جمعية القلب السعودية
Saudi Heart Association

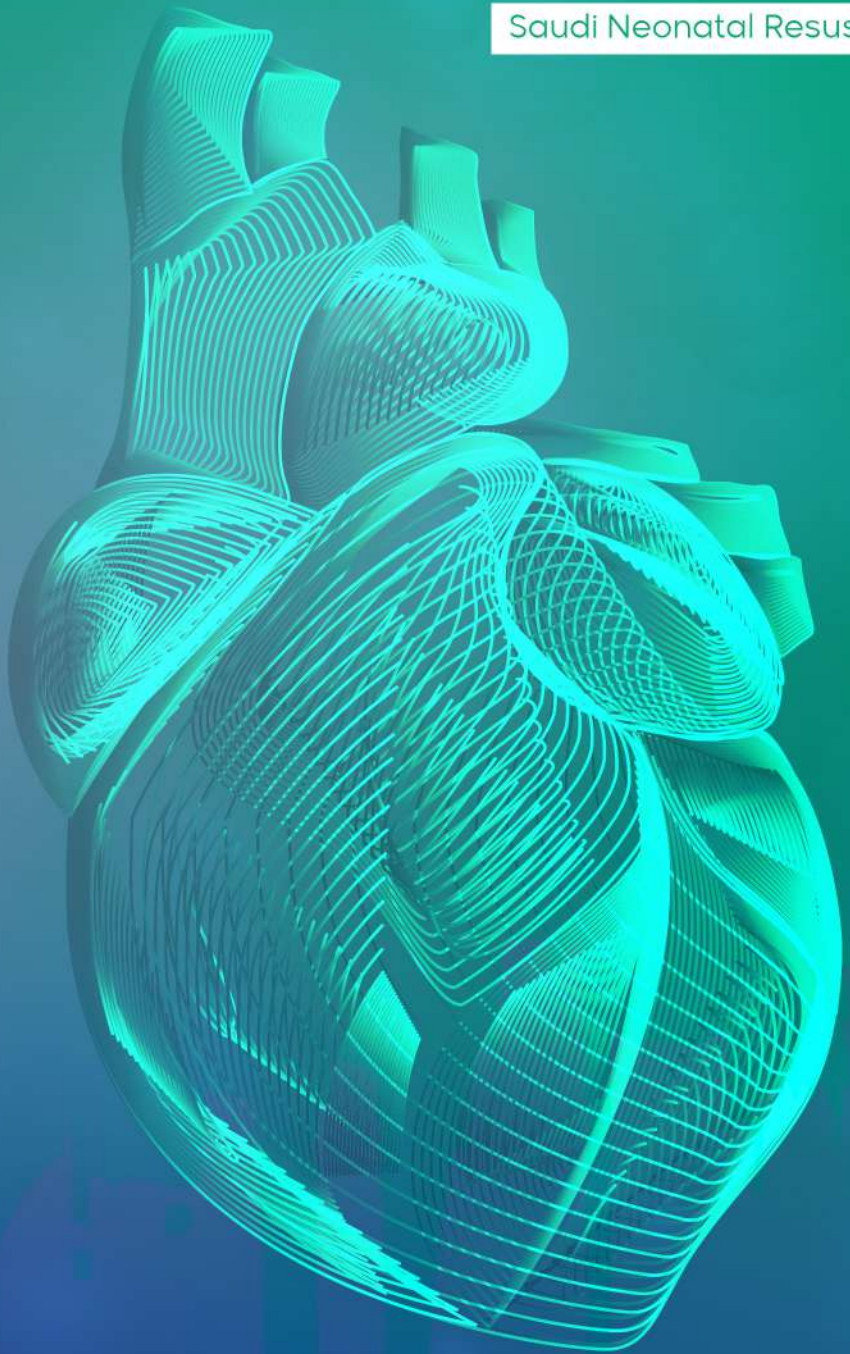
National Life Support Committee

NRP

SHA Neonatal Resuscitation Program
Provider Manual

Saudi Neonatal Resuscitation Program Provider Manual

2023



SHA Neonatal Resuscitation Program Provider Course
"SHA NRP Provider Course"

Preface

This course is intended to all healthcare professionals who are involved in the care of critically or seriously ill neonates including neonatologists, paramedics, respiratory therapists, or nurses. This course is composed of four main modules, for each module, the learning objectives are specified and the most important elements are reviewed.

The content of this material is dedicated for the SHA NRP course, it is a summary of the latest evidences in the literature. For further details you can refer to the references indicated in the last chapter.

Acknowledgements

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PART 1

Course overview

The Saudi Heart Association Neonatal Resuscitation Program (SHA NRP) Provider Course is an evidence-based educational course designed to facilitate learning and effective team-based care for healthcare professionals who care for newborns at the time of delivery and in acute care settings. During the SHA NRP Provider course, the healthcare professionals will learn how to quickly assess a newborn, make decisions about what actions to take, and practice the steps involved in resuscitation.

Goal of the SHA NRP Provider Course

The Saudi Heart Association Neonatal Resuscitation Program (SHA NRP) Provider Course is an evidence-based educational course designed to facilitate learning and effective team-based care for healthcare professionals who care for newborns at the time of delivery and in acute care settings.

During the SHA NRP Provider course, healthcare professionals will learn how to assess a newborn quickly, decide what actions to take, and practice the steps involved in resuscitation.

Course Description

To help you achieve these objectives, the SHA NRP Provider Course includes

- Pre-course Textbook
- Didactic lectures
- Interactive Discussion
- Skills stations
- Simulation sessions with debriefing
- Case scenario testing and written exam.

SHA NRP Course Agenda

CHAPTER 1

Neonatal Resuscitation Fundamentals

Chapter Objectives:

When this chapter is finished, you'll be able to:

- Be aware of the physiological changes that take place before, during, and after birth.
- Based on the mother's prenatal history and risk variables, identify the neonates that require resuscitation.
- Identify newborns who need to be revived.
- Set up the tools and materials required for performing resuscitation.
- To know how to put together and inspect resuscitation tools and supplies.
- Appreciate the relevance of high performance team components as well as the duties and responsibilities of the members of the resuscitation team.
- Start the neonatal resuscitation procedure.

Introduction

WHY TO LEARN NEWBORN RESUSCITATION?

The birth process is accompanied by significant physiological changes, which can reveal problems that were undetectable during intrauterine existence. That's why each birth has to have a neonatal resuscitation expert there. The risk of newborn pathology can be determined with the aid of gestational age and growth characteristics.

Overall, 10% of newborns need some sort of respiratory help when they are born. Only 1% require prolonged resuscitation. There are many factors that require resuscitation at birth that lead to depression (Table). Other maternal or fetal comorbidities considerably increase the need for resuscitation.

These early mortalities and the burden of unfavorable neurodevelopmental outcomes in survivors are significantly impacted by the newborns' failure to begin and maintain adequate or spontaneous respiration. Resuscitation at birth that is efficient and timely may therefore enhance newborn outcomes. For additional information on the physiologic alterations that occur during the shift from intrauterine to extrauterine life.

To optimize the odds of life, successful newborn resuscitation attempts depend on crucial steps that must be taken quickly after one another. The International Liaison Committee on Resuscitation's (ILCOR) Formula for Survival places a strong emphasis on three key factors that contribute to successful resuscitation outcomes: rules based on reliable resuscitation science, effective resuscitation provider education, and implementation of efficient and timely resuscitation.

The Saudi Heart Association (SHA) took an initiative aiming to develop a national program that is based on the latest and best evidenced based practices yet simplified, concise and versatile to KSA needs.

SHA objective:

To provide a course of instruction for neonatal resuscitation for:

- Pediatricians and neonatologists (Advanced)
- Any healthcare provider who deals with neonates (Basic)
- To create a new chapter on managing preterm infants <35 weeks or < 1800 grams
- To create a program for resource limited settings in KSA
- To apply ethical consideration related to unique situation in KSA

Physiology of the intrauterine to Extrauterine Cardiorespiratory Transition

Numerous physiologic and functional changes occur as a newborn transitions from life in utero to life outside the womb.

Cardiovascular Function and Normal Circulation In Fetus

A patent ductus arteriosus (which connects the pulmonary artery to the aorta) and foramen ovale are two features of right-to-left blood shunting around the unventilated lungs during pregnancy (connecting the right and left atria). Shunting is encouraged by high pulmonary arteriolar resistance and relatively low blood flow resistance throughout the body, including the placenta. 90 to 95% of the output of the right heart bypasses the lungs and enters the systemic circulation. The fetal ductus arteriosus is kept open by locally produced prostaglandins and a low level of fetal systemic oxygen (about 25 mm Hg). The left atrial pressure is low because not much blood is returned from the lungs, but the right atrial pressure is comparatively high because significant volumes of blood return, keeping the foramen ovale open.

The placenta has already infused oxygen into the blood before it enters the right side of the fetus' heart. Because the lungs are not functioning, just a small amount of blood needs to pass via the pulmonary artery. Most of the right side of the heart's blood flows through the foramen oval and ductus arteriosus. These two structures typically close soon after birth (Figure 1.1).

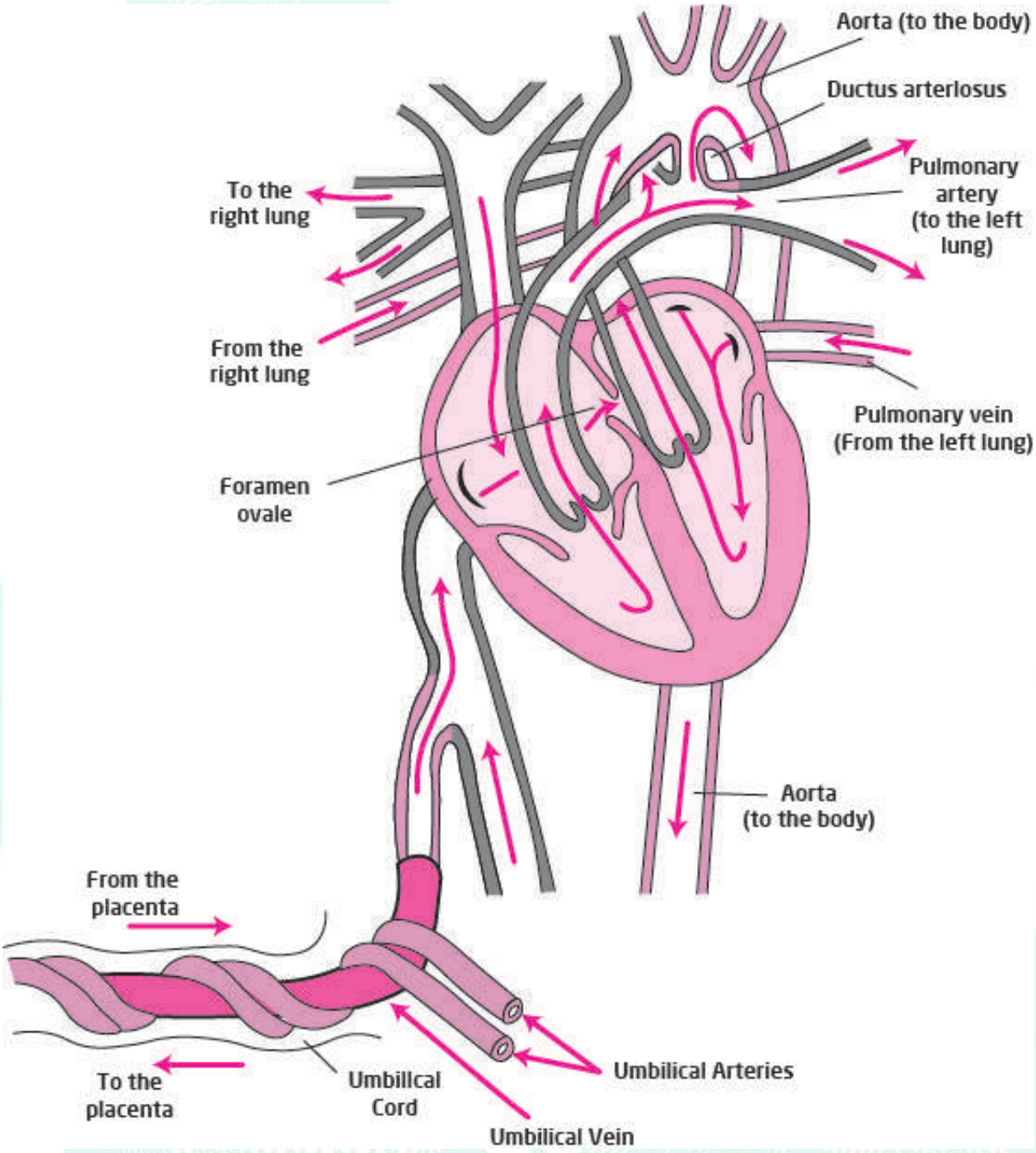


Figure 1.1 Fetal Circulation Path

Transition from fetal to neonatal circulation.

After the first few breaths, this system undergoes significant modifications that lead to an increase in pulmonary blood flow and the functional closure of the foramen ovale. Vasodilation resulting from lung expansion, elevated PaO_2, and decreased $PaCO_2$ cause a sharp decrease in pulmonary arteriolar resistance. Pulmonary interstitial pressure is reduced due to the elastic forces of the ribs and chest wall, which further improves blood flow through pulmonary capillaries. The foramen ovale is functionally closed as a result of increased venous return from the lungs, which elevates left atrial pressure and lowers the pressure difference between the left and right atria.

Venous return from the lungs increases as pulmonary blood flow is established, increasing left atrial pressure. By raising the PaO_2, air breathing narrows the umbilical arteries. Blood return to the right atrium is decreased or stopped due to decreased placental blood flow. As a result, the pressure in the right atrium drops while the pressure in the left atrium rises. As a result, the septum primum and septum secundum, the two fetal parts of the interatrial septum, are forced together and the flow through the foramen ovale is stopped. The foramen ovale eventually disappears in the majority of people when the two septa combine.

Soon after birth, a reversal from the fetal condition occurs where systemic resistance exceeds pulmonary resistance. As a result, blood is shunting from left to right through the patent ductus arteriosus in the wrong direction (called transitional circulation). The ductus arteriosus constricts between 24 and 72 hours after birth, when the pulmonary blood flow increases and the foramen ovale functionally closes, ending this condition. High PO_2 blood from the aorta enters the ductus and its vasa vasorum, which, together with changes in prostaglandin metabolism, causes the ductus arteriosus to constrict and close. A circulation similar to that of an adult occurs once the ductus arteriosus closes. There are no significant shunts connecting the pulmonary and systemic circulations because the two ventricles now pump in series.

A stressed neonate may return to a fetal-type circulation in the days right after birth. Right-to-left shunting occurs through the now-patent ductus arteriosus, the reopened foramen ovale, or both as a result of asphyxia with hypoxia and hypercarbia, which causes the pulmonary arterioles to constrict and the ductus arteriosus to widen. As a result, the newborn has persistent pulmonary hypertension, also known as Persistent Pulmonary Hypertension of the Newborn (PPHN), which causes the infant to become severely hypoxemic (although there is no umbilical circulation). Reversing the causes of pulmonary vasoconstriction is the aim of treatment.

Neonatal Pulmonary Function

The steps of organogenesis and differentiation occur while the fetal lung develops. Type II surfactant-producing pneumocytes first arise around the 25th week and continue to grow throughout the pregnancy. The fluid that the lungs continuously produce is a transudate from pulmonary capillaries and surfactant produced by type II pneumocytes. For adequate gas exchange to occur during birth, lung alveolar fluid and interstitial fluid must be promptly ejected. This clearance mechanism is mostly carried out in the lung by opening sodium channels on the epithelium, which allows fluid to enter lung cells. In terms of pulmonary fluid evacuation, fetal thoracic compression during birth offers little benefit. Delay in this clearance process is likely what causes the newborn's transient tachypnea (Figure 1.2).

Alveoli generate air-fluid interfaces during delivery as a result of the ribs' elastic recoil and the powerful inspiratory efforts used to draw air into the pulmonary tree. Surfactant is released into the air-fluid interfaces with the initial breath. Surfactant, lowers high surface tension, which would otherwise result in atelectasis and increase the work of breathing.

Some newborns may not create enough surfactant to stop diffuse atelectasis, leading to the emergence of respiratory distress syndrome. Maternal hyperglycemia, neonatal meconium aspiration, and neonatal sepsis can all have an adverse effect on the development and function of surfactant. By administering corticosteroids to the mother for 24 to 48 hours prior to delivery, it is possible to boost the preterm infant's synthesis of newborn surfactant. The newborn can also receive intratracheal surfactant after delivery.

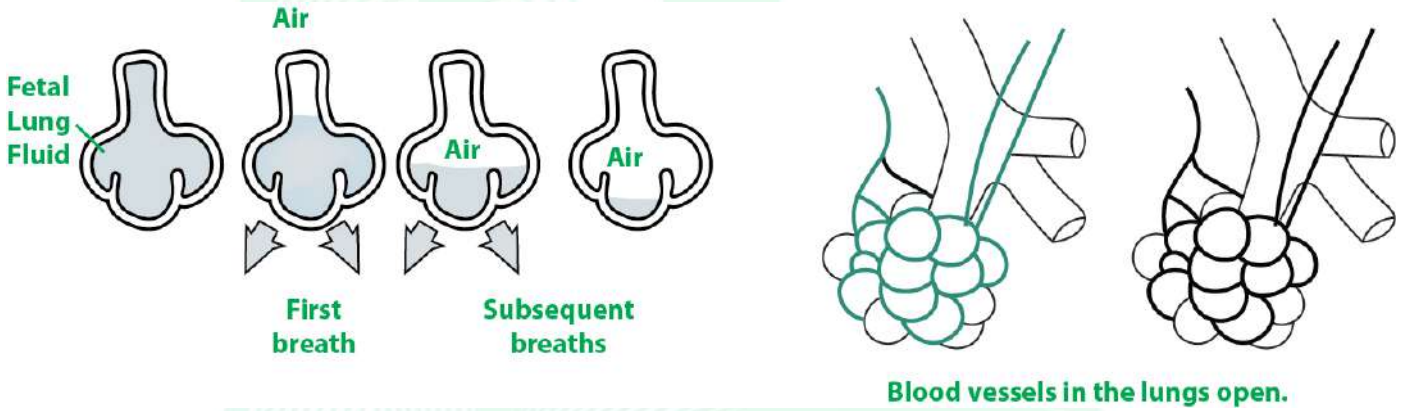


Figure 1.2 Air replaces fluid in the alveoli.

Predicting the Need for Resuscitation

There are some indicators that a baby might need resuscitation. As we have already seen, premature infants are more likely to need resuscitation. Additionally, it has been demonstrated that babies born to Obesemoms have a higher likelihood of needing ventilation. Another sign of health connected to ventilation is muscle tone. Flexed extremities suggest strong muscle tone, whereas flaccid extremities may be a sign of inadequate ventilation.

Table 1.1 Problems in the Neonate That May Require Resuscitation at Birth

Respiratory distress/respiratory failure	Drugs that cause respiratory depression
Airway obstruction	Analgesics or hypnotics
Blood	Anesthetics
Meconium	Magnesium sulfate
Mucus	Opioids, maternal drug abuse
Anatomical abnormalities of the airway (e.g., agenesis, atresia, stenosis)	

Antepartum disorders	Intrapartum disorders causing asphyxia
Diabetes Maternal toxemia Placental insufficiency Placenta previa Placental abruption Renovascular hypertension Smoking (maternal) Uterine tetany	Cord compression Cord prolapse Fetal blood loss Maternal hypotension Maternal hypoxemia Placental insufficiency
Central nervous system abnormalities	**Lung or chest disorder**
Congenital abnormalities of the brain stem Intracerebral hemorrhage Spinal cord injury	Diaphragmatic hernia Pneumothorax Pulmonary hypoplasia **Pneumonia (congenital)**
Congenital heart disease	**Surfactant deficiency**
Ductal-dependent lesions causing hypoxia due to decreased pulmonary blood flow Mixing lesions	Prematurity **Infant of diabetic mother**
Hypotension	

Others:

The possibility of needing resuscitation, admission in the neonatal intensive care unit (NICU), and perinatal mortality is increased by a number of perinatal risk factors. These factors are illustrated in the attached appendix.

The pregnancy risk is assigned using a validated antenatal risk score index, creating low, moderate, and high-risk pregnancy categories (Table 1.2)

Based on the risk category the institute might create guidelines that can guide transfer of high risk pregnancies to tertiary centers, allocate appropriate personnel and resources and assign the need of attendance of a specialized team to the delivery room.

Table 1.2 Perinatal Risk Factors Increasing the Likelihood of Neonatal Resuscitation	
Antepartum Risk Factors	
Gestational age less than 36 0/7 weeks Gestational age greater than or equal to 41 0/7 weeks Preeclampsia or eclampsia Maternal hypertension Multiple gestation Fetal anemia	Polyhydramnios Oligohydramnios Fetal hydrops Fetal macrosomia Intrauterine growth restriction Significant fetal malformations or anomalies No prenatal care
Intrapartum Risk Factors	
Emergency cesarean delivery Forceps or vacuum-assisted delivery Breech or other abnormal presentation Category II or III fetal heart rate pattern Maternal general anesthesia Maternal magnesium therapy Placenta abruption	Intrapartum bleeding Chorioamnionitis Opioids administered to mother within 4 hours of delivery Shoulder dystocia Meconium-stained amniotic fluid Prolapsed umbilical cord

Apgar Score

The cardiorespiratory and neurological status of a newborn is described by their Apgar score at birth. The score does not establish a patient's prognosis or serve as a tool to direct resuscitation or future care.

