the NICU is approximately 10 times higher than in the delivery room.

In the NICU, many babies who require intensive cardiopulmonary resuscitation are already intubated and receiving mechanical ventilation. At the time of the acute cardiorespiratory event, they may be critically ill and receiving multiple medications, including vasoactive drips. Potential underlying etiologies of the acute event include electrolyte abnormalities, septic shock, cardiac arrhythmias, cardiac tamponade, pneumothorax, and postsurgical bleeding complications. The wide range of potential causes can make intensive cardiopulmonary resuscitation in the NICU very complicated. Health care providers working in the NICU must be prepared to perform a complex resuscitation, including chest compressions, emergency vascular access, and medication administration.

Although this program is not intended to teach resuscitation in the NICU, some strategies for applying the principles you have learned are presented below.

What are some strategies to resuscitate babies in the NICU?

Temperature management

Most babies in the NICU are already receiving thermal support from a radiant warmer or incubator. However, maintaining normal body temperature remains a priority. During resuscitation, the baby is often fully exposed and can rapidly lose heat. Measures to prevent unintended cooling include applying a servo-controlled temperature sensor to the baby's skin to monitor and control the baby's body temperature and placing a hat on the baby's head.

Clearing secretions from the airway

In the NICU, in-wall (vacuum) suction is readily available. If secretions are obstructing the airway, a suction catheter attached to vacuum suction should be used to remove them. This is especially important for babies receiving respiratory support with CPAP or with an endotracheal tube and mechanical ventilator. Airway obstruction from thick secretions is a common etiology of acute cardiorespiratory events in the NICU.

Ventilation

Many babies resuscitated in the NICU are already intubated and receiving support from a mechanical ventilator when they require cardiopulmonary resuscitation. If a baby has an acute deterioration while receiving respiratory support with a mechanical ventilator, use the *DOPE* mnemonic (Displaced, Obstructed, Pneumothorax, Equipment failure) to rule out a reversible cause. When an intubated baby has a sudden deterioration, consider disconnecting the baby from the ventilator and providing manual breaths through the endotracheal tube with a flow-inflating bag, self-inflating bag, or T-piece resuscitator to ensure that the endotracheal tube is inserted correctly and patent. As noted above, if you suspect secretions are obstructing the endotracheal tube, use a suction catheter to clear the tube. Because multiple interventions may be required quickly, call for additional help.

Many babies who require resuscitation in the NICU have underlying lung disease and may require higher ventilating pressures than recommended in the delivery room. In babies with established severe BPD, longer inflation times may also be required to achieve adequate ventilation.

For babies that are not intubated, and those with an unintended extubation, face-mask ventilation should be provided using one of the previously described PPV devices. Similar to resuscitation in the delivery room, troubleshooting ineffective face-mask PPV should include the MR. SOPA steps.

Alternative airways

Endotracheal intubation is the most common method used to establish an alternative airway during NICU resuscitation. A laryngeal mask may be an effective alternative when intubation is not feasible or not successful. Studies have demonstrated a high first-attempt success rate even among newborns with airway anomalies. If endotracheal intubation is difficult, inserting a laryngeal mask may be a better option than repeated attempts at intubation. Insertion of a laryngeal mask may provide a safe and stable way to support ventilation while additional specialists, such as anesthesiologists or otolaryngologists, with advanced training and equipment are consulted.

Chest compressions

The NRP recommendations outlined in this textbook apply primarily to newly born babies transitioning from intrauterine to extrauterine life. However, the guidelines also may be applicable to neonates who have completed newborn transition and require resuscitation during the first weeks, and potentially months, after birth. Therefore, practitioners who resuscitate babies in the NICU should consider following these guidelines.

Current Pediatric Advanced Life Support (PALS) recommendations for infants recommend a chest compression-to-ventilation ratio of 30:2 (single-rescuer) or 15:2 (2 rescuers).[3] This ratio prioritizes compressions over ventilation and is appropriate for adults where the cause for sudden cardiac arrest is frequently a non-perfusing cardiac arrhythmia. Applying this ratio to infants was recommended to decrease the educational complexity of resuscitation education for health care providers working with multiple age groups and for lay rescuers.

