

NRP Study Guide

Lesson 1 – Overview and Principles of Resuscitation

All newborns require initial assessment to determine whether resuscitation is required. Most newly born babies are vigorous, but approximately 10% of newborns require some assistance to begin breathing at birth. One percent needs extensive resuscitative measures to survive. Every birth should be attended by someone who has been trained in initiating neonatal resuscitation.

Additional trained personnel will be necessary if a full resuscitation is anticipated or required.

Babies are initially assessed the same as adults:

- A = Airway
- B = Breathing
- C = Circulation

Before birth, a baby receives oxygen from the mother through the placenta. At birth, the following things must happen in seconds for the baby to complete a normal transition to breathing on its own and getting oxygen into the blood stream from the lungs.

- Lung fluid must be absorbed from the alveoli and replaced by air that contains oxygen.
- The umbilical arteries and vein constrict and are then clamped. This increases systemic blood pressure.
- Blood vessels in the lungs must relax to increase blood flow to the alveoli so that oxygen can be absorbed and carried to the rest of the body.
- As blood oxygen levels increase, the pulmonary blood vessels relax and the ductus arteriosus begins to constrict. This causes additional increase in systemic blood pressure and results in closure of the foramen ovale.
- Blood should then fully flow through the lungs, picking up more oxygen and causing the baby to turn pink.
- Complete newborn transition may take hours or even several days. It may take 10 minutes for a newborn to achieve an oxygen saturation of 90% or greater.

Normally, stimulation will help a baby transition. If a baby does not begin breathing immediately after being stimulated, he or she is likely in secondary apnea and will require positive-pressure ventilation (PPV). Continued stimulation will not help.

Primary apnea = responds to stimulation

Secondary apnea = does NOT respond to stimulation

Oxygen deprivation from primary apnea causes the heart rate to drop. Positive-pressure ventilation must be provided to reverse the process triggered by oxygen deprivation.

4 Questions to ask at birth while assessing the need to resuscitate a newborn:

1. Is the baby term gestation?
2. Is the amniotic fluid clear?
3. Is the baby breathing or crying?
4. Does the baby have good muscle tone?

Provide the steps of resuscitation if the answer to any of the questions is no:

- Resuscitation should proceed rapidly.
- You have approximately 30 seconds to achieve a response from one step before deciding whether you need to go on to the next.
- Evaluation and decision making are based primarily upon: respirations, heart rate, and color.

A. Initial Steps:

1. Provide warmth
2. Position & clear airway as necessary*
3. Dry stimulate, reposition
4. Next evaluate 3 critical signs: respiration rate, heart rate, and color

B. Provide positive pressure ventilation (PPV) with a resuscitation bag and supplemental oxygen*

- If apneic, gasping, or heart rate is < 100 bpm, provide PPV. Ventilating the lungs is the most important and effective action in a neonate requiring resuscitation. May consider E.T. intubation.
- If breathing, but cyanotic with a heart rate > 100 bpm, give supplemental oxygen.

C. Provide chest compressions as you continue assisted ventilation.*

- If the heart rate is < 60 bpm, begin chest compressions as you continue to ventilate.
- If heart rate is > 60 bpm and < 100 bpm, continue PPV.

D. Administer epinephrine as you continue assisted ventilation and chest compressions.*

- If heart rate is < 60 bpm despite 30 seconds of effective assisted ventilation and another 30 seconds of coordinated chest compressions and ventilation, administer epinephrine as you continue assisted ventilation and chest compressions.*

* Consider intubation of the trachea at these points.

Apgar scores are not useful for determining the need for resuscitation. They are only useful for providing information about overall status and response to resuscitation.

- Perform Apgar scores at 1 minute and 5 minutes of age.
- When 5 minute score is less than 7, continue additional scores every 5 minutes for up to 20 minutes.

