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Acknowledgements

RN.com acknowledges the valuable contributions of...

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Purpose and Objectives

The purpose of this course is to prepare nurses for program and practice changes to the Neonatal Resuscitation Program (NRP) 7th edition.

Upon successful completion of the course, you will be able to:

1. Describe how research studies and outcomes are used as evidence to create guidelines for NRP.
2. Identify three changes to the NRP guidelines from the 6th edition to the 7th edition.
3. List initial questions asked at the delivery of an infant.
4. Identify two levels of care for infants according to the NRP algorithm.
5. List two indications for ventilatory assistance including continuous airway pressure and ventilation.
6. Discuss the use of pulse oximetry with neonatal resuscitation.
7. Identify two indications for circulatory assistance including compressions and medications.
8. List three potential complications of neonatal resuscitation.
9. Describe two factors of consideration to determine withholding or discontinuing resuscitation.
10. Discuss rationale for using simulation scenarios with NRP courses.

Introduction

There are approximately 4,000,000 babies born in the United States every year. Of these infants, about 400,000 of them will need some resuscitation to effectively transition to extrauterine life. Around 12,000 of these babies will need extensive resuscitation (Sawyer, Umoren, & Gray, 2016).
The knowledge and skills to perform neonatal resuscitation can make the difference between life and death for infants.

There have been many changes throughout history in techniques to resuscitate infants.

With the ever-growing research and evidence based on studies, actions of the healthcare team with newborns will continue to evolve.

Note: This purpose of this course is to provide history and overview of neonatal resuscitation. It is not meant to substitute completion of the Neonatal Resuscitation Program.

Neonatal Resuscitation Before 1927

In the late nineteenth and early twentieth century, newborn resuscitation consisted of basic techniques of cleaning mucus from the mouth and providing warmth. If this was not successful, infants were deemed “asphyxiated”. If it was determined the infant was too small or “weak” it would be left alone.

If providers felt the infant was an adequate size, they could work for hours attempting to resuscitate a newborn.

Techniques at that point either focused on providing a counter stimulus to infants to counteract asphyxia (methods similar to adult resuscitation), or other concepts.

(McAdams, 2008)

Methods of Resuscitation Used Before 1927

Methods used as counter stimulus included:

- Hot and cold contrast baths- placing infants into alternate water temperatures to stimulate breathing
- Rubbing infants forcefully and placing them near a fire- stimulation and temperature to promote breathing
- Placing infants into baths of brandy or mustard, or rubbing the substance on them- the noxious stimuli was thought to trigger breathing
- Dilation of the anus including blowing air or smoke into the rectum- sensory experience and increase pressure to stimulate breathing
- Vigorous rubbing or slapping the infants’ buttocks- the shock was believed to rouse breathing

(McAdams, 2008)

Methods based on principles of adult resuscitation included:

- Swinging infants up and over shoulders of the provider- believed this assisted in extension and compression of the thorax, causing passive inspiration and expiration
- Holding infants in the provider’s lap, folding and unfolding them- based on the principle believed as above
- Abduction and adduction of shoulders, arms, or thighs- to increase and decrease the intra-thoracic capacity
- Mouth to mouth- based on resuscitation of drowned adults
Methods based on other concepts:

- Grabbing and pulling on the tongue up to a dozen times—thought that the reflex reaction would cause the infant to breathe
- Drawing blood from the umbilical vein—believed that this released pressure on the right side of the heart, which would relieve asphyxia

**History of Neonatal Resuscitation Between 1927-1950**

Research was conducted to study respiratory physiology, and specifically fetal development and neonatal physiology. There was a discovery of fetal transition to newborn, and a realization that principles of adult resuscitation could not be applied to the neonate.

Studies were conducted on animals using blood gas analysis to provide data to assist with ventilation methods in newborns. There was debate between researchers as to the method that effectively assisted ventilation.

**Methods Used Between 1927-1950**

Methods of resuscitation during this time period included:

- Clearing the airway of obstruction such as mucus suctioning
- Inhalation of oxygen and carbon dioxide, either through a mask or endotracheal intubation
- Positive pressure ventilation with oxygen alone or with carbon dioxide
- Negative pressure ventilation
- Many forms of resuscitation from earlier methods existed in practice

**History of Resuscitation Between 1950-1970**

Research continued to thrive, with discoveries of vaccinations, antibiotics, and blood transfusions. Neonatology developed into a specialization, neonatal intensive care units were created, and surfactant was discovered.

The use of carbon dioxide with neonatal resuscitation was dismissed, and the use of oxygen was the focus.