Each of the five indicators of neonatal health included in the Apgar score (appearance, pulse, grimace, activity, and respiration; Table 2) receives a score between 0 and 2. Scores depend on physiologic maturity and birthweight, maternal perinatal therapy, and fetal cardiorespiratory and neurologic conditions. At five minutes, a score of 7 to 10 is regarded as normal, 4 to 6, as intermediate, and 0 to 3, as low (Table 1.2).

Low (0 to 3) Apgar scores can have a variety of causes, including acute issues that can be treated promptly and have a favorable prognosis as well as severe, chronic issues that have a terrible prognosis. Low Apgar scores are a clinical observation rather than a diagnosis.

Table 1.3 Apgar Score				
			Score*	
Criteria	Mnemonic	0	1	2
Color	Appearance	All blue, pale	Pink body, blue extremities	All pink
Heart rate	Pulse	Absent	< 100 beats/minute	> 100 beats/minute
Reflex response to nasal catheter/ tactile stimulation	Grimace	None	Grimace	Sneeze, cough
Muscle tone	Activity	Limp	Some flexion of extremities	Active
Respiration	Respiration	Absent	Irregular, slow	Good, crying
* A total score of 7–10 at 5 minutes is considered normal; 4–6, intermediate; and 0–3, low.				

What Inquiries Have to Be Made Prior to Every Birth?

It is crucial for the obstetric and infant healthcare professionals to develop effective communication in order to coordinate care. Review the antepartum and intrapartum risk factors before each birth, and then ask the following four prenatal questions:

1. What gestational age is typical?
2. Do you have clear amniotic fluid?
3. Exist any extra risk factors?
4. What is our strategy for managing umbilical cords?

Assemble the required team members and tools based on the answers to these questions.

Resuscitation Team

The most recent guidelines from the American Academy of Pediatrics and the American Heart Association should be followed when performing neonatal resuscitation.

Making preparations is crucial. Assign tasks to team members, identify perinatal risk factors, and prepare and inspect equipment.

Your risk assessment will determine the team members and their qualifications. Create a documented policy that specifies who should attend births, what credentials they should possess based on the perinatal risk assessment, and how to get further assistance if necessary.

Figure 1.3 Neonatal resuscitation team

Every birth should have at least 1 person present who is trained in the first steps of neonatal resuscitation, including giving positive pressure ventilation (PPV), and additional staff who are capable of performing a complete resuscitation should be quickly accessible even in the absence of specific risk factors (Low risk score 0-2).

At least two skilled individuals should be there solely to handle the newborn if risk factors are present (Moderate risk score 3-6). Depending on the anticipated danger, the number of infants, and the hospital setting, the quantity and qualifications of staff will change.

A team of 4 or more members may be required for a complex resuscitation, and depending on the risk factors (high risk score >6). The complete resuscitation team should potentially be there before the birth.

Every resuscitation should have a certified team on hand who are fully trained in resuscitation techniques such endotracheal intubation, chest compressions, emergency vascular access, and medicine administration. If the need for advanced resuscitation techniques is anticipated, the fully qualified resuscitation team should be present at the time of birth.

High Performance Team Elements

One of the most productive work styles is teamwork, which yields superior outcomes over solo efforts. Effective teamwork has been found to reduce medical errors, shorten wait times, and increase patient safety in the healthcare industry. Working well as a team has other advantages for healthcare professionals, such as fostering a sense of belonging and social connectedness, which all contribute to enhanced job satisfaction.

NICU is a prime example of a complex, high-acuity healthcare setting that depends on interdisciplinary cooperation and teamwork. A strong team that works effectively together and in communication is necessary to provide high-quality care for infants with medical complexity. Effective collaboration is crucial since there are numerous duties that must be coordinated during newborn resuscitation. Neonatal outcomes following resuscitation have been proven to benefit from collaboration and teamwork; as a result, SHA NRP has recently begun to place more emphasis on the significance of non-technical aspects like teamwork. (Table 1.4)

Depending on the difficulty of the resuscitation, the team size may change. This team has to regularly incorporate new individuals, including trainees (such as resident doctors, nursing students, and new recruits).

The NICU resuscitation team identified three key components that would promote effective teamwork: effective communication, efficient task completion, and effective collaboration.

Table 1.4 High Performance Teamwork Elements in the NICU

Good communication	Complete task efficiently	Cooperating effectively
Speaking out loud	Clear roles and responsibilities	Team synergy
Sharing information	Coordination the roles and responsibilities	Conflicts resolution
Closing the loop	Delegate a right team member to specific role	

1. Good Communication

Successful teamwork during a code in the newborn unit is largely dependent on effective communication. This involved three techniques that we have named speaking aloud, discussing one's ideas, and clarifying what one has heard.

Saying It Out Loud

Declaring what one is thinking, doing, or intending to do aloud includes vocalizing it. The infant's vital signs, the team member's intervention (such as counting chest compressions or administering medications), and the development of the code (such as how long the neonate has been "down" or "up" or "down") are all reported aloud. Additionally, it's crucial to give new team members that join the code a concise summary of what had occurred in the code up to that moment.

Saying it out loud or not had an impact on whether team members were able to work together effectively. These variables included the volume, frequency, and tone of team members' voices.

Sharing Information

Sharing one's views entails expressing one's opinions as opposed to speaking it out loud, which includes conveying significant information. Giving advice to others, especially the team leader, and objecting to other people's actions during the code are examples of sharing one's ideas. The sharing of ideas is facilitated by teams that "allow everyone to voice their ideas" and that encourage new team members to speak out.

Participants recommended that comments be offered in a style that is "pleasant and low-toned" rather than severe because the tone of sharing one's opinions affects how the message is perceived, much like when it is said out loud.

Figure 1.4 Closed loop communication

Closing the Loop

Clarifying what one hears is a part of "back and forth" communication, which also entails giving feedback to people who offer information or voice opinions. Repeating what was said, verifying that a team member has been heard, verifying one's observations with other team members, and clarifying if anything was expressed in a way that wasn't clear are all examples of this procedure (Figure 1.4).

2. Complete task efficiently

Getting Tasks Done Well is a crucial component of effective collaboration during a code in the neonatal unit. This procedure was based on the organizational structure of the team's work. to facilitate teamwork efforts during resuscitations in the NICU, three main elements should be applied: communicating well, getting tasks done well, and working well together.

Clear Roles and Responsibilities

A successful code required assigning each team member to a certain duty. Chest compressions, "bagging," drug administration, equipment management, documentation, "running" (for example, for required medications and equipment), monitoring, and "viewing the complete picture" are only a few of the responsibilities that should be delegated to particular staff members.

Team members who don't have designated duties feel awkward and ineffective as they "stand around" and wait to be told what to do. In addition, team members might need to "multi-task" if no roles are assigned.

Coordinating Roles and Responsibilities

Being explicit and direct in their directions is one of the leadership behaviors that helps with task coordination.

Delegate A Right Team Member to Specific Role

A successful code also required having clearly defined tasks, good leadership, and the correct personnel to carry them out. The ideal team comprised the ideal number of team members. Being "bombarded with bodies," or having too many people at a code, caused confusion. Being "short-handed" is also a concern because it forces team members to multitask.

3. Cooperating Effectively

Working Well Together is a crucial third component of effective teamwork in the neonatal unit during a code. Instead, this approach involves working well with coworkers. Two procedures that we have dubbed "working synergistically" and "managing conflict" were included in Working Well Together.

Team Synergy

The teams that worked synergistically—that is, when every member was "in sync" and the group was cohesive—were the most successful at creating codes. This happens when team members are confident in one another, trust one another, and have previously collaborated. A sense of being "near to" and "supported by" team members was linked to team synergy.

Conflicts Resolution

Managing disagreements well is crucial to collaborate effectively. Successful teams must therefore manage the disagreements that frequently develop during codes. If the team leader was insensitive to the feelings of the team members, interpersonal issues were amplified. When the code was not working well, "finger pointing" and passing the blame to others were most typical.

The "debrief" that followed the code was the most effective technique to resolve interpersonal disputes. Debriefing gives teams the chance to consider how they could collaborate more effectively while prevent-

ing "resentments" from festering. In order to resolve interpersonal problems, team members must be willing to discuss their concerns and to inquire of others' concerns if they appeared unhappy during a code.

Neonatal Resuscitation Team Members

Team Leader

The main roles of a team leader are: assigning team member's roles and responsibilities, making a decision regarding patient health, ensuring that his team members perform their duties as expected and correcting team member's actions if needed based on his / her proficiency in knowledge, skills, and leadership capabilities.

Team members

They are competent and knowledgeable in their roles.

High-Performing Resuscitation Team

- Team leader
- Compressor
- Airway manager
- I.V/I. O provider
- Time recorder/ documenter and monitoring

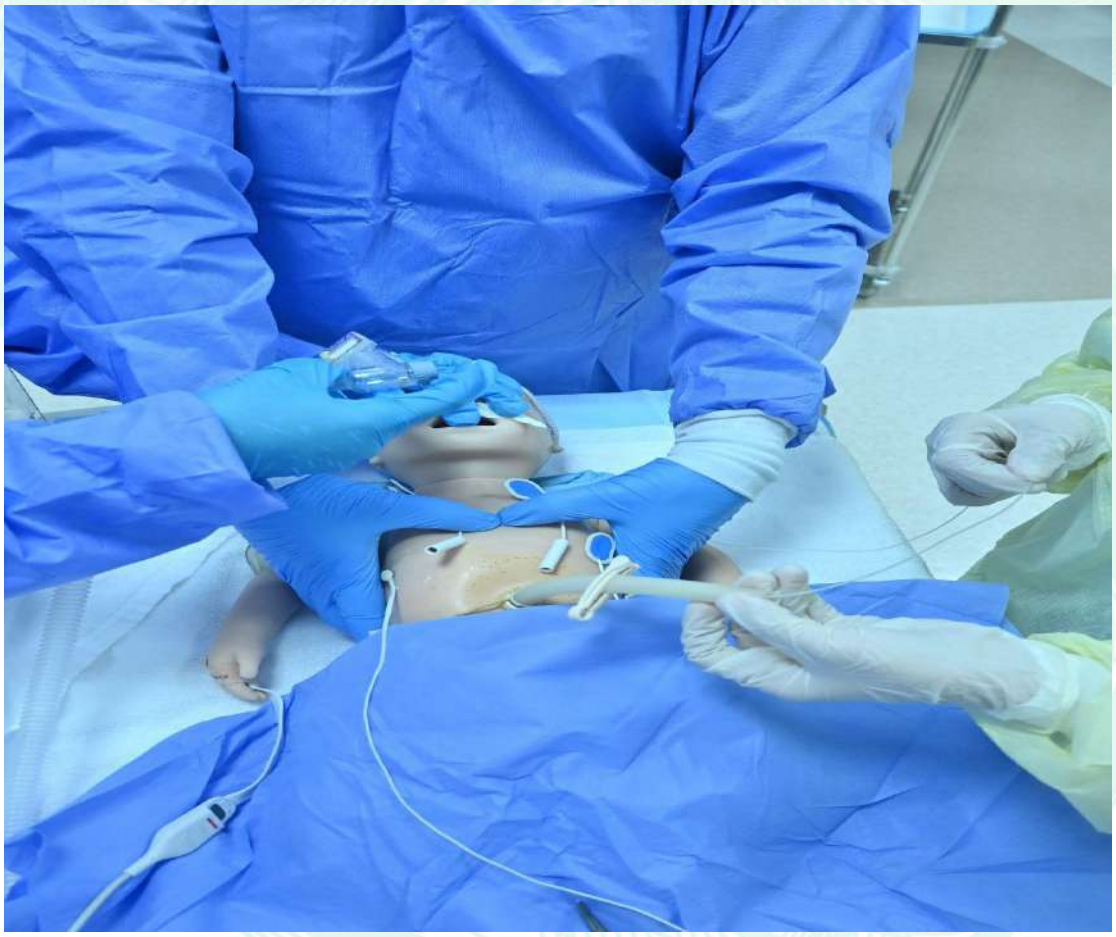


Figure 1.5 Team Members positions.

Equipment and Supplies for Neonatal Resuscitation

All appropriate supplies and equipment for neonatal resuscitation must be available and functional for every birth especially for expected high risk babies (Figure 1.6). using a routine standardized checklist before every birth makes the preparation more organized and effective for immediate use and identifies which pieces of equipment are missing (Table 1.5).

Set the temperature in the room to between 23 and 25 °C before a preterm delivery.

Table 1.5 Pre-Resuscitation Checklist

Warm	Preheat warmer (in every delivery room, at least one unit in E.R.) Warm towels or blankets Long-term resuscitation headgear with temperature sensor and sensor cover Hat Plastic bag or plastic wrap Chemically activated warming pad Transport incubator ready
Clear Airway	Bulb syringe 10F or 12F suction catheter attached to wall suction set at 80-100 mm Hg "when occluded" Meconium aspirator
Auscultate	Stethoscope " Pediatric/Infant size"
Oxygenate	Method to give free-flow oxygen (mask, tubing, gas-inflating bag or T-piece) Gases flowing between 5 and 10 L/min immediately before birth Blender configured in accordance with protocol Oximeter pulse probe (detached from oximeter until needed) Pulse oximeter

Ventilate	Positive-pressure ventilation (PPV) device(s) present with term and preterm masks - T- piece resuscitator - Self-inflating bag size 240 ml or PPV device(s) functioning Connected to air/oxygen source (blender) 8F feeding tube and 20-mL syringe Cardiac monitor and leads
Intubate	Laryngoscope Size 0 and Size 1 (and size 00) blades with bright light Endotracheal tubes, sizes 2.5, 3.0, 3.5, 4.0 Stylets End tidal CO_2 detector Laryngeal mask airway (size 1) and 5-mL syringe Measuring tape
Medicate	Access to 1:10,000 epinephrine and normal saline Supplies for administering medications and placing emergency umbilical venous catheter Documentation supplies

Figure 1.6 Equipment and Supplies preparation

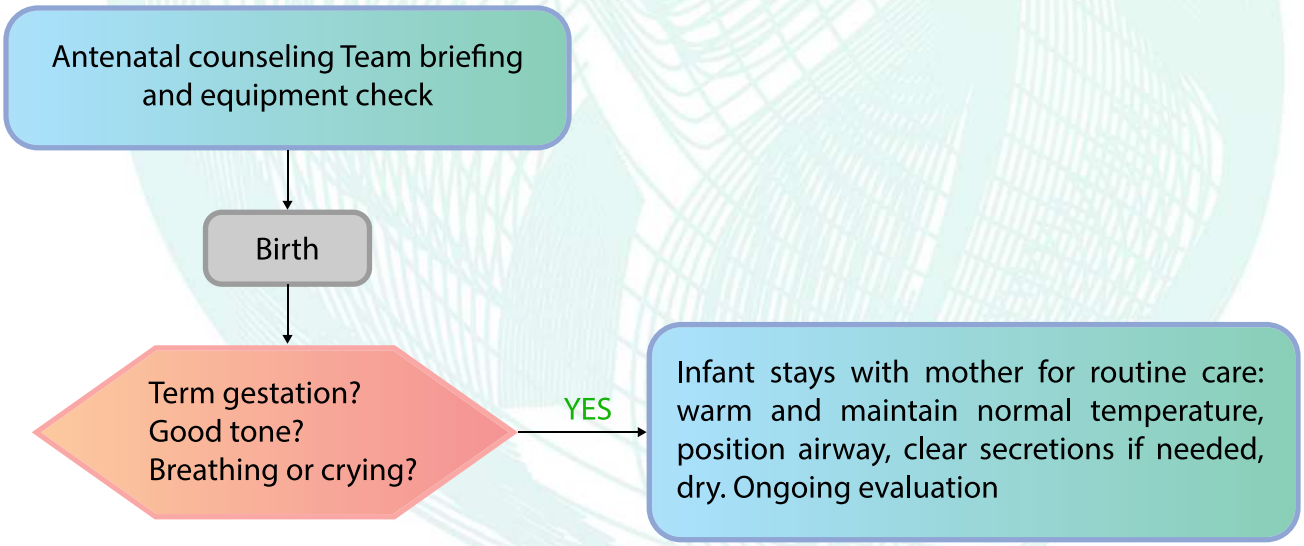
Initial Evaluation of a Newborn

How should the newborn be assessed right away? All infants should have a quick assessment soon after birth to see if they may continue their transition with their mothers or if they need to be moved to a radiant warmer for more time. This preliminary assessment could take place between delivery and umbilical cord clamping.

Three questions are part of every newborn baby's initial evaluation, which is done immediately after birth:

1. Is the baby looks term?
2. Does the baby cry or breathe?
3. Is the infant's has good muscle tone?

If the response to each of these three questions is "yes," the infant may remain with the mother when the first procedures are carried out on her chest or abdomen. If any of the three questions has a negative response, move on to the next step of the assessment.



Keeping the mother company

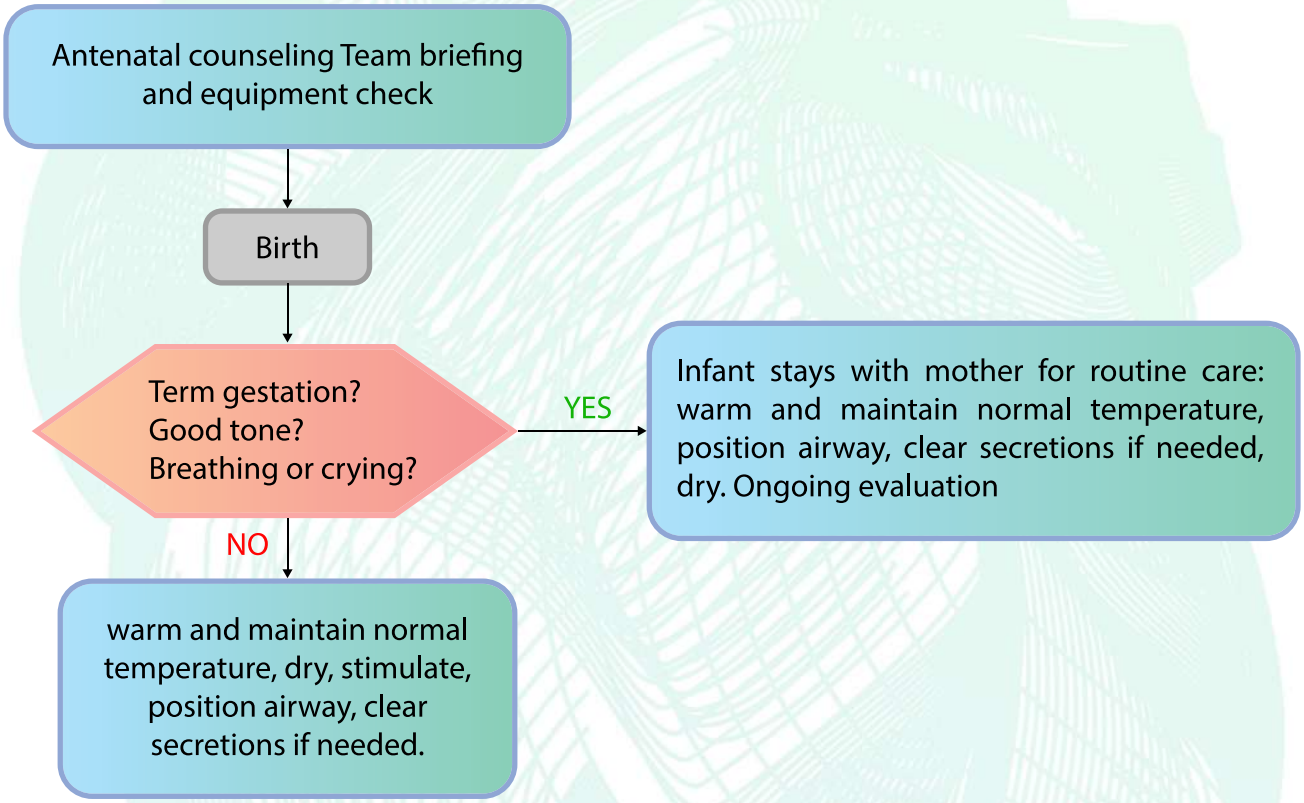
Warm the baby up by making direct skin-to-skin contact, drying him or her off, removing any wet bedding, and gently stimulating the infant.

To ensure that the baby's airway is open, place the infant on the mother's chest or abdomen.

Clear the baby's airway if needed: The baby's activity level and the presence of meconium on the skin will determine how exactly you clear the airway.

Further Evaluation (Initial Steps)

Continue with the subsequent assessment if any of the previous three questions have a negative response.



Provide Warmth

By placing the infant under a radiant warmer, attaching a temperature sensor to prevent hypo- or hyperthermia, and leaving the infant uncovered for better visualization, you can keep the infant's body temperature between 36.5 and 37.5 C. (Figure 1.7)

Figure 1.7 Provide warmth using warmer radiant

Dry

With the case of very preterm babies fewer than 32 weeks' gestation, drying is not essential and the baby should be covered immediately in polyethylene plastic, which reduces evaporative heat loss. Dry the baby with a warm blanket and remove the wet one and put in a new one to avoid heat loss. (Figure 1.8)

Figure 1.8 Dry the baby

Stimulate.

Increase breathing but take note:

1. Gently rubbing the back or clicking the sole if there is inadequate respiration.
2. Refrain from intense stimulation
3. Don't ever shake a child. (Figure 1.9)

Figure 1.9 Stimulate technique by Gently rub the newborn's back, trunk, or extremities

Open the Airway

To keep the baby's airway open and allow for unhindered air entry, keep the baby's head and neck in the sniffing position (neutral or slightly extended, with the eyes pointed straight up toward the ceiling; (Figure 1.10).