Post-Resuscitation care encompasses 3 levels:

1. **Routine Care** – when the baby is vigorous and may stay with mother. Provide warmth, clear airway, dry and assess baby's color.
2. **Observational Care** – when the baby requires initial steps under the radiant warmer due to depressed breathing or activity, meconium-stained amniotic fluid or cyanosis. Manage with frequent evaluation and perhaps admission to a transitional nursery.
3. **Post-resuscitation Care** – when the baby received PPV or more extensive resuscitation and is at high risk for recurrent deterioration or subsequent complications. Manage where ongoing evaluation and monitoring are available. Neonatal intensive care may be necessary.

Lesson 2 – Initial Steps in Resuscitation

If **meconium** is present and the newborn is **NOT vigorous**, suction the baby's trachea before proceeding with any other steps. If the newborn is **vigorous**, suction the mouth and nose only, and proceed with resuscitation as required.

Vigorous = Strong respiratory effort

Good muscle tone

Heart rate > 100 bpm

Initial Steps of resuscitation:

1. **Provide a warm and dry environment.**
2. **Open the airway by positioning the newborn in a "sniffing" position.**
3. **Dry stimulate, reposition.**
4. **Evaluate respirations, heart rate, and color.**

Appropriate forms of tactile stimulation are:

- Dry with a warm towel
- Slapping or flicking the soles of the feet
- Gently rubbing the back

Continued use of tactile stimulation in an apneic newborn wastes valuable time. For persistent apnea, begin PPV promptly.

Free-flow oxygen is indicated for central cyanosis. Acceptable methods for administering free-flow oxygen are:

- Oxygen mask held firmly over the baby's face
- Mask from the flow-inflating bag or T-piece resuscitator held closely over the baby's mouth and nose
- Oxygen tubing cupped closely over the baby's mouth and nose

Free-flow oxygen cannot be given reliably by a mask attached to a self-inflating bag.

Determine a newborn's heart rate by counting how many beats are in 6 seconds, and then multiply by 10. For example, if you count 8 beats in 6 seconds, announce the baby's heart rate as 80 bpm.

Lesson 3 – Use of Resuscitation Devices for Positive-Pressure Ventilation

Ventilation of the lungs is the single most important and most effective step in cardiopulmonary resuscitation of the compromised infant.

Indications for PPV are:

- Apnea/gasping
- Heart rate less than 100 bpm even if breathing
- Persistent central cyanosis despite 100% free-flow oxygen

Self-inflating bags:

- Fill spontaneously after they are squeezed, pulling oxygen or air into the bag
- Remain inflated at all times
- Must have a tight face-mask seal to inflate the lungs
- Can deliver PPV without a compressed gas source; user must be certain the bag is connected to an oxygen source for the purpose of neonatal resuscitation
- Require attachment of an oxygen reservoir to deliver 90% to 100% oxygen. Without the reservoir, the bag delivers only about 40% oxygen, which may be insufficient for neonatal resuscitation
- Cannot be used to administer free-flow oxygen through the mask

Flow-inflating bags:

- Fill only when gas from a compressed source flows into them
- Depend on a compressed gas source
- Must have a tight face-mask seal to inflate
- Use a flow-control valve to regulate pressure/inflation
- Look like a deflated balloon when not in use
- Can be used to administer free-flow oxygen

Flow-inflating bags will NOT work if:

- The mask is not properly sealed over the newborn's nose and mouth
- There is a hole in the bag
- The flow-control valve is open too far
- The pressure gauge is missing or the port is not occluded

T-piece resuscitators:

- Depend on a compressed gas source
- Must have a tight face-mask seal to inflate the lungs
- Operator sets maximum circuit pressure, peak inspiratory pressure, and positive end expiratory pressure (PEEP)
- Peak inspiratory pressure must be adjusted during resuscitation to achieve physiologic improvement, audible breath sounds, and perceptible chest movements
- Positive pressure is provided by alternately occluding and releasing the hole in the PEEP cap
- Can be used to deliver free-flow oxygen