It was identified that compromised newborns needed clear airways, stimulation, warmth, and assisted ventilations.

**Methods Used Between 1950–1970**

Methods of resuscitation used during this time period included:
• Use of a rocking device to tilt the infant up and down
• Incubators were designed to deliver oxygen to the infant, preferably with the rocking table
• Electrophrenic stimulation was trialed- electrodes placed on the necks of infants to stimulate the phrenic nerve, which would stimulate the diaphragm
• An incubator-type device was developed to provide cycled pressurization to the infant to simulate the pressure of contractions in utero
• Positive pressure ventilation by either face-mask or endotracheal intubation- either “blind” or with direct visualization
• Use of direct visualization and endotracheal intubation increased with time based on study results
• Focus on the amount of pressure needed to ventilate newborn’s lungs, using up to 40-50 cm H₂O
• Use of Apgar scores to determine need for resuscitation

(McAdams, 2008)

History of Resuscitation Between 1970-1990

There were continued studies of pathophysiology, use of fetal monitoring to anticipate neonatal outcomes, development of continuous positive airway pressure (CPAP) prongs, increasing awareness of lung barotraumas, and use of high-frequency ventilators.

Regionalization of neonatal education, guidelines, and recommendations were developed.

(McAdams, 2008)

Test Yourself

Based on what we have learned from the past, an appropriate method of resuscitation is:

A. Use of hot and cold stimuli.
B. Swinging the infant over the shoulder.
C. Drying, warming, and clearing the airway.
D. Positive pressure ventilation with carbon dioxide.

The correct answer is: C.
Swinging an infant, use of carbon dioxide, and hot and cold baths produced negative outcomes for infants in the past. Today’s resuscitation still includes drying, warming, and clearing the infant as an appropriate method. (McAdams, 2008).

Advancing Neonatal Resuscitation Education

The National Institutes of Health (NIH) funded opportunities for neonatal education in the 1970s which was initially known as the Neonatal Education Program (NEP).

Then, under the direction of the American Academy of Pediatrics (AAP), and in collaboration with the American Heart Association (AHA), the focus centered on resuscitation.

The Neonatal Resuscitation Program was formed in 1987 by members of the American Academy of Pediatrics to develop a standardized, core curriculum for neonatal resuscitation. The training program created expanded to an international level.

Currently, NRP interactive education is performed in 130 countries. As of January 2017, over 3.9
million healthcare professionals have been trained or refreshed, with about 23,000 active instructors. Approximately 200,000 learners complete the NRP provider course every year. (American Academy of Pediatrics, 2017; Sawyer, Umoren, & Gray, 2016)

**Use of Evidence-based Guidelines**
Currently there is a five-year process in evaluating material and creating guidelines for NRP. Studies that are conducted and published are reviewed for reliability and validity through the International Liaison Committee on Resuscitation (ILCOR). ILCOR is comprised of councils representing the US, Canada, Asia, South Africa, Europe, Australia, and New Zealand.

Volunteers review literature that is peer-reviewed and develop summaries, including levels of evidence. These summaries are discussed and open to public comment. Then, international consensus for guidelines is made through the International Consensus on Cardiopulmonary Resuscitation (CPR) and External Chest Compression (ECC) Science with Treatment Recommendations. (Perlman, et al., 2015; Sawyer, Umoren, & Gray, 2016).

**More on Evidence-based Guidelines**
Each resuscitation council that comprises ILCOR creates guidelines for practice in their represented country. The AHA and the AAP formulate the guidelines for the United States. The Neonatal Resuscitation Program Steering Committee then designs education based on these guidelines (Perlman, et al., 2015; Sawyer, Umoren, & Gray, 2016).

*The Neonatal Resuscitation Program (NRP) has grown to incorporate standards of resuscitation at all levels of care.*

**Test Yourself**

The review of evidence that is done for resuscitation:
- A. Occurs in North America only.
- B. Is done through trial and error.
- C. Is done over a period of a few months.
- D. Is a rigorous process that has international volunteers.

The correct answer is: D.
The review of evidence occurs over a five-year period, beginning with the ILCOR. Volunteers examine peer-reviewed research and evidence to determine revisions for resuscitation guidelines (Perlman, et al., 2015; Sawyer, Umoren, & Gray, 2016).