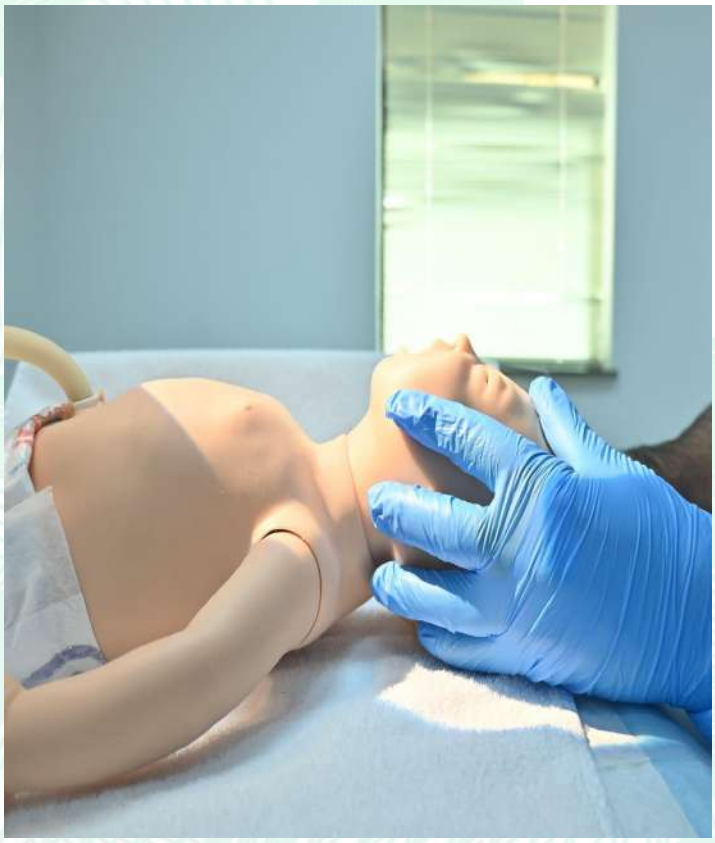


Figure 1.10 Open newborn airway by sniffing position

If necessary, you can place a small, rolled towel under the baby's shoulders to help clear secretions from the airway.

Remove the secretions if the infant is gasping or not breathing, if the airway is blocked, if the baby is having trouble clearing their secretions, if PPV is predicted, or if they have weak muscle tone. Routine suctioning is not advised if the baby is active.

With the baby's head turned to the side, gently clear the secretions; suction the mouth before nose to prevent aspiration (Figure 1.11).

Figure 1.11 Suction the mouth before the nose using a bulb syringe.

In the first minute, excessive suctioning of the posterior pharynx can trigger a vagal reaction that can result in bradycardia or apnea.

- If utilizing a suction catheter, the suction control should be set so that the tubing is blocked and the negative pressure is between 80- and 100-mm Hg.

Assessing the Infant's Reaction to The First Steps

It shouldn't take more than 30 seconds to monitor the newborn's respirations to see if the baby is responding to the first steps.

Is the Infant Gasping or Apneic?

Call for more assistance If the infant is not reacting to the first steps and is still not breathing, gasping for air, or has a heart rate of less than 100 bpm despite breathing, start the PPV right away.

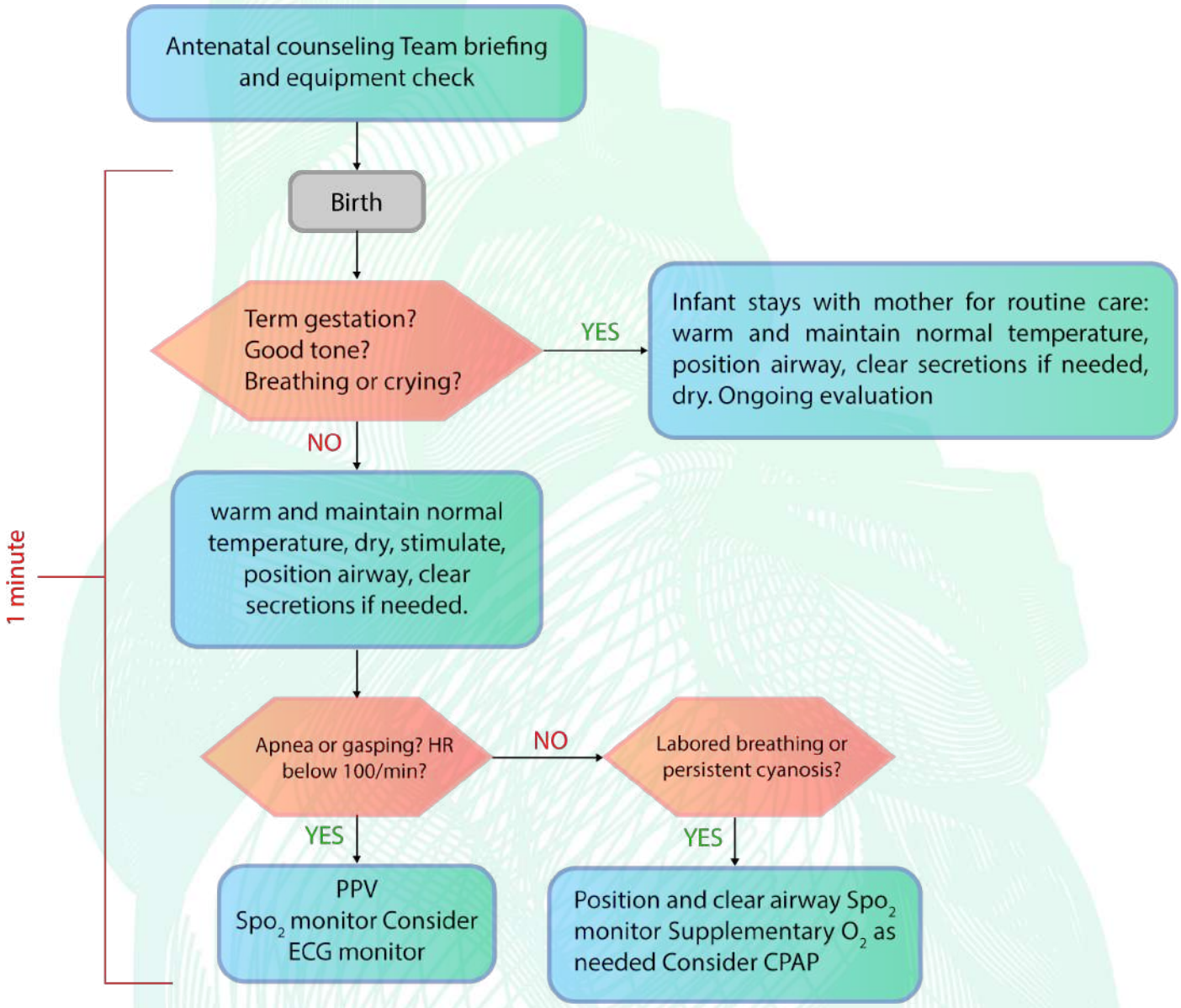
Heart rate is measured by:

- The most accurate way to perform a physical examination is to use a stethoscope and listen to the baby's left side of the chest (Figure 1.12).

Figure 1.12 Assessment of newborn's heart rate

- Feeling the pulse near the base of the umbilical cord is less reliable and may overestimate the real heart rate. You can tap out the heartbeat on the bed as you're listening so that the rest of your team can hear it.
- If earlier techniques failed to accurately estimate HR, connect the cardiac monitor (in this case you need to call for additional help).

To calculate the heart rate, multiply the number of beats in six seconds by ten. The heart rate is 120 bpm, for instance, if you listen for 6 seconds and hear 12 beats.



Central Cyanosis Vs Acrocyanosis

A blue tint on the skin or mucous membranes brought on by low blood oxygen levels is referred to as cyanosis. Acrocyanosis, which affects only the hands and feet, is a frequent condition in newborns and does not signify low oxygenation. Central cyanosis is the medical term for low oxygen saturation that results in the baby's lips, tongue, and body appearing blue. After birth, healthy infants may have central cyanosis for a few minutes.

Only when oxygen saturation falls below the desired range is additional oxygen required. Oxygen therapy should be based on oxygen saturation. A pulse oximeter should be used to check the baby's oxygenation if persistent central cyanosis is suspected. It should be put on the baby's right hand or wrist.

Preductal Oxygen Saturation Goal

It typically takes several minutes for healthy infants going through a normal transition for their blood oxygen saturation to rise from about 60%, which is the typical intrauterine state, to more than 90%, which is the final state of healthy neonates breathing air.

Compare the infant's preductal oxygen saturation with the range of goal values in (Table 1.6) when the pulse oximeter has a reliable signal. These numbers are based on oxygen saturation measurements taken within the first 10 minutes of life from healthy, term newborns breathing room air.

Table 1.6 Neonates' Target Concentration During Resuscitation

Time from birth	Neonates' target concentration during resuscitation in %
1 min	60-65 %
2 min	65-70 %
3 min	70-75 %
4 min	75-80 %
5 min	80-85 %
10 min	85-95 %

There is still debate about which targets should be employed, and the appropriate oxygen saturation after birth has not been determined. These goals have been chosen to symbolize an agreement on respectable principles that are simple to recall.

Administering Supplemental Oxygen

Put the oxygen tubing close to the baby's mouth and nose to start free flow oxygen if preductal oxygen saturation falls below the normal range, but keep in mind that this is ineffective if the child is not breathing. (Figure 1.13)

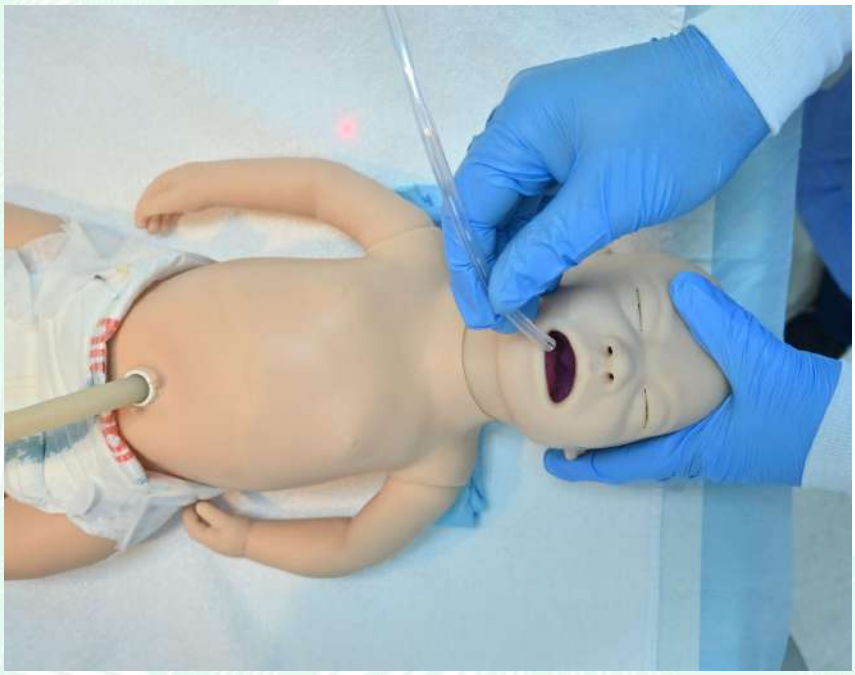


Figure 1.13 Providing Free-flow oxygen by holding oxygen tubing close to the baby's mouth and nose

- If you're using a T-piece resuscitator, make sure the opening on the T-piece cap is not covered and that the pressure manometer on the T-piece is set to read (zero).

Figure 1.14 Providing Free-flow oxygen given by T-piece resuscitator

Figure 1.15 Providing Free-flow oxygen given by the tail of a self-inflating bag with an open reservoir.

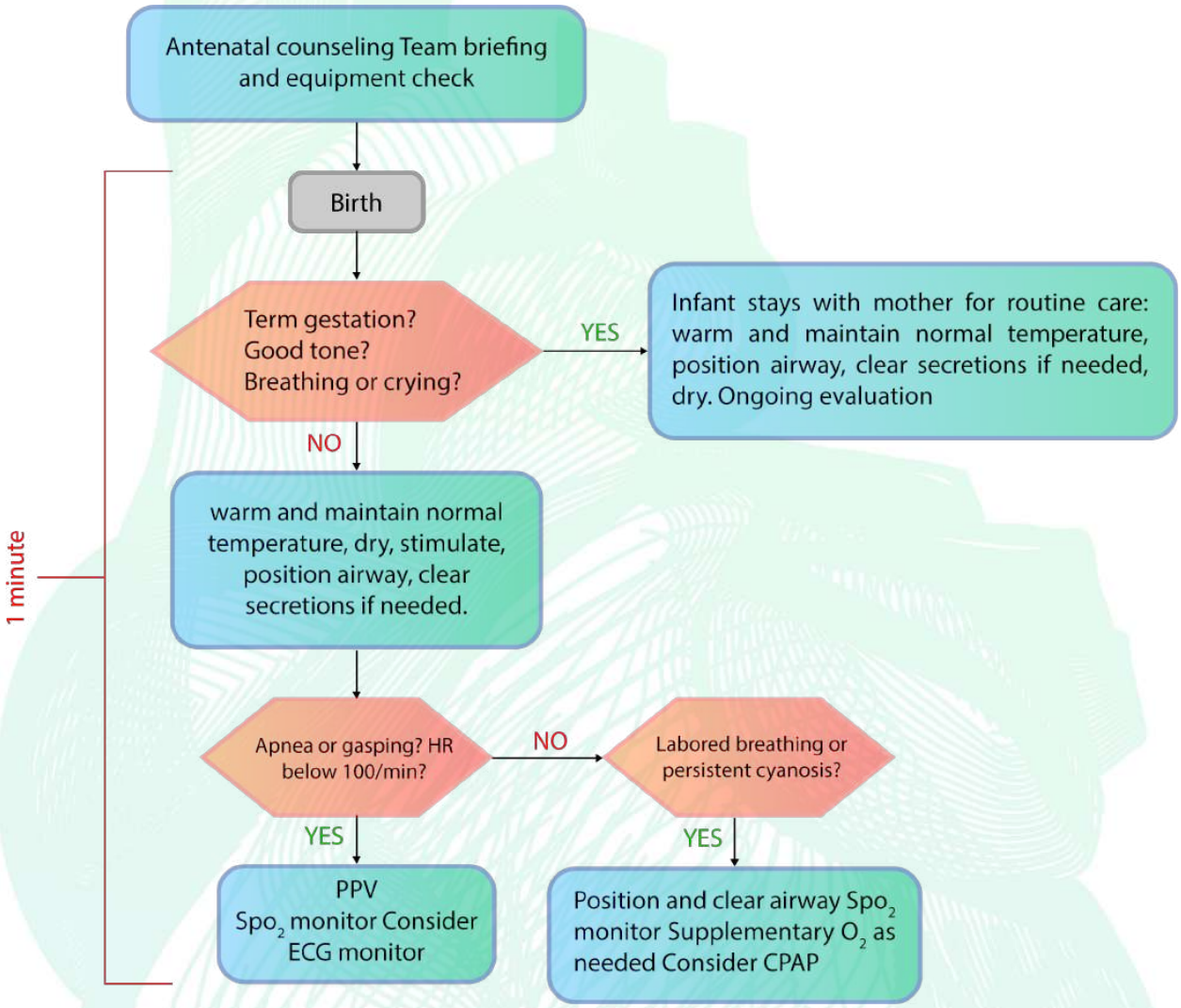
How should extra oxygen be administered if the infant still need it after the first few minutes?

Use pulse oximetry to determine the proper FiO_2 if the newborn's respirations and heart rate are stabilized but He/She still need extra oxygen.

- Oxygen administered to babies for an extended amount of time should be heated and humidified to minimize heat loss.

What should you do if a baby's breathing is laborious or if their oxygen saturation level is consistently low?

CPAP could be used if despite 100% oxygen and labored breathing, the oxygen saturation remains below the normal range. CPAP is a technique for respiratory support that keeps a baby's lungs open by applying a constant, low gas pressure. Only if the baby is breathing and has a heart rate of at least 100 beats per minute could CPAP be considered in the delivery room.



In the delivery room, a flow-inflating bag or a T-piece resuscitator can be used to administer a CPAP trial. A self-inflating bag cannot be used to administer CPAP.

CHAPTER 2

The Control of Breathing During Newborn Resuscitation Ventilation under Positive Pressure

Chapter Objectives:

When this chapter is finished, you'll be able to:

- Describe the positive pressure ventilation indications.
- Outline the correct procedure for delivering positive pressure ventilation.
- Assess the anticipated effects of adequate ventilation.
- Take appropriate action regarding ventilation.
- Be able to correctly insert a laryngeal mask.
- Recognize when endotracheal intubation is necessary.
- Know how to perform tracheal intubation.
- List the circumstances in which endotracheal intubation is necessary for resuscitation.
- Set up the necessary tools for endotracheal intubation.
- Aid in performing endotracheal intubation
- Insert an endotracheal tube with the aid of a laryngoscope.
- Confirm the endotracheal tube's placement in the trachea.
- Suck out the trachea's heavy secretions with an endotracheal tube.

Positive Pressure Ventilation indications

Providing efficient breathing is one of the cornerstones of newborn resuscitation. After the initial steps, if the infant is still not breathing, is breathing abnormally (gasping), or has a heart rate below 100 beats per minute, positive pressure ventilation devices are used to start ventilation. Make sure the baby's head is in a neutral posture while it is already under radiant warmer. (Figure 2.1) or by using a shoulder roll to keep the airway open, particularly for premature infants (Fiure 2.2).

Figure 2.1 Sniffing position

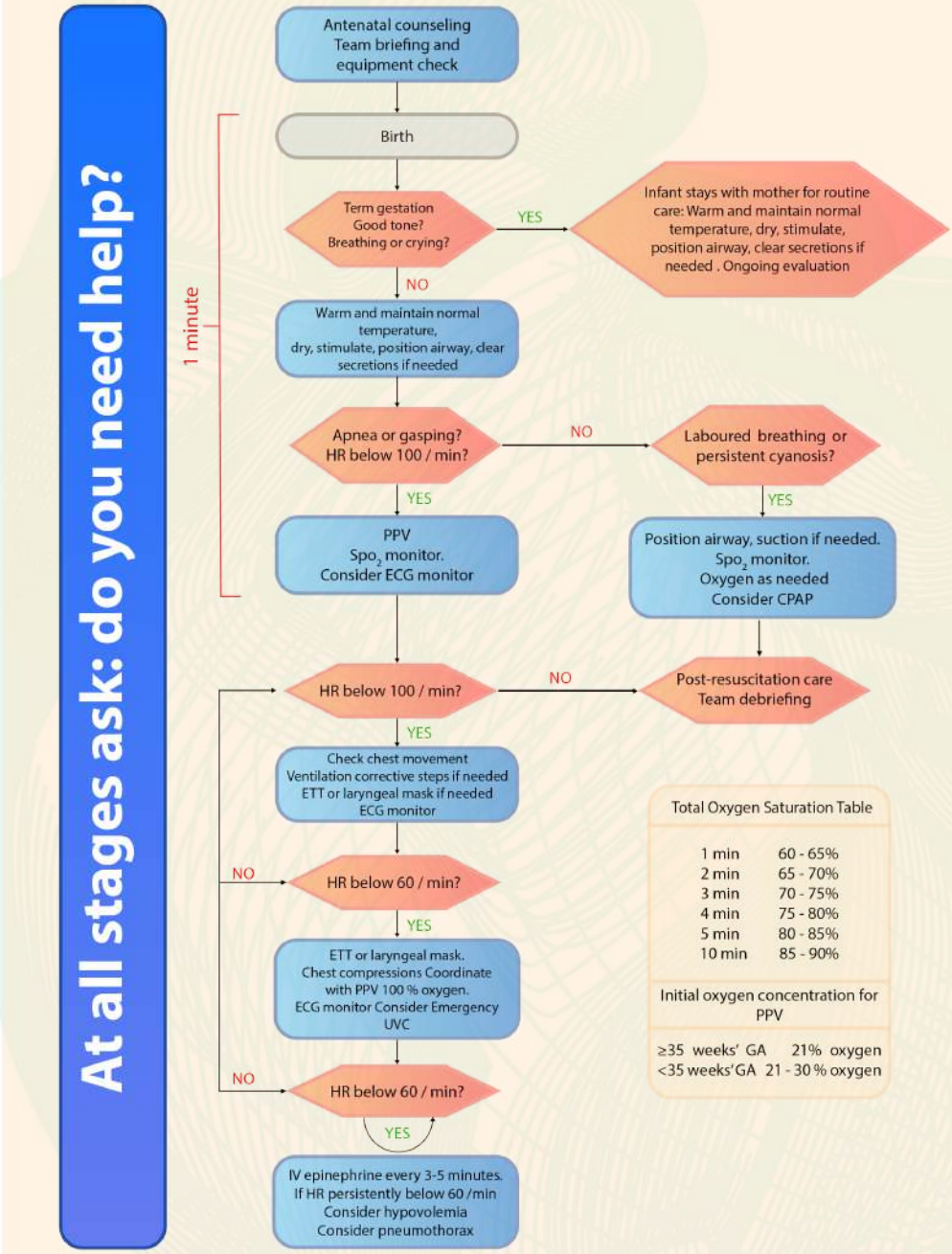
Figure 2.2 Shoulder roll to position the head and neck

Which phrases or terms are most often used to describe positive-pressure ventilation?