Manual resuscitation bags should have the following safety devices to prevent the pressure from becoming too high:

- A pressure release ("pop-off") valve and/or
- A pressure gauge and a flow-control valve

If there is not physiologic improvement and no perceptible chest expansion during assisted ventilation:

- Reapply mask to face using light downward pressure and lifting the mandible up toward the mask (Make sure that you are using the right size mask – the rim should cover the tip of the chin, the mouth, and the nose, but not the eyes.)
- Reposition the head
- Check for secretions; suction mouth and nose
- Ventilate with the baby's mouth slightly open
- Increase pressure of ventilations
- Recheck or replace the resuscitation bag
- After reasonable attempts fail, intubate the baby

Improvement during PPV with a mask is indicated by a rapid increase in heart rate and subsequent improvement in:

- Color and oxygen saturation
- Muscle tone
- Spontaneous breathing

Current evidence is insufficient to resolve all questions regarding supplemental oxygen use for PPV during neonatal resuscitation:

- The NRP recommends use of 100% supplemental oxygen when PPV is required during neonatal resuscitation
- However, research suggests that resuscitation with something less than 100% may be just as successful
- If resuscitation is started with room air, supplemental oxygen, up to 100% should be administered if there is no appreciable improvement within 90 seconds following birth
- If supplemental oxygen is unavailable, use room air to deliver PPV

If PPV will be continuing for several minutes, insert an orogastric tube:

- To prevent upward pressure on the diaphragm, preventing full expansion of the lungs, that may be caused by a stomach distended with gas
- To prevent regurgitation of gastric contents that may be aspirated during PPV
- By measuring the distance from the bridge of the nose to the earlobe and from the earlobe to a point halfway between the xyphoid process and the umbilicus to determine how much tube to insert
- Through the mouth rather than the nose

Lesson 4 – Chest Compressions

Chest compressions are indicated when the heart rate remains less than 60 bpm despite 30 seconds of effective PPV.

Chest compressions:

- Compress the heart against the spine
- Increase intrathoracic pressure
- Circulate blood to the vital organs, including the brain

There are 2 acceptable techniques for chest compressions – the two-thumbs encircling hands technique and the 2-fingers technique – but the two-thumbs encircling hands technique usually is preferred

Locate the correct area for compressions by running your fingers along the lower edge of the rib cage until you locate the xyphoid. Then place your thumbs or fingers on the sternum, above the xyphoid and on a line connecting the nipples.

To ensure proper rate of chest compressions and ventilation, the compressor repeats “One-and-Two-and-Three-and Breathe. One-and-Two-and. . .”

During chest compressions, the breathing rate is 30 breaths per minute and the compression rate is 90 compressions per minute. This equals 120 “events” per minute. One cycle of 3 compressions and 1 breath takes 2 seconds.

During chest compressions, ensure that:

- Chest movement is adequate during ventilation.
- Supplemental oxygen is being used.
- Compression depth is one third the diameter of the chest.
- Pressure is released fully to permit chest recoil during relaxation phase of chest compression.
- Thumbs or fingers remain in contact with the chest at all times.
- Duration of the downward stroke of the compression is shorter than duration of the release.
- Chest compressions and ventilation are well coordinated.

After 30 seconds of chest compressions and ventilation, check the heart rate. If the heart rate is:

- Greater than 60 bpm, discontinue compressions and continue ventilation at 40 to 60 breaths per minute.
- Greater than 100 bpm, discontinue compressions, and gradually discontinue ventilation if the newborn is breathing spontaneously.
- Less than 60 bpm, intubate the newborn, if not already done, and give epinephrine.

Intubation provides a more reliable method of continuing ventilation.

A potential danger of administering chest compressions is fracturing ribs.

Lesson 5 – Endotracheal Intubation

A person experienced in endotracheal intubation should be available to assist at every delivery.