**Practice Changes over the Years**
Since 1990, there have been multiple changes in practice with neonatal resuscitation. Areas of focus have preparation for the delivery, such as having the appropriately trained personnel present. Also included is temperature monitoring, and strategies for prevent hyperthermia and hypothermia. The use of monitoring has increased over the years, such as the use of pulse oximetry. For many years, suctioning with meconium (thick and thin) was regular practice. 100% oxygen was used for all resuscitations. Equipment has involved flow-inflating and self-inflating bag and mask, as well as the t-piece and use of CPAP. Medications included the use of epinephrine, sodium bicarbonate, and naloxone, and dosing and administration has varied over the years. Volume expanders in the past comprised of blood, normal saline, lactated ringer’s solution, and albumin. Ethical considerations of
Changes in Editions

With the 7th edition of NRP in 2016, the newborn resuscitation program and guidelines changed from previous editions. These changes will be reviewed in more detail in consequent sections of this course.

Changes to the 7th edition NRP:

- There are now six educational components for the NRP program: self-study of the NRP textbook, knowledge assessment via an online examination, computer-based practice via NRP eSim®, performance skills stations, integrated skills station (scenario based technical and behavioral skills), and simulation with debriefing
- There are now 11 lessons in the NRP program, and all must be taken for provider status
- Antenatal counselling is considered as an initial component prior to resuscitation
- Equipment check and team briefings are at the beginning of every resuscitation
- Delay cord clamping in neonates who do not need resuscitation for at least 30 seconds
- The neonate’s normal body temperature should be maintained during resuscitation
- Consider using a cardiorespiratory monitor when positive pressure ventilation is initiated
- Inflation and movement of the chest with ventilation should be ensured
- It is recommended to intubate prior to starting chest compressions
- If no cardiac monitor is placed, it is recommended to use one during chest compressions to accurately assess heart rate
- A team debriefing should be done at the end of the resuscitation

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

Neonatal Resuscitation Algorithm

This new algorithm provides a visual reference chart for steps of resuscitation. It is important to note that the most important and effectual action in neonatal resuscitation is ventilation of the infant’s lungs.
Neonatal Resuscitation

Antenatal counselling. Team briefing. Equipment check.

Term gestation? Breathing or crying? Good tone?

No

Warm, maintain normal temperature, position airway, clear secretions if necessary, dry, stimulate

HR below 100, gasping, or apnea?

No

PPV, SpO\textsubscript{2} monitoring; consider ECG monitor

Yes

Labored breathing or persistent cyanosis?

No

Position, clear airway, SpO\textsubscript{2} monitoring, supplemental O2 as needed, consider CPAP

Yes

Check chest movement, take ventilation corrective steps if needed, ETT or LMA if needed

No

HR below 60?

Yes

Intubate, chest compressions, coordinate with PPV, 100% supplemental O2, ECG monitor

No

HR below 60?

Yes

Post resuscitation care; team debriefing

No

Stay with mother; routine care
• Provide warmth and maintain normal temperature
• Position airway
• Clear secretions if necessary
• Dry
• Ongoing evaluation

Targeted Preductal SpO\textsubscript{2} After Birth

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<th>Time</th>
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Before the Delivery
Although not every resuscitation can be anticipated, there are many circumstances in which resuscitation may be a possibility. If time allows, antenatal counselling should occur before a delivery. This includes review of high risks and anticipated complications related to these risks. Identification of the need for a team is essential, and a team leader should be assigned. If able, a briefing of the team before the delivery is important to identify potential interventions and assign roles and responsibilities. Effective team work and communication during resuscitation is vital.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

Equipment Check

Equipment for resuscitation must be checked prior to the delivery. A standardized checklist is recommended to ensure all necessary equipment is present and functioning. Supplies specific to a high risk birth, such as those for thermoregulation and respiratory support, should also be checked (Wyckoff et al., 2015).

Enter this link into your browser to access a brief YouTube video:

http://www.youtube.com/watch?v=Rco94ggPgso

The Delivery

Studies demonstrate that most infants are born vigorous. Only 10% of infants born in the U.S. require some form of assistance, with less than one percent requiring intensive resuscitation (Bissinger, 2015; Wyckoff et al., 2015).

Each and every delivery requires one person whose sole responsibility is the care of the newborn. This person must be able to initiate resuscitation, including positive-pressure ventilation and chest compressions. Someone who can perform a complete resuscitation, including endotracheal intubation and administering IV medications, must be immediately available.

Research has shown that a term infant without risk factors born via cesarean section with regional anesthesia does not increase the necessity for endotracheal intubation. (Bissinger, 2015; Wyckoff et al., 2015).

The focus of the Neonatal Resuscitation Program continues to be ventilation.

Did You Know?