There are numerous abbreviations and names used to refer to PPV:

- The highest pressure that is applied with each breath is known as peak inflation pressure (PIP).
- When a newborn is receiving assisted breathing, the gas pressure in the lungs is maintained at a positive end-expiratory pressure (PEEP).
- Continuous positive airway pressure (CPAP) is the gas pressure that is maintained in the lungs when a baby breathes without assistance.
- The number of assisted breaths given each minute is known as rate.
- Inflation time (IT): the length of each positive-pressure breath's inflation phase in seconds.
- Manometer: a device for assessing pressure of the gas

Saudi Heart Association NRP



Always ensure that baby head position is maintained all the time during and after the initial steps.

Positive pressure ventilation devices

1. **A self-inflating bag:** squeezed and released, fills spontaneously with gas (air, oxygen, or a mixture of both).

- Unless squeezed, a self-inflating bag stays completely inflated. When the bag is released, it recoils and pulls in new gas. The bag fills with gas at the specified rate if it is connected to an oxygen source (Figure 2.3).
- If the bag is not connected to an oxygen source, room air (21% oxygen) is drawn into the bag to fill it.
- The bag self-inflates, therefore maintaining inflation does not require compressed gas or a tight seal at the outlet.
- The majority of self-inflating bags contain a pop-off valve, also known as a pressure release valve, which lowers the peak pressure. Normally, these valves are programmed to open at 30 to 40 cm H20 pressure, however due to their unreliability, they may not open until higher pressures are reached. Some self-inflating bags contain a mechanism that enables the pressure release valve to be momentarily blocked, enabling the application of higher pressures. It should be uncommon for the pop-off valve to become blocked, and extreme pressure should be avoided at all costs.

Figure 2.3 Self-inflating bag

- The amount of times you squeeze the bag and how rapidly you do so affect the ventilation rate and inflating time, respectively.
- The degree to which the bag is squeezed determines PIP.
- If the bag has an extra valve attached, PEEP can be given.
- A self-inflating bag and mask cannot be used to give CPAP or free-flow oxygen because gas cannot exit the mask without the bag being squeezed.

- On some self-inflating bags, the open reservoir (or "tail") can be used to give free-flow oxygen.
- A manometer should always be used to precisely measure the gas pressure. Manometer can be either built in or attached. Attachment site should not be left open to prevent gas leak.

Testing a self-inflating bag device: Additionally, in order for the bag mask to function properly, it must be examined sooner than necessary, even before the baby is delivered (Table 2.1).

Table 2.1 Testing A Self-Inflating Bag

Squeeze the bag while blocking the mask or gas outlet. • Does your hand feel pressed against anything? • Does the manometer show pressure readings? • Does the pressure-release valve open at a pressure of 30 to 40 cm H20 as shown by the manometer? • Does the bag immediately re-inflate after you let go?	If not, does the bag have a break or leak? Is there an open attachment site because the manometer is missing? • Is the valve that releases pressure obstructed or missing?

- Select the appropriate self-inflating bag size for neonatal CPR: 240 mL of bag
  A volume of 240 mL should be more than enough to inflate the lungs of any baby as the tidal volume needed by a newborn infant is roughly 5–10 mL/kg body weight. Select the appropriate size mask for the newborn child's size.
  The rim of the mask should only cover the mouth, nose, and tip of the chin; it should not conceal the eyes. It shouldn't go below the chin. If the mask is too big, it will be impossible to get a proper seal and to have enough ventilation.
- Put the mask and bag together, making sure that all the valves are present and properly inserted.
- Squeeze the bag repeatedly while holding the mask firmly against your hand to feel air pressure on your hand and watch the pop-off valve open and close.
- With the baby's head in a neutral position, press the "guide finger" onto the baby's chin. Line-up Roll the mask onto the face starting from the chin up by inserting the outside edge of the mask into the groove between the guiding finger and the tip of the chin.
- Using the thumb and index finger placed towards the outer border of the flat portion of the mask, apply evenly distributed downward pressure on the mask ("two-point top hold")
- Utilize the remaining fingers to apply jaw lift so that the upward pressure counteracts the downward pressure from the two-point top hold to produce a tight seal.
- Ventilate between 40 and 60 inflations per minute.

Beware:
In babies with healthy lungs, hyperventilation can result in dangerously low CO_2 levels (<30 mmHg). Their breathing center may become even more depressed, and cerebral blood flow may be decreased.

In neonates who are unlikely to have lung illness, avoid hyperventilating (e.g. a term infant with peripartum hypoxic ischemic).

Air or oxygen for resuscitation? Term infants and preterm ≥ 35 weeks use air to start (21%). For premature neonates born before 35 weeks, use (21% to 30% oxygen to start).

If a blender is not accessible, use air. The prudent use of additional oxygen should be determined by pulse oximetry.

2. A flow-inflating bag, also known as an anesthetic bag, only fills when gas from a compressed source enters it and the outlet is sealed.

- When a compressed gas source is flowing into the bag and the outlet is sealed, as happens when a mask is placed on a baby's face, a flow-inflating bag will only inflate (Figure 2.4). The bag collapses and resembles a deflated balloon if compressed gas is not entering the bag or the exit is not sealed. and how quickly you squeeze determines the inflating time (Figure 2.5).

Figure 2.4 flow-inflating bag

Figure 2.5 Flow inflating bag deflated when compressed gas is not flowing into the bag

3. Compressed gas is continuously directed at the infant using a T-piece resuscitation device. When a top aperture of the T-shaped device is blocked, pressure rises (Figure 2.6).

T-piece resuscitator

A mechanical device known as a "T-piece resuscitator" employs valves to control the flow of pressurized gas toward the patient. The gadget needs a compressed gas supply, just like the flow-inflating bag. A gas escape port on the top of the T-piece cap is alternately blocked and opened to provide breaths.

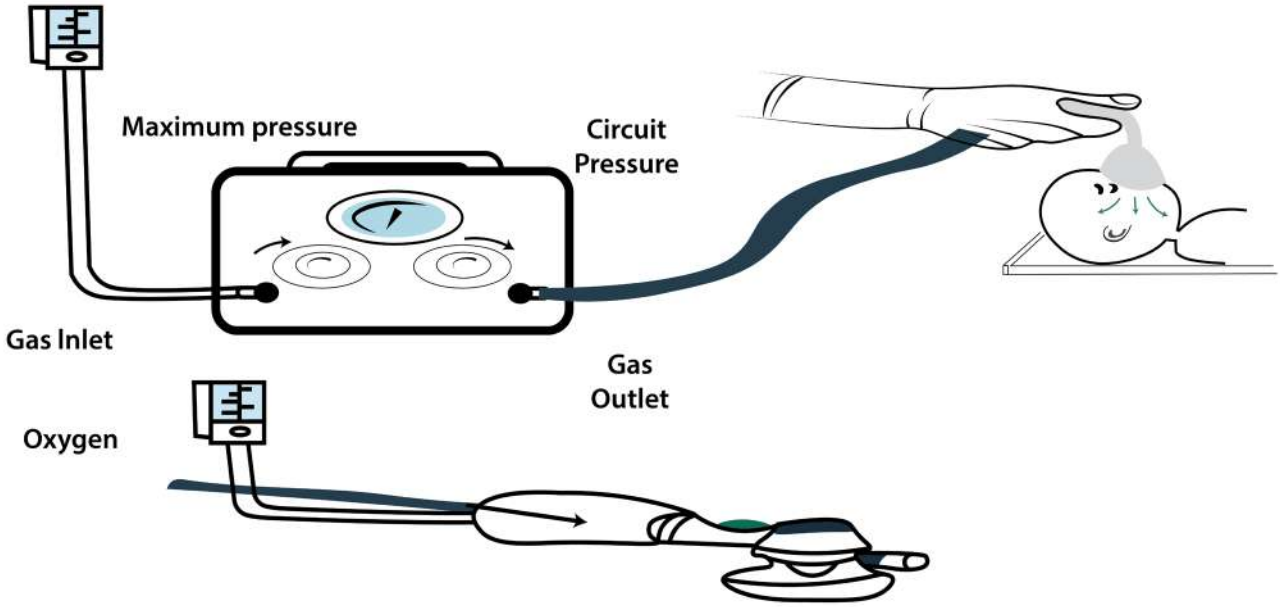


Figure 2.6 T- piece resuscitator Device parts and self inflating bag

Gas is directed through the device and toward the baby when the entrance is blocked. A small amount of gas escapes through the cap when the aperture is opened.

Figure 2.7 Testing a T-piece resuscitator

The frequency with which you cover the cap's opening affects the ventilation rate, and the duration during which the aperture is covered affects the inflation time.

To limit the inflating pressure, there are two control dials.

- The aided breaths' peak pressure is constrained by the peak inflation pressure regulation. Similar to the pop-off valve on a self-inflating bag, the maximum pressure relief control is a safety feature that stops the operator from raising the peak pressure above a certain level. A detachable shield may be placed over this control dial
- The PEEP and CPAP are adjusted by turning a dial on the T-piece cap, which regulates the amount of gas allowed to escape between breaths.
- •Set the desired peak inflation pressure (PIP) by occluding the T-piece cap with your finger and adjusting the inflation pressure control to the selected pressure (Figure 2.8).

Figure 2.8 Adjusting the peak inflation pressure (PIP) with T piece

- The inflation and expiratory pressures are measured via an integrated manometer.

Table 2.3 T-Piece Resuscitator Device Testing	
Without obstructing the T-piece cap's aperture, block the mask or T-piece's outlet. Is the PEEP showing 5 cm H2O? Close off the T-piece cap's aperture. • Is the maximum pressure between 20 and 25 cm H2O?	Is the T-piece gas exit sealed if the pressure is off? • Is the gas inlet's gas tubing connected? The gas flow should be set at 10 L/min, right? • Is the nearby gas outlet disconnected? • Is the PIP, PEEP, or maximum circuit pressure wrongly set?

Indications of Effective Positive Pressure Ventilation

Is your technique effective?

If Your Ventilation Technique Is Effective, three signs are observed:

1. An increase in heart rate
2. Chest is moving.
3. Increase in Oxygenation

Indications of Positive Pressure Ventilation.

When necessary, PPV should begin after 30 seconds following the initial steps and if the HR is less than 100,apnic or gasping. Additionally, a trial of PPV may be considered if the baby is breathing and has a heart rate greater than or equal to 100 bpm, but free-flow oxygen or CPAP are unable to keep the baby's oxygen saturation within the desired range.

If you are alone, make a quick call for assistance. Your assistant(s) will keep an eye on the baby's chest movement, measure the baby's oxygen saturation using pulse oximetry, and record events as they take place.

How should positive-pressure ventilation be started?

Place yourself near the radiant warmer.

The person in charge of holding the mask on the infant's face and setting the airway is positioned at the infant's head (Figure 2.9). It is easier for team members to be to the side of the bed to place the pulse oximeter and cardiac monitor, listen to heartbeat and breath sounds, and Observe chest movement from that position

Figure 2.9 Correct position to provide assisted ventilation.

Complete the initial steps of neonatal care.

Suction the mouth and nose, if you haven't previously, to ensure that secretions won't Obstruct the airway during PPV. The baby's head and neck should be in a position.

In the sniffing position, the baby's head and neck should be in a midline, neutral, or slightly stretched position so that the baby's eyes are pointed directly upward towards the ceiling. One of the most frequent

causes of inadequate mask ventilation is improper positioning of the head. If the neck is overly flexed or stretched, the airway will be blocked. A wrapped towel or small blanket tucked beneath the baby's shoulders can assist elevate the shoulders slightly because the back of a newborn's head (occiput) is prominent.

How should the mask be placed on the infant's face?

Choose the Appropriate Mask.

At every birth, a range of mask sizes ought to be supplied. Neonatal masks have a padded or flexible, soft rim.

Masks with anatomical shapes are worn with the pointed end over the nose. The mask should cover the lips and nose but not the eyes, and should rest on the chin (Figure 2.10). A tight seal will be made on the face with the right mask. A cushioned mask's rim may be difficult to seal if it is not adequately inflated.

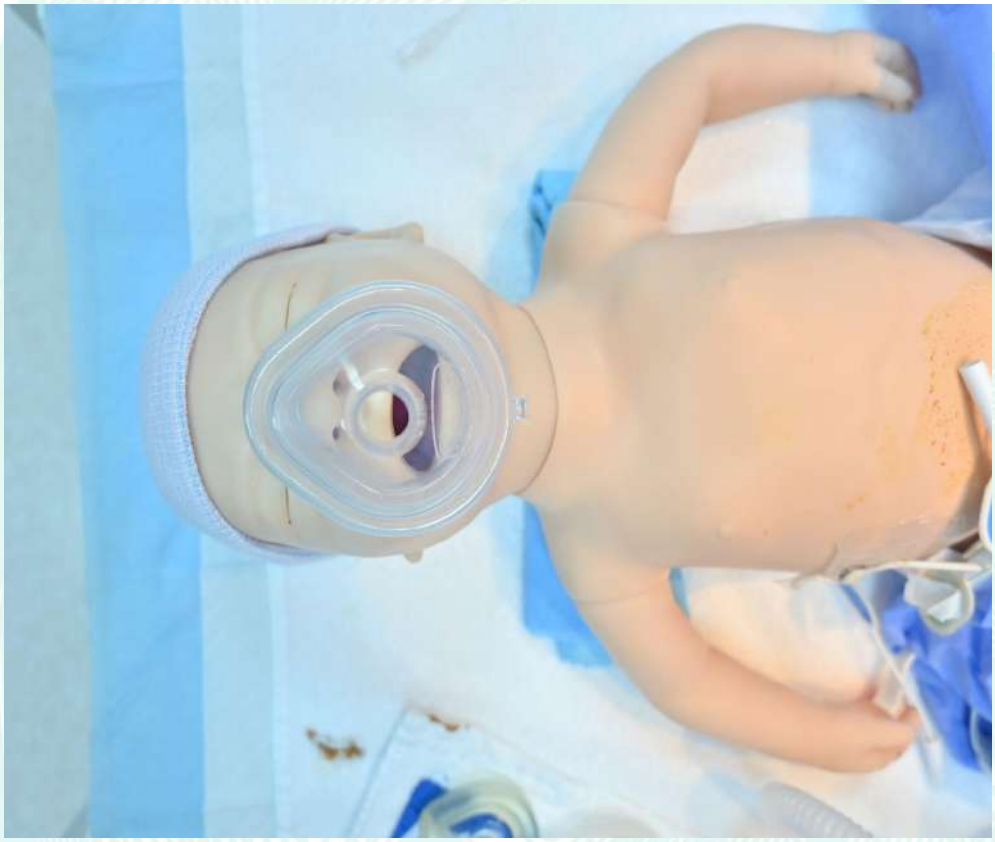


Figure 2.10 Anatomically shaped face mask

Place the mask on the baby's face

To provide the pressure that will inflate the lungs, the mask's rim and face must form an airtight seal.

If there is a large air loss or leak from a poorly positioned mask, ventilation won't function.

One-Hand Hold

- Place the chin at the bottom of an anatomic mask, then cover the mouth and nose with the mask.
- The mask's bottom should lie on the chin rather than below it. To prevent pressing on the baby's eyes or causing a significant leak around the eyes, the mask's tip should sit at or just below the nasal bridge.
- Hold the mask on the face while encircling the rim with your thumb and index finger.
- Put the other 3 fingers beneath the jaw's bony angle and slowly raise it up toward the mask.
- When the mask is on, you can make an airtight seal by consistently pressing down on the rim of the mask with your head in the sniffing position (Figure 2.11).

Some circular masks include a stem that holds them in place rather than the rim, so they can be worn directly over the nose and mouth. This kind of mask will leak if the rim is put under pressure, distorting its shape.

Figure 2.11 Maintaining a seal with the 1-hand hold using an anatomic mask

Two-Hand Hold with Jaw Thrust

With only one hand, it can be challenging to keep a solid seal and the right head posture. If you can't get a good seal, raise the jaw while holding the mask in place with both hands.

The mask should be held against the face with the thumb and first finger of both hands. The other three fingers of each hand should be placed under the bony angle of the jaw, and the jaw should be slowly lifted upward toward the mask (Figure 2.12).

Another team member stands by the baby's side and squeezes the bag or covers the T-piece cap while you focus on creating a strong seal and keeping the proper midline head position.

The baby's response is being watched by a third person.

Figure 2.12 Maintaining a seal with the 2 - hand hold using an anatomic mask

Precautions

The mask must be held with caution.
Make sure your hand doesn't touch the baby's eyes.
Do not "jam" the mask against the face or block the nasal passages.
Be careful not to compress the soft tissue of the baby's neck, as this can clog the mask, cause air to leak around the side of the mask, inadvertently bend the baby's neck, or produce facial bruises.

Recheck the position of the mask and baby's head at intervals as needed.

What Level of Oxygen Should Be Present When Positive Pressure Breathing Is Initiated?

According to studies, starting resuscitation in term and late preterm newborns with 21% oxygen and preterm newborns with 21% to 30% oxygen is just as successful as starting it with 100% oxygen. This approach suggests striving to maintain an oxygen saturation, measured using pulse oximetry, that is close to the saturation measured in healthy babies born at term in order to balance the risks that may be associated with extremes of oxygenation. The fetus's blood oxygen saturation is around 60% before birth. The oxygen saturation progressively rises above 90% after birth.

Set the blender to 21% oxygen for the first resuscitation of neonates who are more than or equal to 35 weeks gestation (Figure 2.13).

Figure 2.13 Adjust blender to desired F102.

Table 2.4 PPV Initial Oxygen Concentration	
GA of greater than or equal to 35 weeks	21% oxygen
GA of less than 35 weeks	21%-30% oxygen

As soon as PPV is started, a helper should insert a pulse oximeter sensor on the right hand or wrist. If necessary, compare the infant's preductal oxygen saturation with the range of goal values listed in Table 2.5 once the pulse oximeter is reliably reading.

Table 2.5 Target Oxygen Saturation	
Time from birth	Target saturations for newborns during resuscitation in %
1 min	60-65 %
2 min	65-70 %
3 min	70-75 %
4 min	75-80 %
5 min	80-85 %
10 min	85-95 %

During positive pressure ventilation, what ventilation rate should be used?

To help you keep the right pace, count aloud.
The recommended breathing rate is 40 to 60 breaths per minute.
Utilize the rhythm "Breathe, two, three, breathe then repeat again.
Squeeze the bag or cover the T-piece cap while saying "Breathe," then release "two and three:

How much pressure should be applied in positive-pressure ventilation?

Gas exchange after delivery depends on the fetal lung fluid within the alveoli being replaced with air. In order to transfer fluid out of the air spaces and inflate the alveoli, the newborn may need more than typical pressure during the first few aided breaths if he or she has not yet taken a spontaneous breath.

However, too high airway pressures and lung volumes can harm the lungs. The objective is to inflate and aerate the lungs with just enough pressure to raise heart rate and oxygen saturation (Table 2.6).

Table 2.6 Initial Positive-Pressure Ventilation Settings	
	Initial Setting
Gas flow	10 liters per minute
Rate	40-60 breaths/minute
PIP	20-25 cm H_2O
PEEP	5 cm H_2O

With each breath, once the lungs are fully inflated, you should notice a gradual rise and fall in the chest. If the infant appears to have deep chest movement, while giving PPV, you're definitely applying too much pressure, which could cause the lungs to become overinflated. This raises the possibility of causing a lung air leak (pneumothorax). Keep in mind that the capacity of a standard resuscitation bag contains substantially more gas than a regular breath. It is possible to produce adequate ventilation without noticeable chest movement in preterm infants, albeit this may be less accurate and increase the risk of harm from overinflation.

How can the baby's response to positive-pressure ventilation be assessed?

The most crucial sign of a effective PPV is an increase in heart rate. An aide will keep track of the infant's heart rate reaction as soon as you start the PPV. A stethoscope can be used to measure the initial heart rate. As soon as PPV starts, a helper should apply a pulse oximeter sensor to track the infant's heart rate and oxygen saturation continuously. If PPV was initiated because the infant's heart rate was low, things need to get better quickly.

- The infant should see an increase in heart rate within 15 seconds after beginning PPV.
- The infant's heart rate ought to exceed 100 beats per minute within 30 seconds of the commencement of PPV.
- Continue PPV if the baby's heart rate starts to rise after the first 15 seconds. Following 30 seconds of PPV, you will verify the response once more.
- After the first 15 seconds, if the baby's heart rate does not rise, ask your helper if the baby's chest is moving.
- Continue PPV while keeping an eye on your breathing technique if the chest is moving. After 30 seconds of PPV, you will assess the baby's response once more.
- If the chest is motionless, you could not be ventilating the infant's lungs. To adjust your ventilation, use the instructions indicated below until you can move your chest with PPV.

If the baby's heart rate does not increase and the chest does not move, you will need to make a sequence of changes known as the ventilation corrective steps.

Leaks surrounding the mask, airway obstructions, and low ventilation pressure are the most likely causes of poor mask ventilation. These typical issues are addressed by the ventilation remedial steps, which are presented in Table 2.7.

Table 2.7 The Corrective Steps for the MR. SOPA Ventilation

Corrective Step	Actions
M: Mask adjustment.	Reapply the mask, then forward the jaw. Think about the two-hand hold.
R: Reposition the head and neck	Place head neutral or slightly extended.
Give 5 breaths, then assess chest movement. Do the following if there is no chest movement.	
S: Suction the mouth and nose.	Use a suction catheter or a bulb syringe.
O: Open the mouth.	To softly open the mouth, use a finger.
Give 5 breaths and assess chest movement. If no chest movement, do the next step.	
P: Pressure increases.	Increase pressure in 5-10 cm H_2O steps. 40 cm H_2O maximum term and 30 cm H_2O maximum preterm.
Take 5 breaths, then assess chest movement. if no chest movement, do the next step.	
A: Alternative airway.	Insert an endotracheal tube or laryngeal mask.
Examine chest movement and breath sounds during PPV.	