Indications for endotracheal intubation include the following:

- To suction trachea in presence of meconium when the newborn is not vigorous
- To improve efficacy of ventilation after several minutes of bag-and-mask ventilation or ineffective bag-and-mask ventilation
- To facilitate coordination of chest compressions and ventilation and to maximize the efficiency of each ventilation
- To administer epinephrine if required to stimulate the heart while intravenous access is being established

The laryngoscope is always held in the operator's left hand.

The correct-sized laryngoscope blade for a term newborn is No.1. The correct-sized blade for a preterm newborn is No. 0.

Choice of proper endotracheal tube size is based on weight.

| Tube size (mm) (Inside diameter) | Weight (g) | Gestational Age (wks) |
|--|----------------------|---------------------------------|
| 2.5 | Below 1,000 | Below 28 |
| 3.0 | 1,000 – 2,000 | 28 – 34 |
| 3.5 | 2,000 – 3,000 | 34 – 38 |
| 3.5-4.0 | Above 3,000 | Above 38 |

The easy way to approximate this is: **2.5 for 25 weeks, 3.0 for 30 weeks, 3.5 for 35 weeks, 4.0 for 40 weeks.**

The intubation procedure ideally should be completed within 20 seconds.

The steps for intubating a newborn are as follows:

- Stabilize the newborn's head in the "sniffing" position. Deliver free-flow oxygen during the procedure.
- Slide the laryngoscope over the right side of the tongue, pushing the tongue to the left side of the mouth, and advancing the blade until the tip lies just beyond the base of the tongue.
- Lift the blade slightly; Raise the entire blade, not just the tip.
- Look for landmarks. Vocal cords should appear as vertical stripes on each side of the glottis or as an inverted letter "V."
- Suction if necessary, for visualization.
- Insert the tube into the right side of the mouth with the curve of the tube lying in the horizontal plane.
- If the cords are closed, wait for them to open. Insert the tip of the endotracheal tube until the vocal cord guide is at the level of the cords.
- Hold the tube firmly against the baby's palate while removing the laryngoscope. Hold the tube in place while removing the stylet if one was used.

Correct placement of the endotracheal tube is indicated by:

- Direct visualization of the tube passing between the vocal cords
- Improved vital signs (heart rate, color, activity)
- Presence of exhaled CO₂ as determined by a CO₂ detector
- Breath sounds over both lung fields but decreased or absent over the stomach
- No gastric distention with ventilation
- Vapor in the tube during exhalation
- Chest movement with each breath
- Tip-to-lip measurement: add 6 to newborn's weight in kilograms
- Chest x-ray confirmation if the tube is to remain in place past initial resuscitation

Lesson 6 – Medications

Epinephrine, a cardiac stimulant, is indicated when the heart rate remains below 60 bpm, despite 30 seconds of coordinated chest compressions and ventilations

Recommended epinephrine:

- Concentration: 1:10,000 (0.1mg/ml)
- Route: IV, endotracheal (ET) administration may be considered while IV access is being established
- Dose: 0.1 to 0.3 ml/kg (consider higher dose, 0.3 to 1 ml/kg for ET route only)
- Preparation: 1:10,000 solution
- Rate: Rapidly – as quickly as possible

Epinephrine should be given by umbilical vein. The ET route is often faster and more accessible than placing an umbilical catheter, but is associated with unreliable absorption and may not be effective at the lower dose.

Indications for volume expansion during resuscitation include:

- Baby is not responding to resuscitation
AND
- Baby appears in shock (pale color, weak pulses, persistently low heart rate, no improvement in circulatory status despite resuscitation efforts)
AND
- There is a history of condition associated with fetal blood loss (e.g., extensive vaginal bleeding, abruption placentae, placenta previa, twin-to-twin transfusion, etc.).