“Helping Babies Breathe,” is a global initiative that centers on assessing infants who need assisted ventilation and intervening quickly (American Academy of Pediatrics, 2016a).

Test Yourself
Which of the following statements is true?
A. All resuscitations can be anticipated
B. About 10% of infants in the U.S. need intensive resuscitation
C. Team briefing before a delivery can be beneficial
D. Antenatal counselling has no benefit
The correct answer is “C”. If able, a briefing of the team before the delivery is important to identify potential interventions and assign roles and responsibilities. Effective team work and communication during resuscitation is vital (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

The Golden Minute
The “Golden Minute” is considered the 60 second time period to quickly assess and take initial steps with resuscitation. There are three critical questions that need to be addressed during an assessment at birth. These questions are:

- Is this a term gestation?
- Is there crying and / or breathing?
- Is good muscle tone present?

If the answer to any of the above questions is “no”, then the infant needs to be taken to a warmer for further evaluation and intervention.

Initial steps involve providing warmth, drying, stimulating, and clearing the airway as necessary.

Interventions for ventilation are required based on assessment of respirations (apnea, gasping, or labored breathing) and heart rate of less than 100 beats per minute (bpm).

The *Golden Minute* rule requires that initial steps, re-evaluation, and initiation of ventilation, if needed, are performed within 60 seconds. The key is to avoid any potential delays with initiating ventilation (Wyckoff et al., 2015).

Test Yourself

The most important intervention for neonatal resuscitation is:

A. Medication  
B. Stimulation  
C. Ventilation  
D. Chest compressions

The correct answer is: C.

The focus of the Neonatal Resuscitation Program continues to be ventilation. Interventions for assisting ventilation are required within the first minute of life (Perlman, et al., 2015; Wyckoff et al., 2015).

Delayed Cord Clamping
Studies have demonstrated that delayed cord clamping, for at least 30 seconds, is associated with improved outcomes. These include:

- Decreased incidence of intraventricular hemorrhage
- Increase blood volume and blood pressure
- Decreased transfusion requirements
- Decreased incidence of necrotizing enterocolitis

More studies are needed to determine the effects of delayed cord clamping with neonates who require resuscitation. Therefore, the current recommendation is to delay clamping of the umbilical cord for at least 30 seconds with neonates who do not require resuscitation.

Initial Steps: Temperature

Actions for infants requiring intervention include providing warmth, drying, stimulating, placing them in the “sniffing” position to open the airway, and clearing the airway as necessary.

Temperature control is important in premature infants, compromised infants and very low birth weight (VLBW) neonates.

Additional strategies for providing warmth include:

• Increasing the room temperature
• Use of radiant heat
• Providing a warming mattress
• Using a plastic wrap to cover the infant
• Use warm, humidified gases for resuscitation

These strategies have demonstrated a reduction in hypothermia.

Hyperthermia can also increase seizures, respiratory depression, cerebral palsy, and progression of cerebral damage.

A normothermic environment produces the best infant outcomes.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

Initial Steps: Suctioning

Suctioning of infants is no longer recommended as routine practice in relation to the incidence of bradycardia and reduced oxygenation.

The suctioning of clear amniotic fluids immediately after birth, using a suction catheter or bulb syringe, should be performed only on infants with an obstruction that impairs spontaneous breathing or when positive-pressure ventilation is required.

There have been many studies that continue to examine the results of tracheal suctioning of infants born with meconium-stained amniotic fluid (MSAF). Even though newborns born through MSAF who are depressed have an increased risk of meconium aspiration syndrome (MAS), there is controversy in the value of direct tracheal suctioning.

Although there is not a current randomized control trial, the current recommendation is to NOT perform routine endotracheal suctioning of the non-vigorous newborn with MSAF. To avoid harm related to procedure and delays, the appropriate intervention is to initiate ventilation within the first minute for those infants who are apneic or breathing ineffectively. This supports the ventilation and oxygenation of the infant. Intubation and suctioning may be required if there is an obstruction of the airway.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)
Test Yourself

Which of the following statements is TRUE?

A. Every step in resuscitation takes 30 seconds.
B. All newborns should be kept hypothermic to prevent brain damage.
C. Routine suctioning of every infant is no longer recommended.
D. There are no additional risks for infants with meconium-stained amniotic fluid.

The correct answer is: C.

Suctioning of infants is no longer recommended as routine practice in relation to the incidence of bradycardia and reduced oxygenation. With clear amniotic fluids, suctioning immediately after birth, whether through use of a suction catheter or a bulb syringe, should be performed only on infants with an obstruction impairing spontaneous breathing or if positive-pressure ventilation is required (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

Cardiac Monitor

Studies have demonstrated that clinical assessment of heart rate through auscultation or palpation of the umbilical cord has been unreliable. The use of pulse oximetry, particularly in the two minutes of life, has also been inaccurate in the heart rate.