You will carry out the corrective actions in order until you can move your chest while taking supported breaths.

Endotracheal & LMA intubation

If the infant's chest began to move following one of the ventilation correction measures. What will you do next?

Declare, "The chest is moving NOW," as soon as you see the chest rise with each assisted breath. This is to make sure that everyone on your team is aware of your assessment and understands why no further MR. SOPA steps are required.

Continue PPV that moves the chest for another 30 seconds while keeping an eye on breathing rate, pressure, and the baby's response in terms of increasing heart rate.

Repeat the breathing correction techniques as necessary if you have trouble maintaining chest movement throughout this period. If you constantly struggle to maintain efficient ventilation while using a face mask, place an alternate airway.

What should you do after 30 seconds of lung-ventilation positive-pressure ventilation?

You will recheck the infant's heart rate response after 30 seconds of PPV that ventilates the lungs, as indicated by increasing heart rate or chest movement.

Assisted ventilation has been successful if the heart rate is greater than or equal to 100 beats per minute.

Continue taking 40–60 breaths per minute of ventilation. Keep an eye on the infant's breathing effort, heart rate, and chest movement.
Based on the results of the pulse oximetry, adjust the FiO_2.

Observe effective spontaneous respirations, gradually reduce the rate of PPV, and gently stimulate the infant to breathe if the heart rate is continuously higher than 100 bpm.

When the infant's heart rate is consistently greater than 100 beats per minute and spontaneous breathing is ongoing, positive-pressure ventilation may be stopped.

The heartbeat is at least 60 beats per minute, but not more than 100.

As long as the infant is steadily improving and the heart rate is increasing, keep giving PPV.

In order to achieve the goal saturation range shown in the table 2.5, monitor the oxygen saturation and modify the FIO_2 as necessary.

If the heart rate does not Increase, take into account each of the following:

- Immediately review your ventilation strategy.

  Does the chest move?
  Do you ventilate at 40 to 60 breaths per minute?
  Do you hear breath sounds?
  Modify the FiO_2 to achieve the desired saturation.
  If it hasn't previously been done, place cardiac monitor leads.
  Consider placing an endotracheal tube or laryngeal mask.

The heart rate is less than 60 BPM

Consider each of the following:

- Right now, review your ventilation plan. Is the chest rising? Are your breathing cycles between 40 and 60 per minute? Are breath sounds audible? Adjust the ventilation techniques as necessary.

If the pulse oximeter provides a strong signal, adjust the FiO_2 to get the desired saturation.
Install the cardiac monitor's leads if you haven't done already, then begin continuous monitoring.

- If not already done, place a laryngeal mask or endotracheal tube. Seek further assistance if facing difficulty.

We have to make sure that all above stepps do not exceed 2 minutes to start chest compression if the infant's heart rate is still less than 60 BPM after at least 30 seconds of PPV that moves the chest, ideally through a different airway, increase the FiO_2 to 100% and begin chest compressions.

Can the performance of ventilation be monitored using a carbon dioxide detector as the ventilation corrective measures are being implemented?

Using a CO_2 detector can provide you and your team with a visual cue to recognize when you have achieved ventilation that expands and aerates the lungs during the ventilation corrective phases. Put a CO_2 detector in between the PPV device and mask. If there is a proper gas exchange and effective lung ventilation, CO_2 should be evacuated through the mask.

- If you are properly ventilating the lungs, the detector should turn yellow during each exhalation (Figure 2.14).
- If, after a corrective measure, the CO_2 detector turns from purple to yellow, the measure is successful, and the infant's heart rate is expected to shortly improve.

Figure 2.14 Carbon dioxide detector used during ventilation corrective steps.

If the CO_2 detector does not turn yellow, your face-mask ventilation attempts may not be ventilating the lungs.

Laryngeal mask?

A laryngeal mask is a small mask with an attached breathing tube.

The mask is inserted into the infant's mouth and then moved up into the throat. The glottis, via which the baby's trachea enters the body, is sealed off as a result (Figure 2.15).

Because a laryngeal mask creates a tighter seal than a face mask, it may improve ventilation effectiveness. In contrast to endotracheal intubation, a laryngeal mask can be placed without the use of any instruments, and you don't have to look at the baby's vocal cords to do it.

If a face mask is unable to provide adequate ventilation for the newborn and intubation is difficult or unsuccessful, a laryngeal mask may provide a successful rescue airway.

There are several different kinds of masks available, including inflatable masks, soft-gel masks that don't require inflation, pre-curved airway tubes, and ports for stomach drainage tubes. Its use in preterm neonates is restricted because even the tiniest laryngeal masks may be too large for very premature infants. When intubation or face-mask breathing attempts fail, the laryngeal mask provides a reliable backup airway.

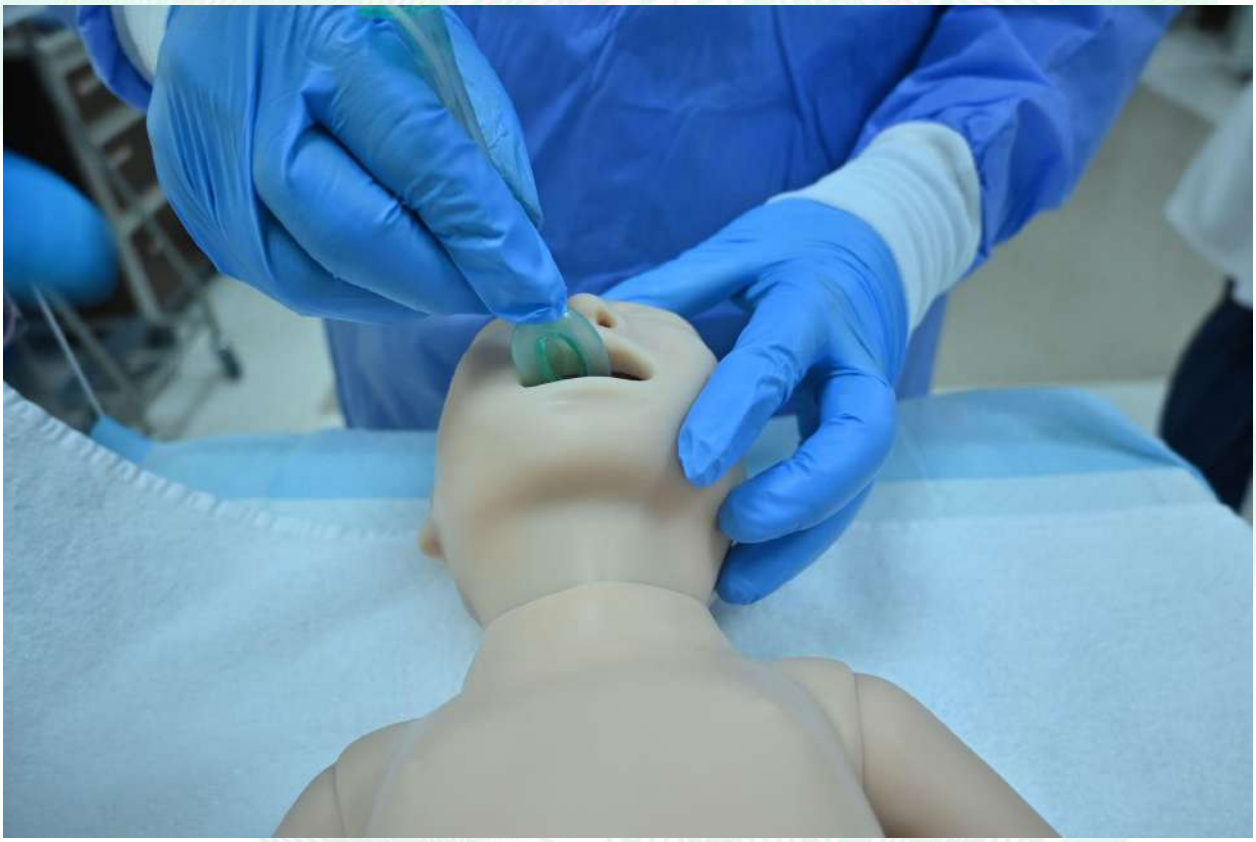


Figure 2.15 Insertion of laryngeal mask into the baby's mouth.

Inserting a laryngeal mask

The instructions and illustrations below provide an example of a disposable laryngeal mask with a pre-curved airway tube and a soft-gel mask that doesn't need to be inflated. It's intended for usage with newborns weighing 2 to 5 kg (Figure 2.16).

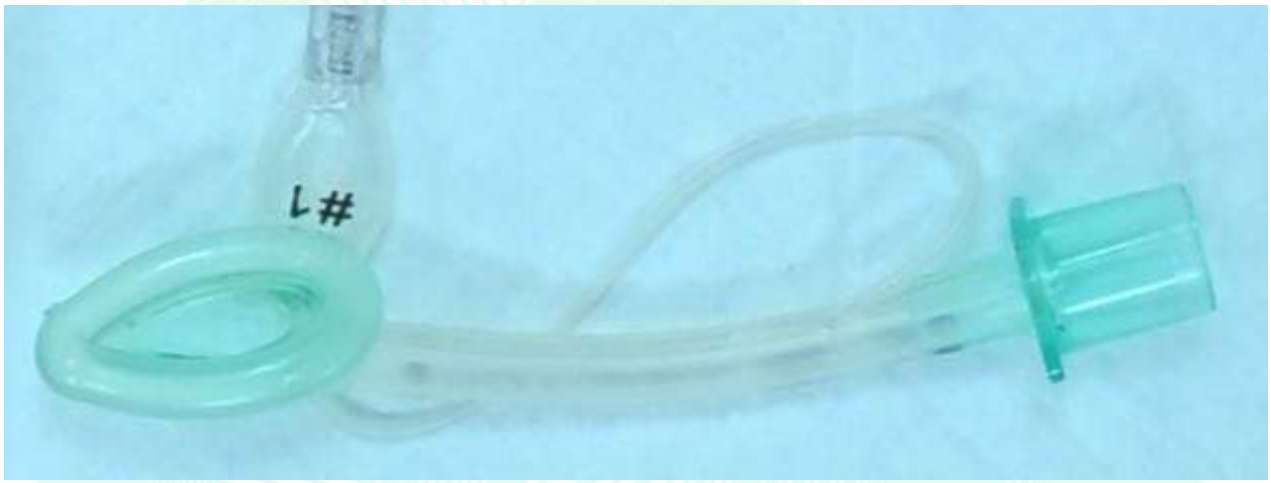


Figure 2.16 Example of laryngeal masks

- Using a clean approach, remove the device from the sterile container and packing. The sides and rear of the mask could be lightly coated with water-based lubricant, although this step may not be necessary because newborns frequently produce enough oral secretions to lubricate the device on their own.

Figure 2.18 Gently pulling baby's chin while LMA insertion

- Remove the device and grease the sides and rear (optional).
- Put the mask in the baby's mouth after preparing it for insertion.

- Stand next to the baby and position him/her in the sniffing position.
- Hold the device with the open bowl of the mask pointed toward the baby's chin and the closed bottom of the mask facing the baby's palate along the airway tube.
- You can get a baby's mouth to open by gently pulling on the chin.
- Place the infant's mouth with the leading point of the mask above the tongue and the bottom of the mask firmly against the palate. Advance the device following the contour of the mouth and palate (Figure 2.19). Attach a CO_2 detector and PPV device while holding the tube in place. Glide the device lower and backward, following the curve of the palate, with a constant but gentle pressure until you feel strong resistance. Start PPV while positioning the device.

Figure 2.19 Advance the device following the contour of the mouth and palate.

- If the laryngeal mask is properly placed and you are giving ventilation that expands the lungs, you should be able to detect exhaled CO_2 within 8 to 10 positive-pressure breaths. You should be able to see the chest wall move when you listen with a stethoscope and hear equal breath sounds. The baby shouldn't have an expanding neck bulge or a loud air leak from the lips.

Removing a laryngeal mask?

The airway can be removed when the baby is able to breathe on his or her own effectively and no longer needs the device, or when an endotracheal tube can be successfully inserted. Through the device, babies can actively breathe, and grunting and weeping sounds may be audible.

- If you decide to remove the laryngeal mask, make sure the mouth and throat are clear of any mucus first.
- If the device has an inflatable rim, deflate it before taking it off.
- What should you do if the infant is breathing on his/her own and has a heart rate of at least 100 bpm, but the breathing is labored or the oxygen saturation is low despite free-flow oxygen being present?

CPAP may be an option if the infant is breathing on his or her own and has a heart rate of at least 100 beats per minute, but the breathing is laborious or grunting, or the oxygen saturation is insufficient.

If the infant is gasping or apneic, or if their heart rate is less than 100 bpm, CPAP shouldn't be used.

A newborn who is breathing on his own can use CPAP to keep pressure in his lungs. In premature infants with surfactant-deficient lungs, where the alveoli collapse at the conclusion of each exhalation, CPAP maintains a slight airway pressure in the lungs at all times.

The baby doesn't have to exert as much effort to fill his or her lungs with air when CPAP is available. Preterm babies that receive early CPAP may not require intubation or mechanical ventilation. Giving CPAP may make a pneumothorax more likely to occur (air leak). Providers need to be aware of this potential issue and ready to handle it.

How should CPAP be administered throughout the initial stabilization phase?

The baby's face is sealed to a mask that is either attached to a flow-inflating bag or a T-piece resuscitator to deliver CPAP. Even with a PEEP valve in place, a self-inflating bag cannot be used to deliver CPAP. The flow-control valve on the flow-inflating bag or the PEEP dial on the cap of the T-piece resuscitator can be adjusted to produce the required CPAP.

- Holding the mask firmly against your hand, check the manometer's reading to see how much CPAP is being delivered before placing the mask on the infant's face (pressure gauge).
- Set the PEEP cap or flow-control valve such that the manometer displays a pressure of 5 to 6 cm H_2O or higher.
- Use the 2-hand hold with jaw thrust to firmly push the mask against the infant's face after adjusting it to the proper pressure (Figure 2.20).
- Instead of pressing the infant's head all the way down into the mattress, lift the jaw into the mask.
- Verify that the pressure remains at the chosen level. If it is lower, there might not be an airtight seal on the baby's face with the mask

Figure 2.20 Using 2- hand hold with jaw thrust to administering face-mask CPAP with a T-piece

- Depending on how hard the infant is trying to breathe, you may need to alter the CPAP. Use no more than 8 cm H_2O at a time.
- When using CPAP, you SHOULD NOT squeeze the flow or occlude the T-piece cap.
- You should administer PPV breaths rather than CPAP if the infant cannot sustain a heart rate of at least 100 bpm through spontaneous respirations.

You will utilize nasal prongs or a nasal mask if CPAP will be used for an extended amount of time. After the initial stabilization, CPAP can be given via a mechanical ventilator, a bubbling water system, or a specific CPAP device.

When should an orogastric tube be inserted?

Gas enters the esophagus and stomach while using a face mask or laryngeal mask for CPAP or PPV. Stomach gas could make ventilation difficult. Consider inserting an orogastric tube and leaving it open to serve as a stomach vent if a newborn needs CPAP or PPV for more than a few minutes.

Required equipment

- 20-mL syringe
- Tape
- 8F orogastric tube

Insertion procedures

- Measure the distances from the earlobe to the lower tip of the sternum (the xiphoid process) and the umbilicus, respectively, as well as from the bridge of the nose to the earlobe. Take note of the centimeter mark on the tube at this location (Figure 2.21). With the mask on, the orogastric tube can be roughly measured to reduce ventilation interruption.

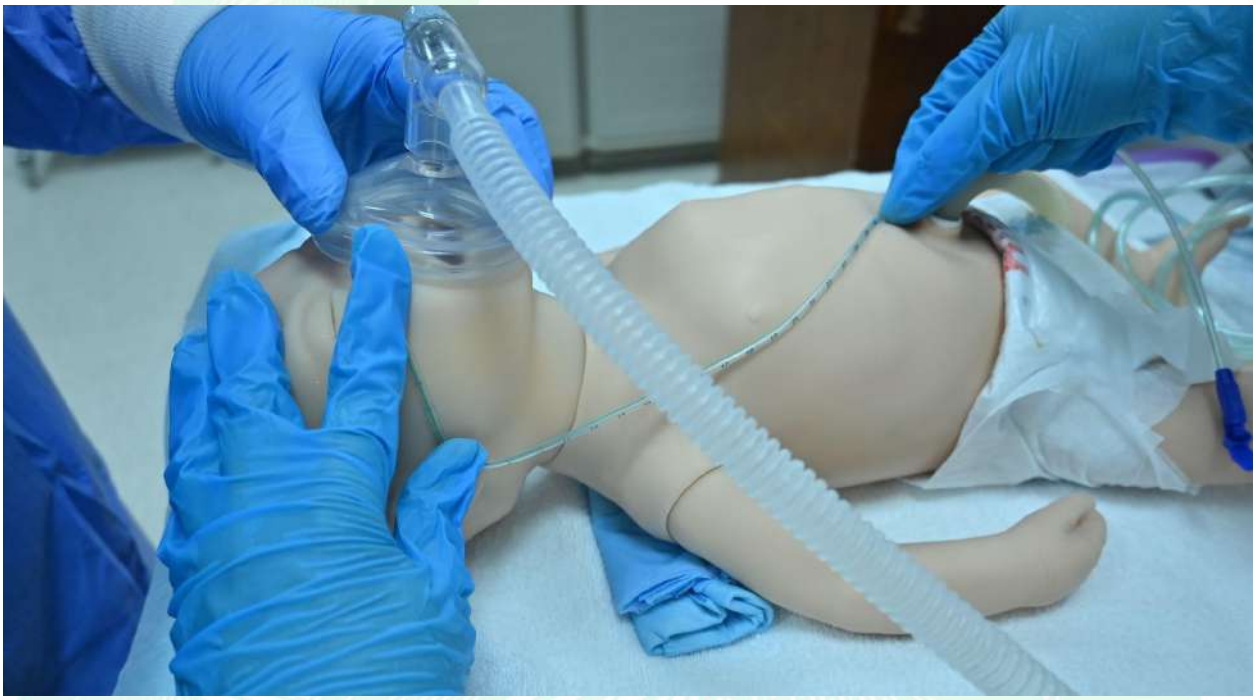


Figure 2.21 Measuring the orogastric tube depth of insertion.

You should put the tube through the mouth (Figure 2.22). Once the tube has been placed, ventilation can begin again. Check the face-mask seal again.

Figure 2.22 Orogastric tube insertion

- After inserting the tube to the correct depth, extract the stomach's contents using a syringe attached (Figure 2.23).
- To allow air to exit the stomach, remove the syringe from the tube and leave the end of the tube open.

Figure 2.23 Aspirating the orogastric tube

- Apply adhesive tape to the baby's cheek (Figure 2.24).

Figure 2.24 Securing the orogastric tube with tape

Focus on Teamwork

Providing PPV highlights several opportunities for effective teams to use the Neonatal Resuscitation

Key Behavioral Skills

Table 2.8 Key Behavioral Skills

Behavior	Example
Consider and plan things	- Depending on the risk factors you recognized, make sure there is enough staff available when the baby is born. - Decide who will conduct PPV, auscultate the heart rate, evaluate chest movement, position the pulse oximeter and cardiac monitor, and record events as they happen during the pre-resuscitation team briefing.
Optimize your workload assignment. When necessary, dial / request for more assistance.	- If PPV is necessary, it will take at least two or three capable providers to complete all tasks promptly. If you have trouble keeping a tight seal, you might need to use the 2-hand hold, which calls for two people: one to administer the aided breath and one to monitor patient response. If intubation is necessary, you might need to call for extra assistance.
Speak clearly.	- It is necessary for the person performing PPV and the person determining how well ventilation is working to exchange information and speak with one another. Sharing information often after each step is essential if any corrective measures are necessary. In order for the team to know that the heart rate should be assessed in 30 seconds, it is crucial to indicate when the chest movement has been achieved ("chest is moving NOW").
Recognize and be familiar with your surroundings. Use the resources at your disposal	- Learn how to use and operate your PPV equipment. - Learn where to get a heart monitor and laryngeal mask.

Using an endotracheal tube

What is an endotracheal tube?

An endotracheal tube (Figure 2.25) is a skinny tube that is advanced into the trachea after being placed through the glottis and between the vocal cords. Endotracheal intubation normally involves the use of a lighted tool (laryngoscope (Figure 2.25) to observe the larynx and guide the insertion of the tube between the vocal cords, despite the fact that digital intubation using only the operator's finger has been described.

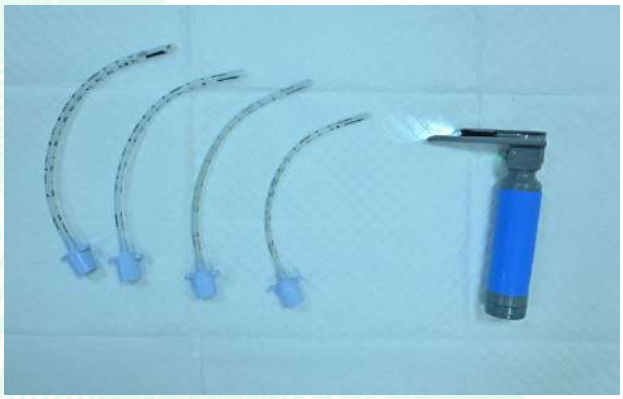


Figure 2.25 Endotracheal tubes and Laryngoscope

When ought one to think about inserting an endotracheal tube?