Recommended volume expander:

- Normal saline, Ringer's lactate, or O Rh-negative blood
- Dose: 10 ml/kg
- Route: Umbilical vein
- Preparation: Correct volume drawn into large syringe
- Rate: Over 5 to 10 minutes

Lesson 7 – Special Considerations

The appropriate action for a baby who fails to respond to resuscitation will depend on the presentation – failure to ventilate, persistent cyanosis or bradycardia, or failure to initiate spontaneous breathing.

Symptoms from **choanal atresia** can be helped by placing an oral airway.

Airway obstruction from **Robin syndrome** can be helped by inserting a nasopharyngeal tube and placing the baby prone.

In an emergency, a **pneumothorax** can be detected by transillumination and treated by inserting a needle into the chest.

If **diaphragmatic hernia** is suspected, avoid PPV by mask. Immediately intubate the trachea and insert an orogastric tube.

Persistent cyanosis and bradycardia are rarely caused by congenital heart disease. More commonly, the persistent cyanosis and bradycardia are caused by inadequate ventilation.

A baby who has required resuscitation must have close monitoring and management of oxygenation, infection, blood pressure, fluids, apnea, blood sugar, feeding, and temperature.

Be careful not to overheat the baby during or following resuscitation.

If a mother has recently received narcotics and her baby fails to breathe, first assist ventilation with PPV, then consider giving naloxone to the baby.

Indications for naloxone (all of the following must be present):

- Continued respiratory depression
- PPV has restored a normal heart rate and color
- A history of maternal narcotic administration within the previous 4 hours

Restoring adequate ventilation remains the priority when resuscitating babies at birth in the delivery room or later in the nursery or other location.

Some alternative techniques for resuscitation outside of the delivery room include the following:

- Maintain temperature by placing the baby skin-to-skin with the mother and raising the environmental temperature.
- Clear airway with a bulb syringe or cloth on your finger.
- Consider mouth-to-mouth and nose for administering positive pressure.
- Cannulation of a peripheral vein or intraosseous space can be used for vascular access.

Lesson 8 – Resuscitation of Babies Born Preterm

Preterm babies are at additional risk for requiring resuscitation because of their:

- Excessive heat loss
- Vulnerability to hyperoxic injury
- Immature lungs and diminished respiratory drive
- Weak muscles and surfactant deficiency, making adequate ventilation more difficult
- Immature brains that are prone to bleeding
- Vulnerability to infection
- Low blood volume, increasing the implications of blood loss

Additional resources needed to prepare for an anticipated preterm birth include:

- Additional trained personnel, including intubation expertise
- Additional strategies for maintaining temperature
- Compressed air
- Oxygen blender
- Pulse oximetry

Premature babies are more vulnerable to hyperoxia; use an oximeter and blender to gradually achieve oxyhemoglobin saturations in the 85% to 95% range during and immediately following resuscitation.

When assisting ventilation in preterm babies:

- Follow the same criteria for initiating positive-pressure ventilation as with term babies.
- Use the lowest inflation pressure to achieve an adequate response.
- Consider using continuous positive airway pressure (CPAP) if the baby is breathing spontaneously and has a heart rate above 100 bpm, but is having difficulty such as labored respiration, persistent cyanosis, or low oxygen saturation. Note: CPAP cannot be delivered with a self-inflating bag.
- Consider giving prophylactic surfactant.

Decrease the risk of brain injury by:

- Handling the baby gently
- Avoiding the Trendelenburg position
- Avoiding high airway pressures when possible
- Adjusting ventilation gradually, based on physical examination, oximetry, and blood gases
- Avoiding rapid intravenous fluid boluses and hypertonic solutions

After resuscitation of a preterm baby:

- Monitor and control blood sugar.
- Monitor for apnea, bradycardia, or oxygen desaturations and intervene promptly.
- Monitor and control oxygenation and ventilation.
- Consider delaying feeding if perinatal compromise was significant.
- Increase your suspicion for infection.

Lesson 9 – Ethics and Care at the End of Life

The ethical principles regarding the resuscitation of a newborn should be no different from those followed in resuscitating an older child or adult.