It is recommended that if neonatal resuscitation is required, use of a 3-lead electrocardiogram (ECG) monitor should be used for an accurate heart rate. This should be in addition to the use of pulse oximetry for monitoring oxygenation. (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

Initial Steps: Oximetry

Blood oxygen levels in newborns take approximately ten minutes after birth to reach extrauterine values.

A pulse oximeter applied preductally (on the upper right extremity such as the wrist or palm) is recommended whenever resuscitation is anticipated. It is best to use a pulse oximeter when using positive-pressure ventilation, administering supplemental oxygen, or in the presence of persistent cyanosis.

Through a variety of studies, it has been shown that pulse oximeters give reliable readings within one to two minutes after birth, providing that the newborn has sufficient cardiac output and skin blood flow.

The use of skin color (i.e. cyanosis) is not a dependable predictor of oxygenation. (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

Initial Steps: Oxygen

The use of oxygen with resuscitation has implications for both hypoxia and hyperoxia in infant outcomes. Multiple studies have been reviewed comparing use of 100% oxygen, 21% oxygen, and a blend of oxygen for initiation of resuscitation in term and pre-term infants.
Recommendations are that resuscitation of term infants should be started with room air (21%) and titrate according to the SpO2 range defined on the algorithm. Preterm infants should be started at 21-30% and adjusted as needed to achieve the targeted O2 saturation.

Targeted preductal SpO2 values are included in the NRP algorithm, based on term newborn studies. These levels are defined as:

- 1 min- 60-65%
- 2 min- 65-70%
- 3 min- 70-75%
- 4 min- 75-80%
- 5 min- 80-85%
- 10 min- 85-95%

If blended oxygen is not available, then room air should be used to begin initiation of resuscitation.

If the newborn has a heart rate of <60 bpm and requires chest compressions, then oxygen should be increased to 100% until the heart rate stabilizes over 100 bpm. Oxygen should be weaned as soon as the heart rate recovers.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

**Test Yourself**

Pulse oximetry:
A. Should be applied post-ductally.
B. Is less reliable than assessing skin color.
C. Provides accurate readings in all situations.
D. Is recommended when using supplemental oxygen or positive-pressure ventilation.

The correct answer is: D.

A pulse oximeter applied preductally (on the upper right extremity, such as the wrist or palm) is recommended for anticipated resuscitation, with the use of positive-pressure ventilation, persistent cyanosis, or with administration of supplemental oxygen (AAP & AHA, 2016).

**Assisting Ventilation**

Positive-pressure ventilation is indicated in infants that are apneic, gasping, or have a heart rate of less than 100 bpm after the initial steps.

The pressure required for inflation is individualized to the infant’s gestational maturity. Premature lungs are more susceptible to damage from over-inflation.

The infant should have chest wall movement that demonstrates an easy breath in and out.

The best measure for sufficient ventilation is a rapid improvement in the heart rate.

The rate of ventilation remains at 40-60 breaths/minute.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015;
**Positive End-Expiratory Pressure (PEEP)**

There have been some research studies looking at the value of adding PEEP during neonatal resuscitation. There have been little results, other than one study suggesting that using PEEP with preterm neonates may reduce the amount of oxygen required to attain oxygen saturation goals during resuscitation.

Implications are that PEEP is effective in keeping alveoli open, and should be used with flow-inflating bags or T-piece resuscitators. Adding a PEEP valve for self-inflating bags is also recommended. With preterm neonates, PEEP should be used at approximately 5 cm H2O. (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

**Devices and Inflation Pressures**

A T-piece resuscitator offers the potential benefit of achieving controlled target peak inspiratory pressure (PIP) and delivering consistent positive end expiratory pressure (PEEP) to help functional residual capacity (FRC) and improve lung volume.

**Enter this link into your browser to view a YouTube video on using the T-Piece Resuscitator:**

http://www.youtube.com/watch?v=DTYUm0YYeaw

Inflation pressures are variable according to the needs of the infant, and will need modification as lung compliance changes after birth. Providing continuous positive airway pressure (CPAP) and PEEP can only be done with the flow-inflating bag or the T-piece resuscitators. (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

**Laryngeal Mask Airways**

Studies of the use of laryngeal mask airways (LMA) have shown effectiveness for ventilating neonates more than 34 weeks gestation or more than 2000g. Limited research has been done at younger gestations or lower birth weights.