- After PPV using a face mask or laryngeal mask, if the infant's heart rate stays below 100 beats per minute and does not rise, intubation with an endotracheal tube is strongly advised.
- It is strongly advised to place an endotracheal tube before beginning chest compressions. A laryngeal mask may be used if intubation is unsuccessful or not possible and the infant weighs more than 1.5 kg.
- 30 seconds of endotracheal tube ventilation may increase ventilation effectiveness and avoid the need for chest compressions.
- If chest compressions are required, breathing through an endotracheal tube might help with coordination.
- The compressor can deliver compressions from the head of the bed after intubation.
- If the trachea is blocked by thick secretions, an endotracheal tube should be placed for direct tracheal suction, the delivery of surfactant, and the stabilization of a newborn with a suspected diaphragmatic hernia.
- An endotracheal tube may be taken into consideration if PPV is prolonged to increase the effectiveness and simplicity of assisted ventilation. Endotracheal intubation must be carried out as soon as possible when necessary. If necessary, a person with intubation expertise should be able to be reached right away. This person should be present in the delivery room when the baby is born if intubation will be required.

What tools and supplies must be on hand for intubation?

Supplies and equipment for intubation should be maintained close by and easily accessible.
Before a high-risk birth, it's critical to plan the materials and equipment needed for an intubation and anticipate the need for one.

The following items should be included in each birth room, nursery, and emergency room in at least one full set each (Figure 2.26):

- Laryngoscope grip an extra pair should be accessible if the handle relies on replacement batteries and bulbs.
- Laryngoscope blades (straight Miller): No. 1 for term newborns, No. 0 for preterm newborns, and No. 00 for premature newborns (optional for extremely preterm newborn)
- Although size 2.0 mm to size 4.0 mm, and tubes with inflatable cuffs are available and may

be considered for certain causes, they are not frequently used during neonatal resuscitation. Endotracheal tubes with internal diameters of 2.5, 3.0, and 3.5 mm are available.
- A stylet that can be inserted into the endotracheal tube.
- Detector CO_2, suction setup using suction catheters of the following sizes: size 8F, size 5F, or size 6F (for suctioning the throat) (for suctioning endotracheal tubes of various sizes that become obstructed with secretions during resuscitation)
- 1/2- or 3/4-inch waterproof adhesive tape, or another tube-securing tool
- Table for measuring the depth of endotracheal tube insertion with measuring tape (Table 2.9)
- Laryngeal mask (size 1) as a rescue airway
- Scissors to cut tape
- Tracheal aspirator
- Stethoscope (with neonatal head)
- Positive-pressure ventilation device (bag or T-piece resuscitator)
- Tubing for blended air and oxygen Pulse oximeter, sensor
- cover 5-mL syringe if using a laryngeal mask
- A clean procedure should be used while intubating someone.

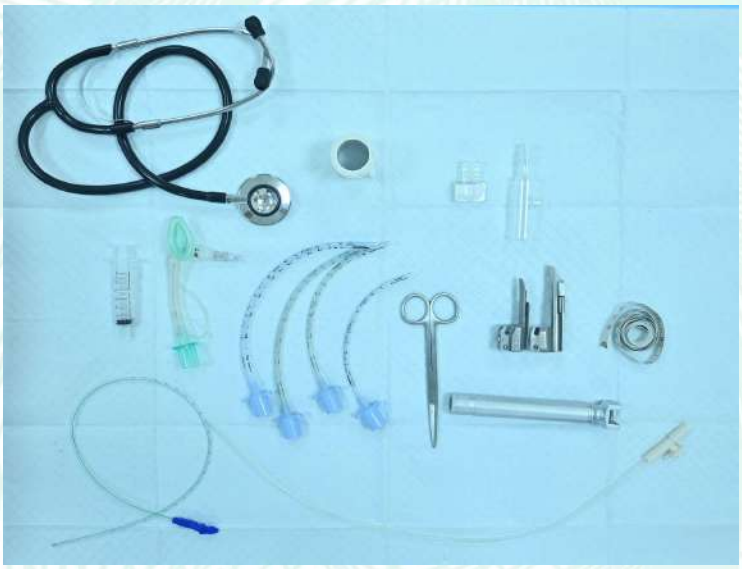


Figure 2.26 Endotracheal intubation supplies and equipment.

Table 2.9 Suction Catheter Size for Endotracheal Tubes of Various inner Diameters

Endotracheal Tube Size	Catheter Size
2.5 mm ID	5F or 6F
3.0 mm ID	6F or 8F
3.5 mm ID	8F

All supplies should be opened, assembled, and then sealed in their packing until immediately before use to prevent contamination. After each usage, the laryngoscope handle and blades should be cleaned in accordance with your hospital's protocols.

A cardiac monitor is advised for the most precise evaluation of the infant's heart rate when intubation is required. Auscultation can be challenging during resuscitation, and pulse oximetry may not consistently show the baby's pulse.

The decision to continue chest compressions after intubation depends on precise measurement of the heart rate, therefore a cardiac monitor is an important instrument at this stage of the resuscitation. This is because a rising heart rate is an important indicator for appropriate endotracheal tube insertion.

How should an endotracheal tube be used?

The endotracheal tube needs to be the same diameter all the way down the tube. It is not advised to use tapered tubes while resuscitating newborns. Endotracheal tubes are marked with centimeter measurements down the side, indicating how far the tube extends from the tip. Near the tip of many tubes are lines or markings (Figure 2.27) that are meant to serve as a vocal cord guide. The tip of the tube should be above the carina when the tube is inserted so that the vocal cords are situated between the two sets of lines; however, the positioning and construction of the lines varies greatly between manufacturers.

The vocal cord guide is simply a rough indication and might not consistently show the right insertion of the depth.

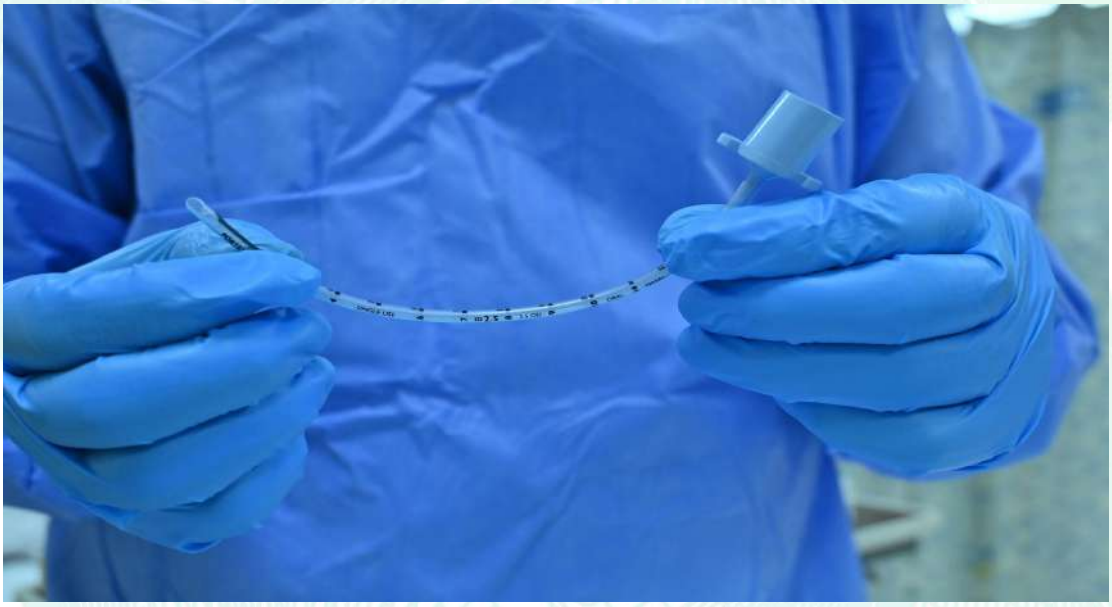


Figure 2.27 Neonatal endotracheal tube

How should the endotracheal tube be prepared?

Pick the appropriate size. The internal diameter of endotracheal tubes serves as a measure of their size (mm ID). The baby's weight or gestational age are used to determine the suitable endotracheal tube diameter. For various weight and gestational age categories, the recommended endotracheal tube size is shown in the (table 2.10). Utilizing a tube that is too small increases airflow resistance and the possibility that it will become clogged with secretions. An airway injury could result from using a tube that is overly big. Although they are accessible and might be utilized in some circumstances, tubes with inflated cuffs, size 2.0 mm tubes to size 4.0 mm tubes are not frequently used during neonatal resuscitation.

Table 2.10 Endotracheal Tube Size for Babies of Various Weights and Gestational Ages Endotracheal Tube Size		
Weight	**Gestational Age**	**Endotracheal Tube Size**
Below 1 kg	Below 28 weeks	2.5 mm ID
1-2 kg	28-34 weeks	3.0 mm ID
Greater than 2 kg	Greater than 34 weeks	3.5 mm ID

Think about using a stylet.

In order to provide more rigidity and curvature to the endotracheal tube, many operators find it advantageous to employ a stylet (Figure 2.30). The choice of whether to use a stylet is up to the operator. The point of a stylet should not protrude from the end or side hole of a 2.5 mm ID, 3.0 mm ID, or 3.5 mm ID. The tissues may be injured if the tip protrudes. In order to prevent the stylet from advancing farther into the tube during the insertion procedure, it should be fastened with a stopper or bent at the top.

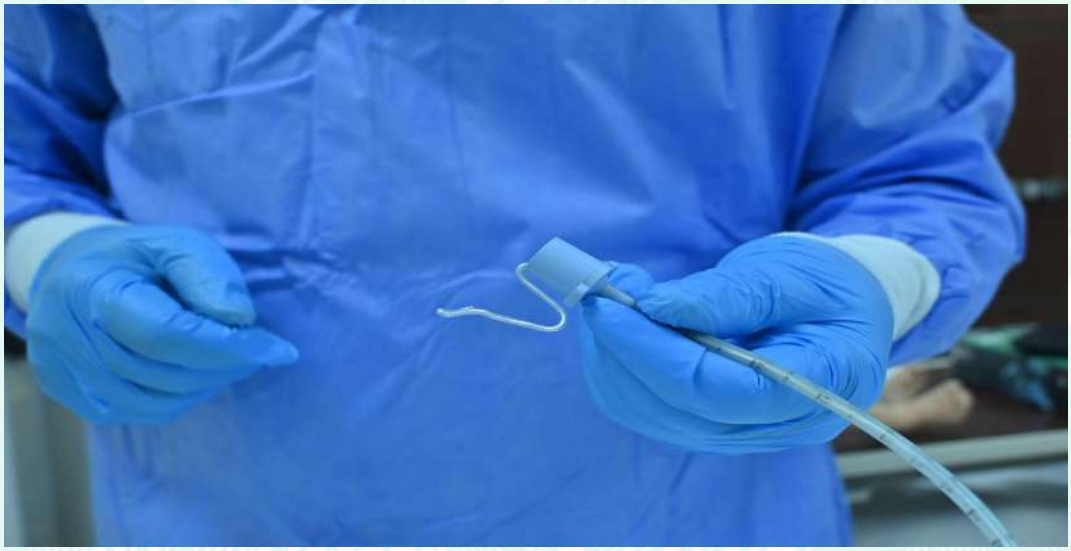


Figure 2.30 Stylet for maintaining curvature and stiffness of ETT during intubation

Because forceful attempts to remove the stylet after intubation can mistakenly displace the tube, it is crucial to make sure the stylet is simple to remove from the endotracheal tube.

How should the laryngoscope and other necessary equipment be prepared?

The steps for setting up the intubation equipment are as follows:
For a precise evaluation of the infant's heart rate, attach cardiac monitor leads if you haven't previously.
Choosing the proper laryngoscope blade, you should then fasten it to the handle.
A No. 1 blade should be used for term babies.
B. For preterm neonates, use a No. 0 blade.
For neonates who are severely premature, some doctors might choose to use a No. 00 blade.

To make sure the batteries and light are functional, click the blade into the open position and turn on the light. Replace the laryngoscope, install a fresh battery, tighten or replace the bulb if the light is dim or flickers. To prevent overheating the light bulb and blade when using a laryngoscope with a light bulb, keep the laryngoscope closed until you are ready to use it.

Set up the suction apparatus.

To guarantee that the suction is set to 80 to 100 mm Hg,

A. Obstruct the end of the suction tubing.
B. Attach a suction catheter of size 10F (or bigger) to remove mucus from the mouth and pharynx.
C. Smaller suction catheters (size 8F, size SF, or size 6F) have to be accessible for clearing obstructions from endotracheal tubes following placement. In Table 2.9, suitable catheter diameters are provided.
D. To directly suction meconium or other viscous secretions that clog the trachea, an attachment called a tracheal aspirator can be placed on the endotracheal tube. A tracheal aspirator is not necessary when using some endotracheal tubes because they include an integrated suction port that may be connected to suction tubing directly. Prepare a PPV device with a mask so that you can ventilate the infant in between attempts at intubation, if necessary.

- Make sure you have access to a CO_2 detector, stethoscope, measuring tape or insertion depth table, waterproof adhesive tape (1/2 or 3/4 inch), scissors, or another tube-securing tool.

How should the baby be positioned for intubation?

Lay the infant down with his or her head in the middle, torso straight, and neck slightly stretched in the sniffing position. To preserve a tiny neck extension, it could be good to place a small roll under the baby's shoulders. By enabling a straight line of sight into the glottis after the laryngoscope has been appropriately placed, this posture aligns the trachea for optimal vision. Throughout the procedure, a team member should assist in maintaining optimal placement.

If at all feasible, adjust the height of the bed so that the baby's head is level with the operator's upper belly or lower chest. This will bring the baby's head closer to eye level and enhance the operator's vision of the airway.

How should the laryngoscope be held?

Always hold the laryngoscope in your left hand with the blade facing away from you and your thumb resting on the upper side of the handle (Figure 2.31). Both right- and left-handed people should hold the laryngoscope in their left hand. Your ability to see through the open, curving part of the blade will be impeded if held in the right hand.

Figure 2.31 Hold the laryngoscope in your left hand.

How is the intubation technique carried out?

The procedure for endotracheal intubation is briefly outlined below, although mastery necessitates extensive observation and practice. Understanding the steps will help you to assist the operator efficiently even if you are not doing the procedure.

Prepare to place the laryngoscope.

- Position the baby properly. If feasible, change the bed's height as necessary. While a team member makes sure the baby's entire body is resting straight and the head is in the sniffing position, you can support the baby's head with your right hand as shown in Figure 2.31.
- To gently open the infant's mouth, use your right index finger or thumb.
- Insert the laryngoscope, then note any important landmarks.
- The laryngoscope blade should be inserted in the midline, softly slid over the tongue, and across the oropharynx until the tip is in the gap between the tongue's base and the epiglottis. The vallecula is the name of this area (Figure 2.32). The vallecula in very preterm infants could be rather small, therefore you might need to gently position the laryngoscope tip right under the epiglottis.

Figure 2.32 Insert the laryngoscope blade in the midline

- Open the mouth and move the tongue out of the way to expose the glottis. Lift the entire laryngoscope in the direction the handle is pointing. To lift the epiglottis and view the glottis and vocal cords, you might need to very slightly incline the tip of the blade.

When doing the procedure for the first time, users frequently bend their wrists and "rock" the baby's upper gum by bringing the handle's top toward themselves. This won't give the desired effect and could harm the infant's lips and gums (Figure 2.33).

Figure 2.33 Correct method for lifting the laryngoscope to expose the larynx.

Sometimes it may be required to use the blade tip to gently lift the epiglottis directly if the vallecula is small or the epiglottis is big and floppy.

- When you gaze down the laryngoscope, the glottis and vocal cords can be seen at the very top of your view. By gently pressing the baby's thyroid and cricoid cartilage with their thumb and first finger, a helper can aid in bringing the glottis into view. They ought to apply pressure downward and in the direction of the infant's right ear
- The epiglottis should hang if the blade's tip is properly positioned in the vallecula. If you can't see these structures right away, move the blade around until you can. To observe the vocal cords, you might have to slowly insert or remove the blade (Figure 2.34).

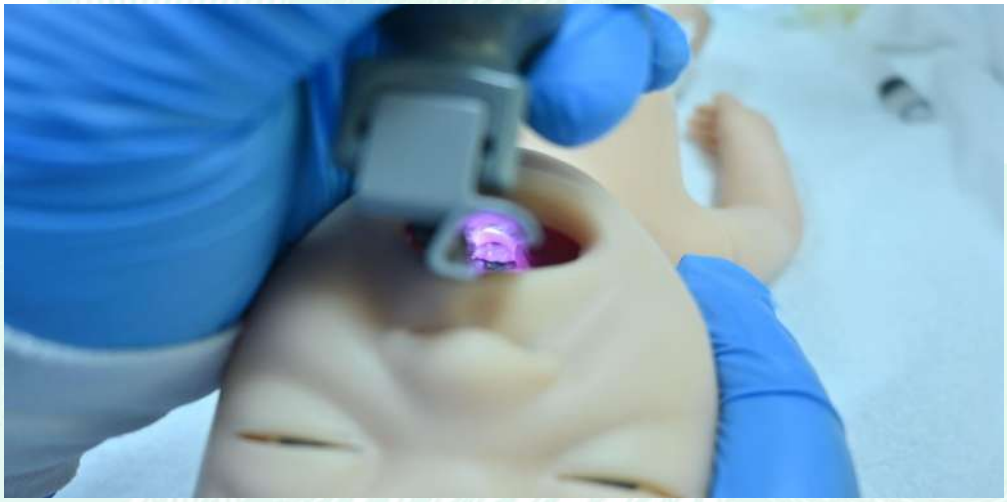


Figure 2.34 Using a curved portion of the laryngoscope blade to identify the landmarks.

You will be able to view the posterior pharynx and base of the tongue if the blade is not entered deeply enough. Once the epiglottis is visible, slightly advance the blade.

If you insert the blade too far, you will only be able to see the esophagus, and you will need to slightly remove the blade until the epiglottis descends from above.

Use a size 10F or 12F catheter to remove mucus from the mouth and throat if any secretions are obstructing the anatomic landmarks (Figure 2.35).

Figure 2.35 Suctioning secretions

Once the vocal cords have been located, hold the laryngoscope steadily and keep an eye on them while a helper puts the endotracheal tube in your right hand. During a laryngoscopy, the tube is inserted into the baby's right side of the mouth, outside the blade, with the concave curve in the horizontal plane, to suction secretions.

The baby's vocal cords are reached by advancing the tube along the right side of the mouth. Rotate the curvature of the tube into the vertical plane when the tip approaches the voice cords to direct the tip upward. When the vocal cords are open, insert the tube such that the vocal cords are in the space between the tube's indicated guiding lines. Keep an eye out for the centimeter depth marker on the tube's outside that lines up with the infant's top lip.

Wait for the vocal cords to open if they are closed. Never try to force the tube between closed cords and never touch the closed cords with the tube's tip. If the cords don't open after 30 seconds, stop and breathe through a mask again until you're ready to try insertion again.

Secure the endotracheal tube.

With your right index finger, firmly press the tube on the infant's firm palate. Remove the laryngoscope carefully without moving the tube. If a stylet was used, have an aide take it out of the endotracheal tube while you hold the tube firmly in place (Figure 2.36).

Figure 2.36 Removing the tube carefully while stabilizing the tube against baby cheeks.

While it's crucial to hold the tube firmly, you ought to take care to avoid squeezing it too much and making it impossible to remove the stylet. (Figure 2.37)

Figure 2.37 Remove the optional stylet while holding the tube in place.

Ventilate through the endotracheal tube.

A CO_2 detector and PPV device should be attached by a helper to the endotracheal tube (Figure 2.38). It may be possible to prevent unintentional extubation by having the same person hold both the endotracheal tube and the PPV device. Ventilation through the tube should start after the PPV device is installed.

Figure 2.38 Connect a C02 detector and T- piece resuscitator to the endotracheal tube and begin ventilation and secure the endotracheal tube in place by right index.

How much time should be allowed for an intubation attempt?

The intubation procedure should be finished in around 30 seconds. To complete this process fast, an effective team effort is essential. Rapid intervention is necessary because the baby is not being ventilated during the insertion. It is usually advisable to pause, resume PPV with a mask, and then attempt again if the baby's vital signs deteriorate during the process (severe bradycardia or low oxygen saturation).

It is not recommended to attempt intubation repeatedly because doing so will raise the risk of soft tissue injury and make subsequent airway management more challenging. If the initial attempts fail, consider other options, such as continuing face-mask ventilation or using a video laryngoscope, if one is available. You can also ask another healthcare professional with experience in intubation (such as an anesthesiologist, emergency room doctor, respiratory care practitioner, neonatal nurse practitioner, or physician's assistant) for help.

Confirm that the endotracheal tube is in the trachea

Exhaled CO_2 and a quickly increasing heart rate are the two main indicators of endotracheal tube implantation into the trachea. Connect a CO_2 detector (Figure 2.39) and check for the presence of CO_2 during exhale as soon as the endotracheal tube is in place.

Figure 2.39 The colorimetric C02 detector is purple or blue before detecting exhaled C02

You should be able to detect exhaled CO_2 within 8 to 10 positive-pressure breaths if the tube is correctly inserted and you are effectively ventilating via the tube. In the presence of CO_2, colorimetric devices alter their appearance. Capnograph is the most frequently Electronic monitor used in the delivery room which shows the amount of CO_2 in the air with each breath.

Can the tube be in the trachea even though CO_2 is NOT detected?

The use of CO_2 detectors is, indeed, subject to restrictions. The amount of exhaled CO2 may not be sufficient to be detected if the tube is inserted in the trachea but the lungs are not sufficiently ventilated. This could happen if the trachea or endotracheal tube are blocked by secretions, you are not applying enough ventilation pressure, or there are significant bilateral pneumothoraces and collapsed lungs. Furthermore, infants with very low heart rates or diminished cardiac output may not deliver enough carbon dioxide to their lungs to be recognized.