At birth, almost all cardiopulmonary arrests are caused by impaired placental respiration resulting in a hypoxemic arrest. Therefore, restoring ventilation using PPV is the most important step in resuscitation of newly born babies. During the first weeks following birth, respiratory failure is still the cause of most cardiopulmonary arrests and this program recommends using a compression-to-ventilation ratio that prioritizes ventilation. In a neonate, the higher compression-to-ventilation ratio recommended by PALS may interfere with achieving adequate ventilation.

There is currently no evidence to identify a specific age after birth when babies in the NICU should receive chest compressions following PALS guidelines. In general, where differences exist between the NRP and PALS recommendations, you should apply the NRP recommendations during the immediate newborn period and the initial hospitalization following birth. If a newborn has cardiopulmonary arrest in the NICU during this period, the NRP recommends using a 3:1 compression-to-ventilation ratio unless there is a reason to suspect an alternate etiology such as a primary cardiac arrhythmia or electrolyte disturbance.

Vascular access and medications

Some babies who require intensive cardiopulmonary resuscitation in the NICU already have central venous access. This includes an umbilical venous catheter or a peripherally inserted central venous catheter (PICC or PCVC). If no IV access is in place at the time of the event, emergency catheterization of the umbilical vein may be successful during the first week after birth. Beyond the first week,

this is generally not an option. In such cases, prompt insertion of an intraosseous needle into the flat surface of the tibia just below and medial to the tibial tuberosity (the bony bulge below the kneecap), as described in Lesson 7, is an effective alternative for emergency vascular access. An existing peripheral IV catheter may be used; however, attempts at inserting a peripheral IV are likely to be unsuccessful due to the baby's poor perfusion.

Medications, including epinephrine and volume expanders, should be used as outlined in Lesson 7 for cardiopulmonary events in the NICU secondary to hypoxemia and volume loss. Given the range of etiologies leading to acute cardiorespiratory deterioration in the NICU, intensive resuscitation may involve additional medications to treat respiratory failure, shock, and cardiac arrhythmias. A few examples of such medications include the use of beta-agonists to treat lower airway obstruction, antibiotics to treat septic shock, prostaglandin E_1 to treat ductal-dependent cardiogenic shock, calcium chloride to treat hyperkalemia, and antiarrhythmic medications such as adenosine. Use of these medications is beyond the scope of this program. For additional information, health care providers are directed to the American Heart Association's guidelines for PALS and the PALS course.

Should I use NRP or PALS for resuscitation in the NICU?

There is currently insufficient evidence to make a universal recommendation that is appropriate for all babies in the NICU. It is unlikely that there is a single post-conceptual age or number of days/weeks after birth when resuscitation following the PALS guidelines, compared with the NRP guidelines, leads to improved outcomes. The recommendations provided by the NRP are primarily intended to address the resuscitation of newly born babies transitioning from intrauterine to extrauterine life. However, portions of the NRP Algorithm are also applicable to babies in the NICU who have completed newborn transition and require resuscitation during the first weeks, and potentially months, after birth.

The PALS program provides recommendations on infant resuscitation that differ in several respects from the NRP. As noted previously, the recommendations related to chest compressions are the most commonly noted differences. The evidence evaluation process that leads to PALS guidelines is performed independently from the process that leads to neonatal resuscitation guidelines and considers a different

body of evidence. Some PALS recommendations reflect a desire to decrease the educational complexity of resuscitation education for health care providers working with multiple age groups and for lay rescuers. Moreover, the science considered when making pediatric advanced resuscitation guidelines is intended to address a broader range of acute events, including cardiac arrhythmias, trauma, septic shock, drowning, and toxicological emergencies. The PALS algorithms include therapies and medications, such as defibrillation and amiodarone, that are not included in the NRP Algorithm. Rather than attempting to identify an age when NRP or PALS guidelines should be followed, considering the etiology of the acute event requiring resuscitation is likely to be more helpful.

At birth, and during the first weeks or months for many babies in the NICU, most acute cardiorespiratory events are caused by respiratory failure. Therefore, restoring ventilation using the principles outlined in this program is most appropriate. For babies that have an etiology for their cardiorespiratory arrest that is addressed in the PALS program, such as a primary cardiac arrhythmia or electrolyte disturbance, the principles outlined in the PALS program may be most appropriate. The practical implications for training staff working in the NICU must be considered. The leadership in each NICU must decide which resuscitation training is most appropriate for its staff based on the needs of their patient population. If the staff within a single unit is trained in both programs, it is essential to develop a plan to determine which resuscitation guidelines are being used and to clearly communicate this plan to the resuscitation team to avoid confusion.

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