If using a bag and mask for ventilation is unsuccessful, or if tracheal intubation is not feasible, then an LMA can be used to provide effective ventilation. The recommendation is to use an LMA during resuscitation of neonates at 34 weeks gestation or greater when tracheal intubation is not feasible or unsuccessful.

There have been no studies for LMA use during chest compressions or for administration of medications. (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

**Continuous Positive Airway Pressure (CPAP)**
Various studies have demonstrated that using CPAP with premature infants with labored or difficulty breathing has improved outcomes. Use of CPAP has shown a decreased rate of intubation and mechanical ventilation and associated problems.

The evidence for using CPAP with term babies is limited at this time; there is none to refute or support the use with these infants with respiratory distress.

The recommendation is to use CPAP with preterm infants who are spontaneously breathing with respiratory distress rather than perform routine intubation for administering PPV. (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

**Test Yourself**

Which of the following statements is FALSE?

A. Inflation pressures must be between 20 and 40 cm H₂O.
B. The use of CPAP has shown improved outcomes in preterm infants.
C. Ventilation rates are recommended at a rate of 40-60 breaths/min.
D. LMA is an option for difficult intubation with infants greater than 34 weeks gestation.

The correct answer is: A.

There are no longer set pressures recommended for inflation. The pressure required for inflation is individualized to the infant. Premature lungs are more susceptible to damage from over-inflation. The infant should have chest wall movement that demonstrates an easy breath in and out (AAP & AHA, 2016).

**Endotracheal Intubation**

Considerations for endotracheal intubation include the following:

- Ineffective or prolonged bag and mask ventilation
- To coordinate with chest compressions
- With special considerations, such as extremely low birth weight infants or congenital diaphragmatic hernia

The best indicator that endotracheal intubation is successful is a rapid increase in heart rate with positive pressure ventilation.

The use of a CO₂ detector is useful in confirming placement in patients with adequate cardiac output. If there is poor or absent pulmonary blood flow or poor cardiac output, a false negative result may occur with the CO₂ detector failing to change color.

Other indicators of confirmation of correct placement include chest movement, auscultation of bilateral breath sounds that are equal, and condensation in the endotracheal tube. (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

**Chest Compressions**

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Effective ventilation is the most valuable action in neonatal resuscitation, rather than chest compression, even though other programs (such as basic life support (BLS), pediatric advanced life support (PALS), and advanced cardiac life support (ACLS) programs) focus on chest compressions rather than effective ventilation.

Compressions are provided on the lower third of the sternum, with a depth of approximately one third of the anterior-posterior diameter of the infant’s chest. The two-thumb technique continues to be the preferred method, as it generates higher coronary perfusion and higher blood pressure, with less fatigue for the rescuer. The two-finger technique is no longer considered needed, as the two-thumb technique can be continued at the head of the bed with the insertion of umbilical catheters.

Enter this link into your browser to view YouTube video of the two-thumb technique:

http://www.youtube.com/watch?v=ItUoVJvhg7w&list=PLYCGqHUOtJOQIGAkQdyc4X-q5vV2UhnPO&index=5

As stated previously, if a neonate requires chest compressions, then oxygen should be increased to 100% until the heart rate stabilizes. Oxygen should be weaned as soon as the heart rate recovers.

Chest compressions are to be provided when the newborn’s heart rate is less than 60 bpm, following adequate positive-pressure ventilation with the use of supplementary oxygen.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

**Test Yourself**

Which of the following statements is TRUE?

A. Endotracheal intubation is not indicated when chest compressions are required.

B. **Effective ventilation is still the most important action in neonatal resuscitation.**

C. CO₂ detectors are the most reliable indicators of correct endotracheal tube placement.

D. Like the changes in ACLS and PALS, the ratio of compressions to breaths in neonatal resuscitation has increased.

The correct answer is: B.

Unlike the change in practice for BLS, PALS, and ACLS that focuses on chest compressions, effective ventilation in infant resuscitation continues to be the most valuable action (AAP & AHA, 2016).

**Chest Compressions: Rate**

The compression rate remains at 3:1, with three compressions to one ventilation. The rate then remains at 30 breaths and 90 compressions, with 120 “events” per minute.

Frequent interruptions of compressions can compromise maintenance of systemic perfusion. When chest compressions are required with ventilation, the heart rate should be checked within 45-60 seconds rather than stopping and checking at 30 seconds.