Ethical and current national legal principles do not mandate attempted resuscitation in all circumstances. Withdrawal of critical care interventions and institution of comfort care are considered acceptable if there is agreement by health professionals and the parents that further resuscitation efforts would be futile, would merely prolong dying, or would not offer sufficient benefit to justify the burdens imposed.

Parents are considered to be the appropriate surrogate decision makers for their own infants. For parents to fulfill this role responsibly, they must be given relevant and accurate information about the risks and benefits of each treatment option.

Where gestation, birth weight, and/or congenital anomalies are associated with almost certain early death, or unacceptably high morbidity is likely among the rare survivors, resuscitation is not indicated, although exceptions may be reasonable to comply with parental wishes.

In conditions associated with uncertain prognosis, where there is borderline survival and a high rate of morbidity, and where the burden to the child is high, parental desires regarding initiation of resuscitation should be supported. Unless conception occurred via in vitro fertilization, techniques used for obstetrical dating are accurate only to ± 1 to 2 weeks. When counseling parents about the births of babies born at the extremes of prematurity, advise them that decisions made about neonatal management before birth may need to be modified in the delivery room, depending on the condition of the baby at birth and the postnatal gestational age assessment.

Discontinuation of resuscitation efforts may be appropriate after 10 minutes of absent heart rate following complete and adequate resuscitation efforts.

Chapter Key Points Summaries taken from *Neonatal Resuscitation Instructor Manual* © 2006.

Megacode Key Points

A script is read for the new Megacode Evaluation. Each item that should be performed during the Megacode is evaluated on a 0 to 2 scoring scale. 0 = not done, 1 = done incorrectly, incompletely, or out of order, 2 = done correctly in order. There are 5 mandatory components that must be performed correctly and in order to pass. See (*) below.

Equipment items (Lesson 1):

- *Checks bag, mask and oxygen supply correctly

Rapid Assessment—Asks 4 questions to rapidly assess need for resuscitation (Lesson 1):

- Term?
- Meconium?
- Breathing?
- Tone?

Initial Steps (Lesson 2):

- Positions, suction mouth, then nose
- If meconium is present, states indications for endotracheal suctioning (breathing, tone, heart rate)
- Dries, removes wet towels and repositions

First Evaluation (Lesson 2):

- Requests description of breathing, heart rate and color

Assisted (Bag)-Mask Ventilation (Lesson 3):

- *Indicates need for assisted ventilation (infant is apneic, or HR < 100/min, central cyanosis despite oxygen)
- *Provides assisted ventilation correctly (40-60/min)
- Checks for improvement in heart rate
- *Takes corrective action when heart rate not rising and chest not moving (Reapply mask, lift jaw forward, reposition head, check secretions, open mouth, increase pressure if necessary.)
- Reevaluates heart rate.

Chest Compressions (Lesson 4):

- Identifies need to start chest compressions (Heart rate < 60/min despite 30 seconds of effective PPV)
- *Demonstrates correct compression technique (appropriate finger or thumb placement, compress one third the AP diameter of the chest)
- Continues assisted ventilation coordinated with chest compressions (appropriate rate and coordination)

The following are advanced skills:

Endotracheal Intubation (Lesson 5):

- Identifies need for endotracheal intubation
- Intubates or assists intubation correctly

Use of Medications (Lesson 6):

- Identifies need for epinephrine (Heart rate < 60/sec despite PPV and compressions)
- Prepares correct dose of epinephrine in syringe (0.1-0.3 ml/kg IV or 0.3-1.0 ml/kg ET)
- Prepares umbilical venous catheter for insertion
- Inserts umbilical venous catheter
- Administers epinephrine via umbilical venous catheter and/or endotracheal tube
- Identifies need for volume administration, route and rate of installation/infusion

Closure (For all Megacodes)

Identifies that baby is adequately resuscitated (evaluation shows that HR>100, breathing and pink) and weans to free-flow oxygen