Can the CO_2 detector change color when the tube is NOT in the trachea?

A colorimetric CO_2 device may change color even if the tube is not in the trachea, however this is uncommon (Table 2.11). The detector is malfunctioning and should not be used if it has already changed color in the package and is yellow when you remove it. Gastric secretions or the administration of epinephrine, surfactant, or atropine through the endotracheal tube may cause the paper inside the C0 2 detector to turn irreversibly yellow, rendering the detector useless.

Table 2.11 Problems With Colorimetric CO2 Detectors

False Negative (Tube IS IN trachea but NO color change)	False Positive (Tube IS NOT in trachea but color changes)
Inadequate ventilation, collapsed lungs, bilateral pneumothoraces, a very low heart rate, insufficient cardiac output, and an obstruction in the endotracheal tube are all factors.	Epinephrine, surfactant, atropine, or gastric secretion contamination; defective device that changed color in the packaging before use.

What are other indicators that the tube is in the trachea?

The two main ways to confirm endotracheal tube insertion within the trachea are by demonstrating exhaled CO_2 and seeing a fast rising heart rate. You should also look for the following signs that the tube is in the right place: audible and equal breath sounds near both axillae during PPV; symmetrical chest movement with each breath; little to no air leak from the mouth during PPV; decreased or absent air entrance over the stomach. Because noises are quickly conveyed, you should exercise caution when interpreting neonates' breath sounds. Use a little stethoscope and place it close to the axilla to hear breath noises. A big stethoscope or one positioned close to the middle of the chest may be able to pick up noises coming from the stomach or esophagus.

What if you suspect that the tube is not in the trachea?

If the CO_2 detector does not detect exhaled CO_2 within 8 to 10 breaths, the tube is not likely to be in the trachea. The baby's lungs cannot be ventilated by an endotracheal tube placed in the esophagus, and its continued use merely delays efficient ventilation. The majority of the time, you should take out the tube, restart ventilation using a face mask, check that all of your equipment is ready, make sure the baby is in the best position possible, and repeat the process using a fresh tube.

Keep in mind that infants with very low heart rates or impaired cardiac function might not transport enough CO_2 to their lungs to cause the CO_2 detector to change color. You may decide to stabilize the tube, re-insert the laryngoscope, and make an effort to verify that the tube is passing through the vocal cords if you are confident that the tube is properly inserted in the trachea despite the lack of exhaled CO_2.

If the tube is not properly put, this "second look" approach can be challenging and may delay establishing efficient ventilation. Chest compressions are advised if the tube location is confirmed and the baby's heart rate does not decrease with endotracheal tube ventilation. CO_2 will be found once cardiac output has increased.

How deeply should the tube be inserted in the trachea?

The endotracheal tube tip should be inserted in the center of the trachea. Typically, to do this, the tube must be inserted with the tip just 1 to 2 cm below the vocal cord. It's crucial to avoid pushing the tube in too far to avoid having the tip contact the carina or enter the major bronchus.

Use a stethoscope to listen for breath sounds in the axillae and over the stomach after inserting the tube (Figure 2.41).

Figure 2.41 Confirm ETT placement by listening to equal breath sounds in both axillae and absent Breath sounds over the stomach.

The breath sounds on either side should be equal if the tube is positioned properly.
If the tube is overly long, one side's breath sounds could become less audible.
Most frequently, if the tube is put too far, it will penetrate the right mainstem bronchus, resulting in louder right-sided breathing and quieter left-sided breathing. Listen to the softer side of the breath sounds as you slowly remove the tube. The breath sounds should become better and more equal after the tube is properly positioned.
if you plan to keep the tube in place, how do you secure it?

The tube can be secured using a variety of techniques. A device made expressly to hold an endotracheal tube in place or water-resistant tape are both acceptable options.

The following is an example of a method

Once the tube is in the proper place, take note of the centimeter marking next to the infant's top lip on the tube's side.

Cut a strip of 3/4- or 1/2-inch tape long enough to go from the baby's lips on one side, across the upper lip, and about 2 cm onto the other cheek, the tape should be cut in half so that it looks like a pair of pants (Figure 2.42).

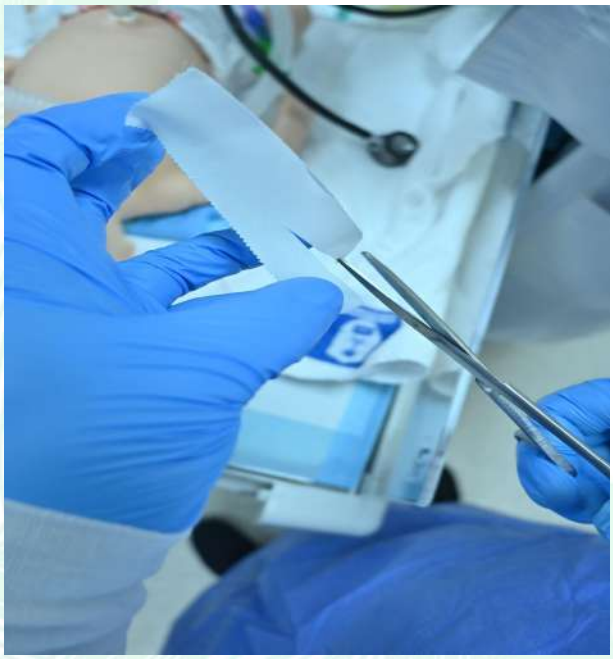


Figure 2.42 Cut the tape from the middle.

Place the uncut piece of tape on the child's face such that the split line starts just inside the baby's mouth corner. Put the tape's upper leg across the baby's upper mouth.

Wrap the lower leg around the tube with caution. Make sure the marker stays near to the infant's upper lip at the desired centimeter location. During the taping process, it is simple to unintentionally push the tube in further than intended (Figure 2.43).

Figure 2.43 Place the uncut section on the baby's cheek close to the corner of the mouth and the upper

"leg" of tape above the baby's lip and Wrap the lower "leg" of tape around the tube.

Turn the tape upon itself at the end to create a little "tab" that you may use to unwind the tape and change the insertion depth or take out the tube (Figure 2.44).

Figure 2.44 Leave a small tab of tape folded over at the end to assist removal.

Make sure the tube hasn't been moved by using a stethoscope to listen over both sides of the chest. Examine the CO_2 detector's color change and the chest's rise and fall with each aided breath.

Get a chest x-ray to confirm the tube's final placement if it will remain in place after the initial resuscitation.

What can an assistant do to help the operator during the intubation procedure?

- To accomplish the intubation technique swiftly and effectively, an effective team effort is needed. A competent assistant can carry out several tasks that enhance teamwork, expedite the intubation process, and raise the success rate of initial attempts.
- Verify the laryngoscope's functionality.
- Verify that the suction is set between 80- and 100-mm Hg.
- Prepare the tube-securing tape or other tool.
- If you haven't already, connect the chest leads and start the cardiac monitoring.
- Ascertain that the endotracheal tube and laryngoscope blade are chosen according to the newborn's anticipated gestational age or weight.
- Discuss with the operator whether the NTL or the expected insertion depth table will be used to predict the depth at which the endotracheal tube will be inserted.
- Verify that the stylet, if present, does not extend over the tube's end or side holes.
- Before beginning the process, make sure the newborn and bed are in the right positions. Then, keep them there throughout.
- Hold the apparatus and proceed as instructed to prevent the operator from having to turn their head away from anatomical landmarks in order to suction secretions or grab the tube in order to insert it.
- Keep an eye on the infant's heart rate and notify the operator if the intubation takes more than 30 seconds.

- As instructed, provide thyroid and cricoid pressure.
- After inserting the endotracheal tube, carefully take out the stylet, then attach the CO_2 detector.
- Assess the CO_2 detector color change and listen for an elevated heart rate.
- Verify the depth of penetration from tip to lip.
- Axillae breath sounds should be heard, and PPV should be used to evaluate chest movement.
- Please help secure the tubing.

How do you use an endotracheal tube to suction thick secretions from the trachea?

There may be thick secretions clogging the airway if a baby's condition has not improved and you are unable to induce chest movement while using all ventilator correction measures and an endotracheal tube that is correctly installed. Thick secretions might come from meconium, vernix, blood, or cellular debris. Using a suction catheter implanted via the endotracheal tube, you can try to open the airway.

If the suction catheter is unable to immediately open the airway, a tracheal aspirator may be able to accomplish so by providing suction directly to the endotracheal tube. Although it's frequently referred to as a "meconium aspirator," this gadget can also be used to remove any thick secretions that are blocking the airway.

After inserting the endotracheal tube, attach a tracheal aspirator to an 80–100 mm Hg suction source and connect it directly to the endotracheal tube connector. Tracheal aspirators come in a number of different varieties. There may be an incorporated suction port on some endotracheal tubes.

As you continue sucking secretions from the trachea, block the suction-control port on the aspirator with your finger and slowly remove the tube over the course of 3 to 5 seconds (Figure 2.45).

Figure 2.45 Tracheal Suctioning using an endotracheal tube and tracheal aspirator

Be prepared to re-intubate with a clean tube, resume face-mask PPV, or place a laryngeal mask.

How many times should suctioning be repeated if thick secretions prevent you from achieving effective ventilation through an endotracheal tube?

Repeat the process until the airway has been sufficiently cleaned to inflate the lungs and establish adequate ventilation if secretions have blocked the airway and stopped you from breathing effectively.

What problems should you consider if a baby' s condition worsens after endotracheal

intubation?

After intubation, if a baby's condition suddenly gets worse, the endotracheal tube might unintentionally move. It might have been drawn back into the pharynx and outside the trachea or advanced too far into the airway. Blood, meconium, or other thick secretions may clog the tube. A tension pneumothorax, which causes the lungs to collapse and restrict gas exchange, may have occurred in the infant.

Last but not least, it's possible that the PPV device lost connection with the endotracheal tube or compressed gas source, or that it started to leak. To remember these possible issues, use the acronym "DOPE" (Table 2.12).

Table 2.12 After Intubation, Sudden Deterioration. The Acronym DOPE
D Displaced endotracheal tube
O Obstructed endotracheal tube
P Pneumothorax
E Equipment failure

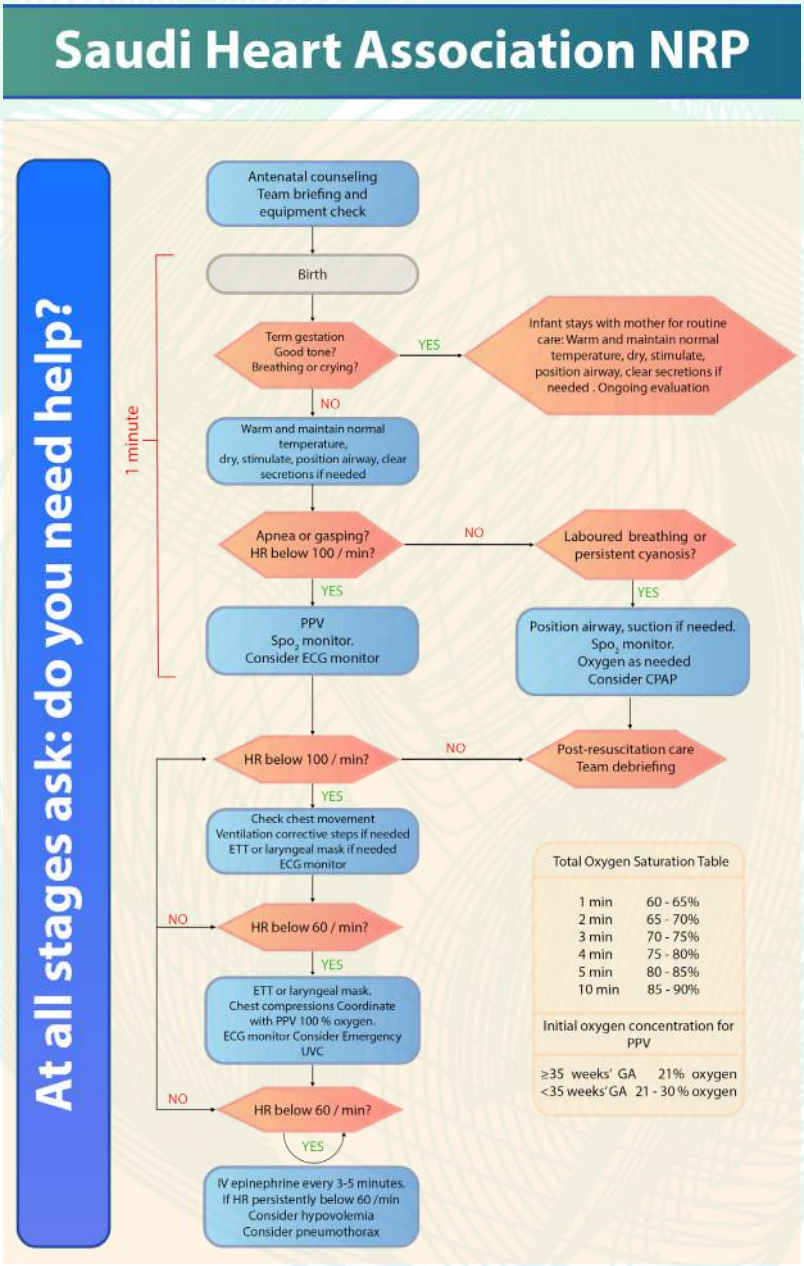
CHAPTER 3

Cardiovascular Management in Neonatal Resuscitation

When this chapter is finished, you'll be able to:

- Know the indications of chest compression in neonatal resuscitation
- How to perform chest compressions
- Know the proper technique.
- Understand the importance of coordinating chest compressions with positive pressure ventilation.
- Know the indications of Epinephrine administration in neonatal resuscitation
- Understand when, where and how to administer fluids in neonatal resuscitation

Saudi Neonatal Resuscitation Algorithm



Chest Compressions: Why They're So Important

One to two neonates per 1,000 are anticipated to require intensive resuscitation that includes chest compressions. Rare situations in which the heart rate does not respond to successful positive pressure ventilation are most likely accompanied by substantial acidosis and hypoxemia, which might compromise myocardial perfusion and function due to low diastolic blood pressure.

Mechanically compressing the heart can increase coronary artery perfusion and oxygenation, which helps the heart function by pumping blood more efficiently.

Optimization of cardiac compressions can achieve greater than 50% of cardiac and cerebral blood flow. Coronary blood supply occurs only during diastole (Figure 3.1) when releasing the pressure on the sternum during chest compressions, and it can be improved by repetitive, uninterrupted chest compressions, and by a systemic vasoconstrictor like epinephrine.

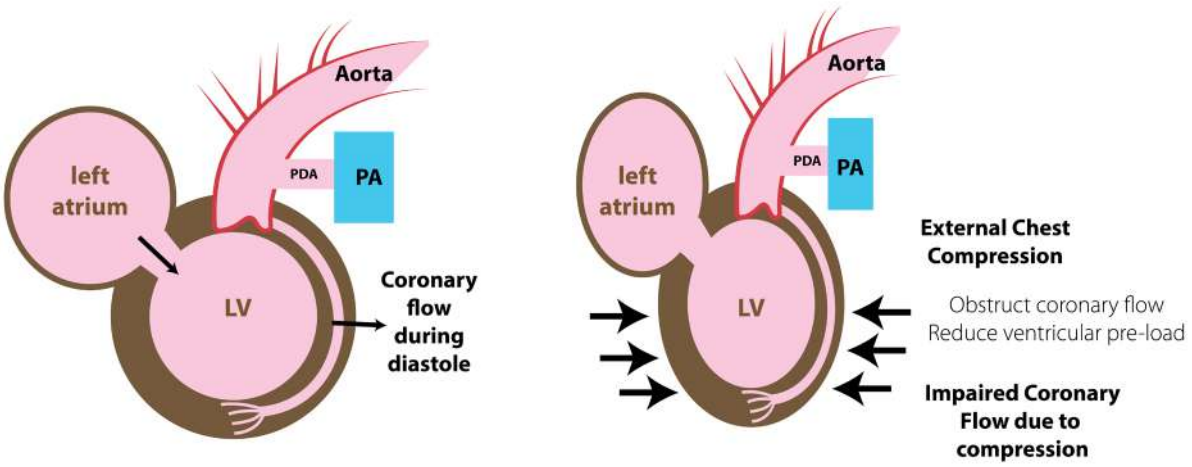


Figure 3.1 The effect of chest compression during the "diastolic phase". The coronary flow and ventricular filling happen during diastole (PA—pulmonary artery, PDA—patent ductus arteriosus).

Indication for chest compressions

Only when the heart rate is still under 60 beats per minute after 30 seconds of efficient ventilation, preferably using a laryngeal mask or an endotracheal tube, are chest compressions necessary.

Before beginning chest compressions, make sure that the chest rise during PPV indicates effective ventilation. If not, use the necessary corrective ventilation procedures (MR-SOPA) to establish successful ventilation.

How to perform chest compressions

You can stand next to the warmer during chest compressions before being intubated. Following intubation, the compressor should be positioned at the baby's head while the team member administering PPV can shift to the baby's side (Figure 3.2), allowing a third person to place an umbilical vein catheter.

Figure 3.2 Compressor position at the head side of the patient.

Use the thumbs technique (Figure 3.3) to support the baby's back during compressions by placing your thumbs at the bottom third of the sternum, right below the intermammillary line.

Figure 3.3 two thumbs-up method of chest compression

Note: Do not squeeze the xyphoid or the ribs (Figure 3.4).

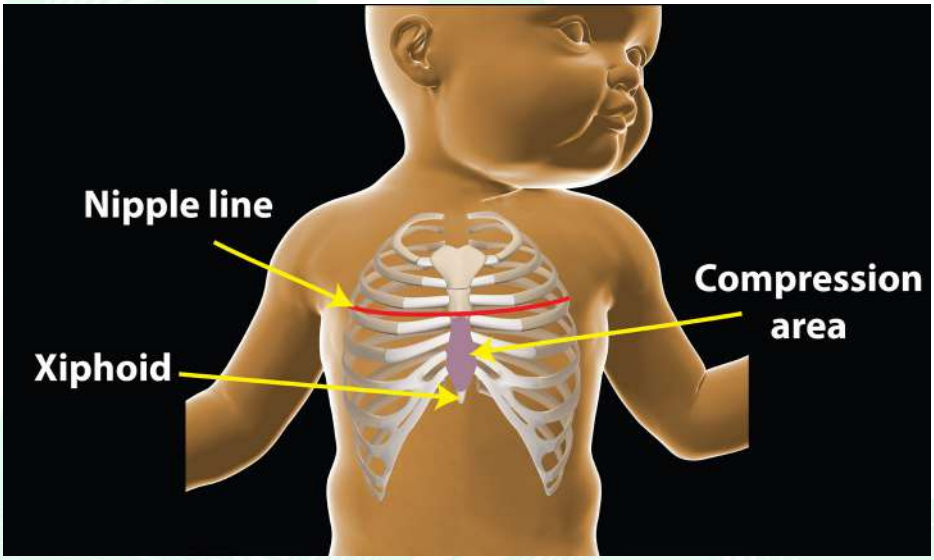


Figure 3.4 Landmark for chest compression.

Keep your thumbs in contact with the skin to prevent compressions on a different area. During compressions, move only your thumbs to depress the sternum to about one-third of the anterior-posterior (AP) diameter of the chest (Figure 3.5), followed by a complete release of the compression to allow for the refilling of the heart, coronary perfusion, and giving the chance for the lungs to expand.

Each cycle (3 compressions and 1 ventilation) lasts for 2 seconds. The rate of compression is 90 per minute, coordinated with ventilation, with a ventilation to compression ratio of 1/3.

Figure 3.5 Chest compression depth is approximately one-third of the anterior-posterior diameter of the chest.

Coordination between compressions ventilation

Even if the baby is intubated, coordination between compressions and PPV is required.
Giving three quick compressions followed by one breath will be used to coordinate.
In a loud voice, the compressor should say, "one and two and three and breath and."

Breathe and; (Figure 3.6) compressing the chest while counting to one, two, and three; the other person will breathe in when he or she hears "breathe-and," at which point the thumbs of the compressor should be released to allow the lungs to expand during PPV.

The infant will get 90 compressions and 30 breaths over the course of one minute.

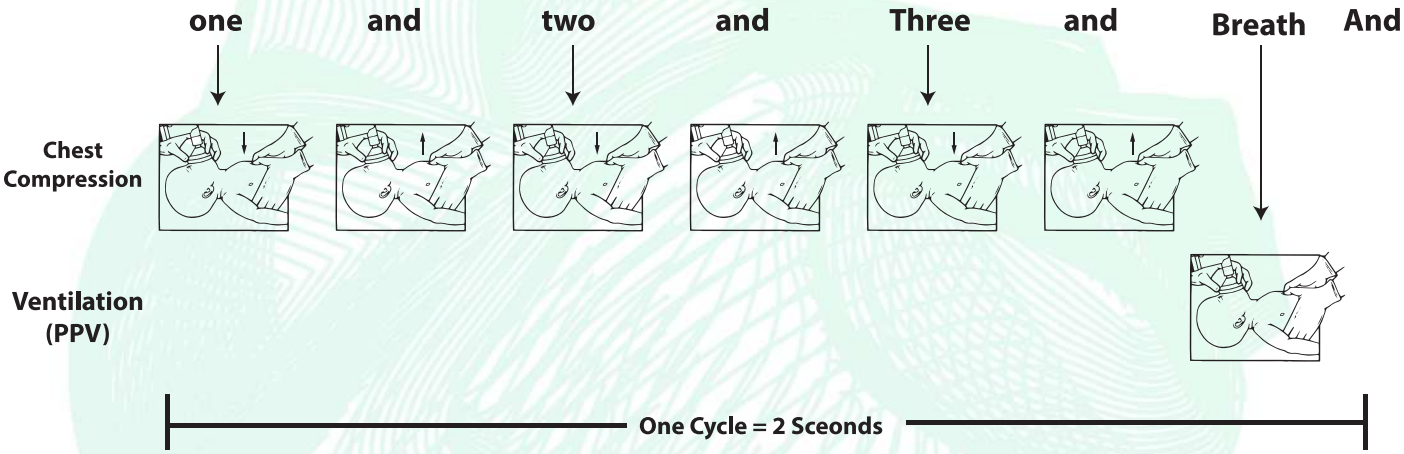


Figure 3.6 Coordination between chest compressions and ventilation.