If there is a cardiac etiology causing the need for resuscitation, studies have shown that a ratio of 15:2 or 30:2 may be more effective. This is not a common cause as the majority of infants have a ventilation compromise rather than cardiac in nature.
Resuscitation should begin with the 3:1 ratio, but consider a higher ratio if resuscitation is believed to be from cardiac causes. (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

**Medications**

Hypoxemia and inadequate lung expansion are the primary reasons for neonatal bradycardia following birth. The need for medications is not very common if effective ventilation is established.

If the heart rate remains less than 60 bpm despite well-coordinated chest compressions and adequate ventilation, the use of epinephrine and/or volume expanders may be needed.

**Epinephrine**

Epinephrine has been studied with the use of intravenous and endotracheal administration. The research supports the use of IV doses of epinephrine as soon as an umbilical catheter is placed.

Higher doses with IV administration have shown outcomes of poor neurological function, decreased cardiac performance, and worsening hypertension.

While establishing IV access, endotracheal tube (ETT) administration of epinephrine can be considered at a higher dose of 0.5-1 mL/kg of the 1:10,000 concentration. The higher dose for ETT is currently being studied for efficacy.

The recommended IV dose remains at 0.1-0.3 mL/kg with a 1:10,000 concentration for IV administration. (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

**Volume Expanders**

Volume expanders are indicated when:

- There is known or suspected blood loss
- Assessment includes poor perfusion, weak pulses and pallor
- The infant’s heart rate remains less than 60 bpm, despite resuscitative efforts

Normal saline or O-negative blood continues to be recommended at 10 mL/kg, which may be repeated if needed. **Ringer’s lactate is no longer recommended to treat hypovolemia.**

Rapid administration of volume expanders with premature infants are associated with increased incidence of intraventricular hemorrhage. (AAP, 2015; American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016)

**Naloxone**

Naloxone (Narcan) is no longer recommended for inclusion in the initial resuscitation at delivery.
Infants with respiratory depression have improvement with oxygenation and heart rate by effective ventilation.  

**Test Yourself**

Changes in medication administration include:

A. Normal saline is not an appropriate volume expander.
B. Epinephrine dose is the same for IV and ETT administration.
C. **Ringer's lactate is no longer recommended for hypovolemia.**
D. Higher doses of IV epinephrine have shown positive outcomes.

The correct answer is: C.

*Ringer's lactate is no longer recommended to treat hypovolemia* (American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016)

**Post Resuscitation Care**

Infants require close monitoring and anticipatory care following resuscitation. Blood pressure, oxygenation, heart rate, respiratory status, temperature stability, and electrolyte balance can be affected by resuscitative efforts.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

**Anticipatory Care and Glucose Monitoring**

Glucose monitoring is especially important with hypoglycemia as a risk factor for increased brain injury and poor outcomes subsequent to hypoxic-ischemic insult.

There is no current target glucose identified. However, it is important to closely monitor and intervene as soon as possible after resuscitation.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

**Induced Hypothermia**

Numerous trials have demonstrated positive effects of induced hypothermia for neonates ≥36 weeks gestation, resulting in reduced mortality and morbidity.

These studies have been in centers with strict criteria and protocols on infants with moderate to severe hypoxic-ischemic encephalopathy.

It is recommended that therapeutic-induced hypothermia should be provided for neonates born greater than 36 weeks gestation, following established protocols in facilities that have available resources. Therapeutic hypothermia may be offered in resource-limited settings but require clearly defined protocols. This should occur within the six-hour time frame after birth for those infants that meet the criteria.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)
Intervention of induced hypothermia within six hours following birth produces the most positive outcomes.

Test Yourself

Post resuscitation care:
- A. Includes anticipatory care.
- B. Includes use of induced hypothermia in all cases.
- C. Has defined targeted guidelines for glucose levels.
- D. Is only required in cases of extensive resuscitation.

The correct answer is: A.

Infants require close monitoring and anticipatory care following resuscitation. Blood pressure, oxygenation, heart rate, respiratory status, temperature stability, and electrolyte balance can be affected by resuscitative efforts (AAP & AHA, 2016).

Withholding Resuscitation

Considerations for withholding resuscitation include conditions with high morbidity and mortality rates, especially in collaboration with the parents.

There needs to be consistent information and coordination between team members.

Withholding and discontinuation of resuscitation efforts are supported when functional survival is highly doubtful.

What are the Guidelines?

Guidelines include:

- Decisions about appropriateness of resuscitation of neonates below 25 weeks gestation have multiple considerations. There is not one prognostic score that can estimate survival. Counselling of a family, considerations of perceived accuracy of gestational age assessment, occurrence of chorioamnionitis, and the level of care available at the facility area all considerations
- With high rate of survival and acceptable morbidity rates, resuscitation is almost always indicated, including gestational age ≥25 weeks and most congenital malformations.
- With borderline survival or relatively high morbidity rates with anticipated burden, parental desires of initiation or withholding resuscitation should be supported.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Perlman, et al., 2015; Wyckoff et al., 2015)

Making the Decision

Examination of infants after birth is essential prior to deciding to provide or withhold resuscitation.

In addition to visual examination of the infant immediately after birth, the use of published tools on morbidity and mortality rates (including computerized programs that calculate rates based on gestational age) is encouraged.
Estimation of gestational age with obstetric techniques may be accurate up to ± 3-4 days if performed in the first trimester and ± 1-2 weeks in subsequent weeks.

Estimation of fetal weight is more difficult as intrauterine growth restriction or large for gestational age affects the impact for survival.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

**Discontinuing Resuscitation**

If the heart rate continues to be undetectable following 10 minutes of resuscitation, with an Apgar score of 0, it is appropriate to consider discontinuing efforts.

Continuing resuscitative efforts is made in contemplation of complications, gestational age, morbidity risk, parental wishes, and the potential role of induced hypothermia. Decisions need to be individualized, and include those considerations.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

**Debriefing**

Just as briefing prior to resuscitation, a debriefing following resuscitation is also recommended. Debriefing techniques allow team members to reflect upon the resuscitative efforts. This is effective for continuing to build the team.

(American Academy of Pediatrics [AAP] & American Heart Association [AHA], 2016; Bissinger, 2015; Wyckoff et al., 2015)

**Test Yourself**

Considerations for withholding or discontinuing resuscitation include:

A. Parental wishes.
B. Laws mandate resuscitation in every situation.
C. Withholding resuscitation for all congenital anomalies.
D. Undetectable heart rate after 15 minutes of resuscitation efforts.

The correct answer is: A.

Considerations for withholding resuscitation include conditions with high morbidity and mortality rates, especially in collaboration with the parents. With borderline survival or relatively high morbidity rates with anticipated burden, parental desires of initiation or withholding resuscitation should be supported (AAP & AHA, 2016).

**Changes in NRP Testing: Online Examination**

With the latest version of NRP, all testing for initial provider and renewal courses is done online.

Online learning provides a self-paced and flexible environment for testing. The new exam includes 50 questions, based upon content from all lessons. Learners will no longer be limited to two attempts per section; multiple attempts to pass the exam are allowed.
The focus for interactions between instructors and learners has shifted from lecture to simulation and hands-on learning.

**Change in NRP Testing: Simulation**

Following successful completion of the online examination, learners will complete online electronic simulation (eSim®) scenarios. The use of eSim is a new simulation exercise within a virtual environment. There is a series of five online cases, and each learner must complete three of those scenarios.

The learner will receive feedback about performance at the completion of each case. The eSim® cases will be available during a two year time frame.

(American Academy of Pediatrics, 2016b).

**Change in NRP Testing: Instructor-Led Events**

Studies have shown that the use of simulation-based learning provides positive performance of resuscitation in real-life situations.

Instructor-led simulation events use scenarios that are based on realistic case studies, and are followed by a debriefing session which helps solidify knowledge and skills. This allows learners the opportunity to perform resuscitative skills in a safe learning environment. Performance of skills and reaffirmation of knowledge of neonatal resuscitation is evaluated in this setting.

NRP instructors will have more materials available to them through a toolkit. Additionally, instructors will have a different structure for their training.

(AAP, 2016b; AAP & AHA, 2016)

**Test Yourself**

In regards to NRP knowledge and skills:

A. Self-directed learning is not effective.
B. Lecture has been shown to be the most effective teaching method.
C. The use of simulation has not been found to be of benefit for learning.
D. The use of simulation and debriefing increases clinical skills and knowledge.

The correct answer is: D.

Studies have shown that the use of simulation-based learning provides positive performance of resuscitation in real-life situations. Scenarios based on case studies simulated in a manner that suspends disbelief, along with debriefing following the simulation help solidify knowledge and skills (AAP & AHA, 2016).

**Conclusion**

Changes continue to be made in neonatal resuscitation based on evidence from research studies and clinical trials.

Awareness of the history and evolution of recommendations provides a basis for what has been learned about patient outcomes.
It is vital to remain current with evidence-based recommendations in the continued pursuit of providing quality patient care in advocating for the infants and families.

References


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