Oxygen concentration during chest compressions:

As soon as you begin chest compressions, raise the oxygen concentration (FiO_2) to 100% and maintain it there until the heart rate reaches 60 or higher; at that point, change FiO_2 to the desired saturation.

When should you stop chest compressions?

After 60 seconds of PPV-coordinated chest compressions, check the heart rate. The cardiac monitor is the recommended tool for measuring heart rate during resuscitation, while a stethoscope or pulse oximeter can also be used. Pulseless electrical activity (PEA), which is cardiac electrical activity without a discernible pulse, is the only restriction of the cardiac monitor. As with asystole, the PEA will be managed similarly.

If the heart rate increases to more than 60 beats per minute, stop doing chest compressions and adjust FiO_2 to the desired oxygen saturation level. Increase the PPV rate to 40–60 beats per minute once the chest compressions have been stopped.

What should be done if, after 60 seconds of PPV-coordinated chest compressions, the heart rate is still below 60?

After 60 seconds of chest compressions, if the heart rate is still less than 60/min, check to see if you are administering an effective PPV with chest rise, that FiO_2 is 100%, that the chest is compressed deeply enough,

and that the rate of chest compression is 90/min. Insert an umbilical venous catheter and inject epinephrine if the heart rate is still less than 60 bpm.

What should you do if, after a minute of compressions timed with ventilation, the heart rate is still below 60 and showing no signs of improvement?

There are 5 inquiries that ensure the baby is receiving high quality compressions and ventilations.

You can use the acronym "CARDIO" as shown in (Table 3.1) to help you remember these 5 questions.

Table 3.1 The Five Questions to Ask If Compressions and Ventilation Don't Improve the Heart Rate

C	**Chest Movement**	Is the chest moving with ventilation?
A	**Airway**	Did you intubate the baby, or use a laryngeal mask to secure the airway?
R	**Rate**	Is the rate of compressions and ventilation adequate (3 compressions and one breath in 2 seconds)
D	**Depth**	Is the compression depth equal to one-third of the chest's AP diameter?
IO	**Inspired Oxygen**	Are you ventilating the infant with 100% oxygen?

It is necessary to provide epinephrine and establish an emergency vascular access (umbilical venous catheter insertion) if the infant's heart rate doesn't rise beyond 60 beats per minute after 60 seconds of effective respiration and synchronized chest compressions.

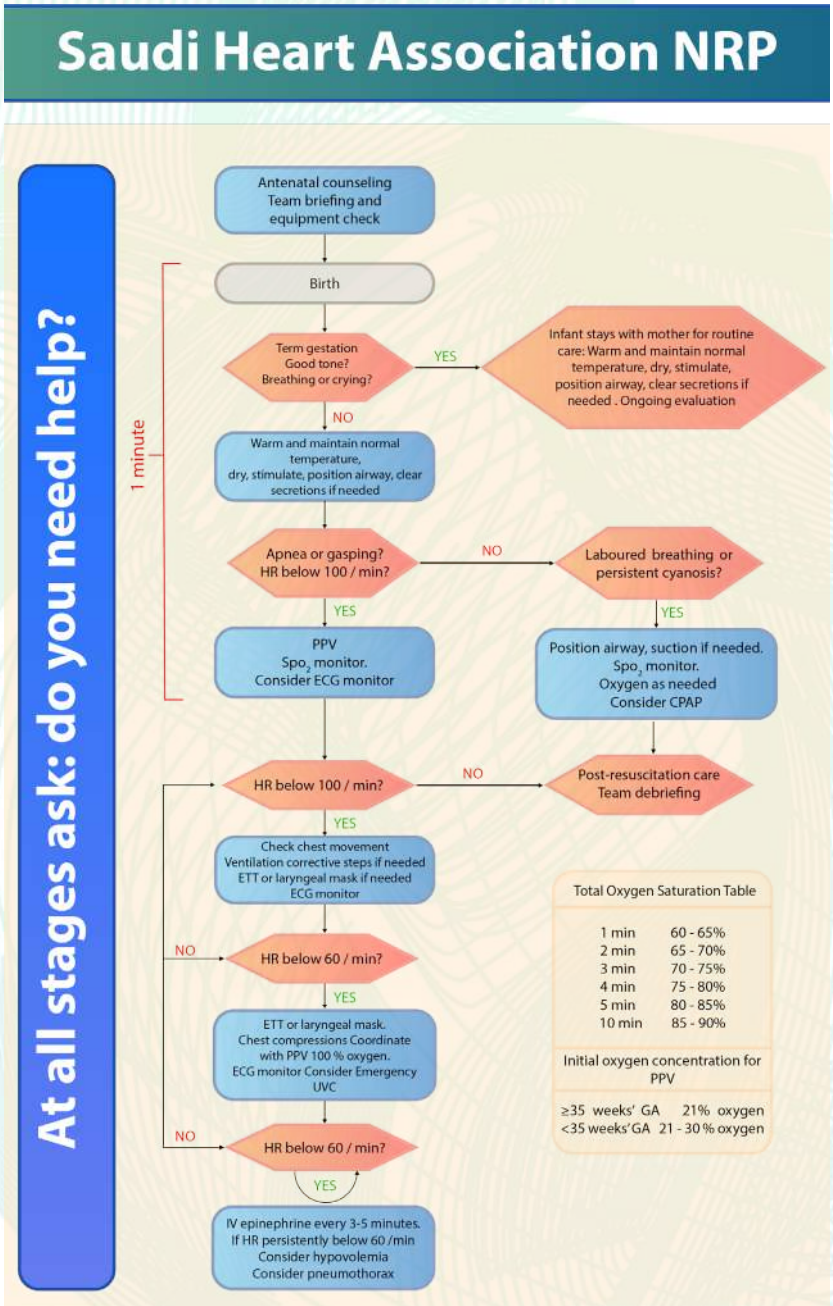
Key points

1. Chest compressions are necessary if, after 30 seconds of effective PPV (breathing that moves the chest) through an endotracheal tube or laryngeal mask, the heart rate is still less than 60 beats per minute.
2. If you start watching PPV, think about wearing a cardiac monitor to check your heart rate.
3. Before beginning chest compressions, you should establish effective PPV (moving the chest).
4. The compressor can be moved to stand at the baby's head side once the endotracheal tube is in place to make room for the third person to insert the umbilical venous catheter.
5. If chest compressions are necessary, raise FiO_2 to 100% until the heart rate exceeds 60 beats per minute. Then, change it in accordance with the desired oxygen saturation.
6. When compressing your chest, use the thumbs technique. Thumbs should be placed just below the inter mammillary line, near the middle of the sternum. During compressions, keep the rest of your fingers stationary to support the back.
7. Chest compressions should be performed to a depth of about one-third of the chest's anterior-posterior diameter.
8. The breathing rate is 30 breaths per minute and 90 chest compressions per minute.
9. After 60 seconds of breathing and chest compressions in unison, reevaluate the heart rate.

a) Using a cardiac monitor is the best way to determine heart rate.
b) Other tools for measuring heart rate include a stethoscope and a pulse oximeter.

10. Stop chest compressions and continue with PPV if the heart rate is 60 beats per minute. Adjust Fio2 in accordance with the intended O_2sat.
11. Get ready to implant an umbilical venous catheter and inject epinephrine if the heart rate is still less than 60 bpm after 60 seconds of chest compressions timed with effective PPV.

Vascular Support, medication, and Volume Expander



The umbilical vein

It is accessible to a newborn, just as it is in photographs. Based on the risk factors indicated, if you expect to administer medication during resuscitation, one member of your team should get ready to place an

umbilical venous catheter while the others continue to perform PPV and chest compressions.

Inserting an umbilical venous catheter emergently:

Put on gloves and have your stuff ready fast. Although you should try to use sterile methods, you should weigh the need of securing venous access against the chance of spreading illness.

Using a syringe, add normal saline to a stopcock-connected single lumen umbilical venous catheter that is 3.5 F or 5 F in temperature (3-10 mL). In order to stop fluid loss and air admission, close the stopcock on the catheter (Figure). Make sure you are familiar with the stopcock's off and on directions.

Figure 3.7 The stopcock's off and directions

Apply an antiseptic solution to the umbilical cord area to clean it. Tie a loose knot at the base of the umbilical cord, around the Wharton's jelly or the skin edge (Figure 3.8). If bleeding occurs when the cord is severed, you can tighten this tie.

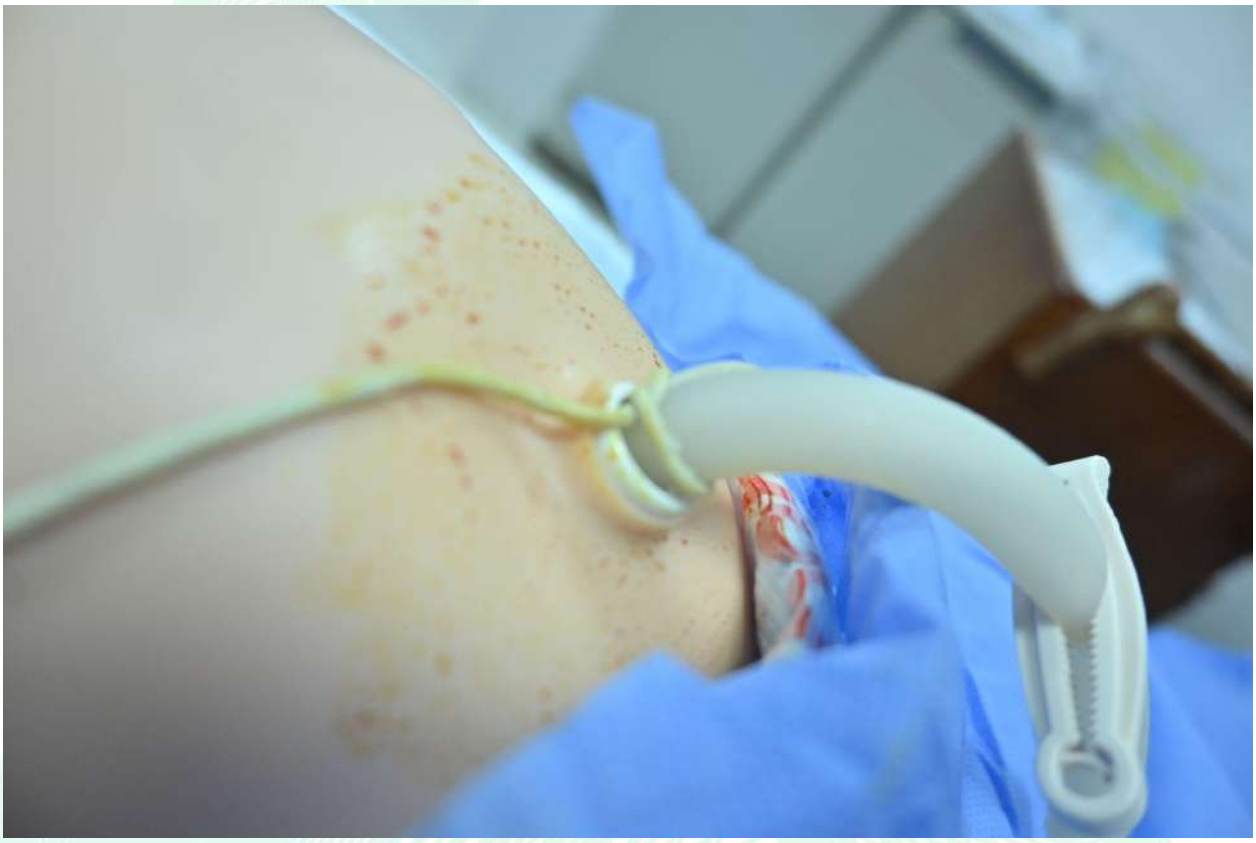


Figure 3.8 Tie placed at the base of the umbilical cord.

Gently instruct the team to stop chest compressions, then use a scalpel to cut the chord just below the umbilical clamp and a few millimeters above the skin's surface. When cutting, it is preferable to cut directly across the rope as opposed to at an angle (Figure 3.9).

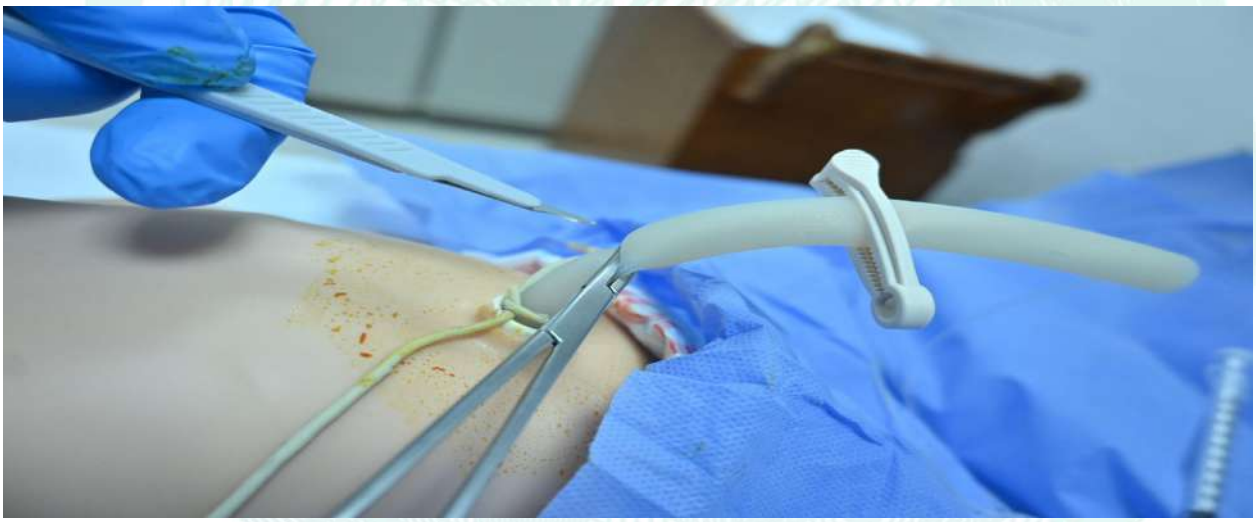


Figure 3.9 Cut the umbilical cord 1 to 2 cm above the skin line.

The umbilical vein can be identified as a bigger, thin-walled structure that is frequently located at the 12-hour mark. The two umbilical arteries, on the other hand, are smaller, have thicker walls, and are commonly

found near to one another (Figure 3.10).

Figure 3.10 The umbilical cord: one umbilical vein and 2 umbilical arteries.

Connect the catheter to the umbilical vein immediately (Figure.

A. When the stopcock between the baby and the syringe is opened and gently aspirated, try inserting the catheter 2 to 4 cm into the skin.

Figure 3.11 Saline-filled catheter inserted into the umbilical vein.

B. The catheter tip should only be inserted into the vein briefly and to the point where blood can be sucked in case of an emergency. The catheter shouldn't be inserted farther in order to prevent liver damage.
C. Until the catheter is either fastened or withdrawn, hold it firmly in place with 1 hand.
D. Connect the stopcock port to the syringe containing either drug, turn the stopcock so that it is open between the syringe and the catheter, check to make sure there are no air bubbles in the syringe or catheter, provide the prescribed dose, and cleanse the catheter (Figure 3.12).

Figure 3.12 Connect the umbilical venous catheter to a 3-way stopcock.

- The catheter can be fixed and secured for temporary intravenous access while the infant is being transported to the NICU after drugs have been given, and it can be removed if no longer necessary. Suturing or applying sticky plaster to secure the catheter.

If you choose to remove the catheter, make sure the area where it was inserted is visible to check for any bleeding. If you decide to do so quickly, be sure to tighten the tie at the base of the umbilicus in case there is any bleeding.

Figure 3.13 Securing the Umbilical venous catheter

The intraosseous needle

An intraosseous needle is a viable alternative in the event that an umbilical venous catheter is ineffective or impractical for obtaining vascular access during emergency resuscitation. Intraosseous needles are routinely used in emergency rooms and occasionally prior to transfer for emergency access.

A large flat bone is penetrated through the epidermis with an intraosseous needle (Figure 3.13), which is then advanced into the bone marrow cavity. The same hemodynamic effect as IV administration is achieved by rapidly infusing fluids and medications into the central venous circulation. Remember that there is a chance of serious side effects such infections, bone fractures, and limb ischemia.

Figure 3.13 IO needle

intraosseous needle insertion

Determine the area of insertion. The flat area of the lower leg, roughly 2 cm below and 1 to 2 cm medial to the tibial tuberosity (the bony protrusion below the kneecap), is the best site for term babies. The IO should be advanced through the skin to the bone's surface (periosteum) while being held perpendicular to the skin (Figure 3.14).

Figure 3.14 Needle insertion site.

If you decide to move the IO manually, apply some downward pressure while twisting. If using an electric drill to advance the needle, push the trigger while maintaining downward pressure in accordance with the manufacturer's recommendations. There is a significant change in resistance (pop) as the needle enters the marrow area.

Remove the stylet first to secure the IO, then adhere to the manufacturer's instructions (Figure 3.15).

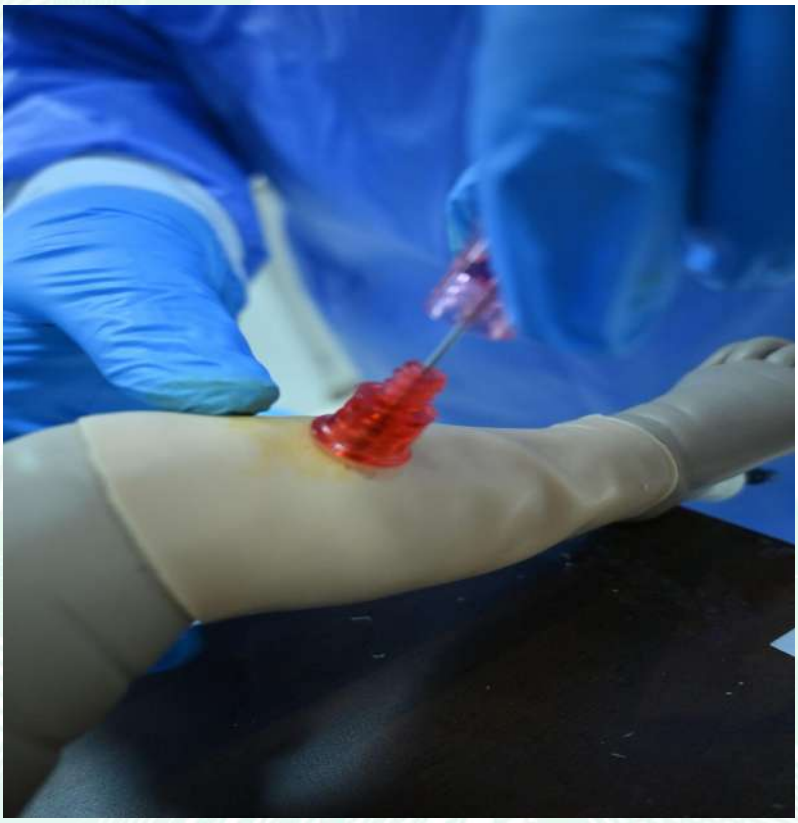


Figure 3.15 Removal IO stylet

To flush the needle with 3 to 5 mL of regular saline to open the bone marrow space, attach an infusion set to the IO hub, open the stopcock toward the needle, and then deliver the drug and saline flush.

Remember to keep an eye out for any swelling or discoloration near the insertion site.

Figure 3.16 Connect the intraosseous needle to infusion set

Medication:
Epinephrine:

Indication:

If the infant's heart rate stays below 60 beats per minute (bpm) following: A. At least 30 seconds of PPV that causes the lungs to expand as shown by chest movement; and B. Another 60 seconds of chest compressions timed to 100% oxygen utilizing PPV.

Before you have established ventilation that successfully inflates the lungs, as shown by chest movement, epinephrine is not recommended.

Epinephrine:

A. The concentration is 1 mg/10 mL at 0.1 mg/mL (Figure 3.16).
B. Route: Intravenous or intraosseous (preferred)
C. While vascular access is being established, one endotracheal dose may be taken into consideration.

Figure 3.16 Epinephrine 1: 10.000

D. Setting up:

1. A 1-mL syringe for intravenous or intraosseous use (labeled Epinephrine-IV), A 3- to 5-mL syringe for endotracheal use (labeled Epinephrine-ET ONLY),
2. You might repeat this after every three to five minutes.
3. Dose: 0.02 mg/kg (equivalent to 0.2 mL/kg) intravenously or intraosseously the range is 0.1 to 0.3 mL/kg, or 0.01 to 0.03 mg/kg,
4. Rate: Quickly, as soon as feasible
5. Saline flush after intravenous or intraosseous dose: 3 mL
6. The endotracheal dose is 0.1 mg/kg (1 mL/kg), 0.05 to 0.1 mg/kg (0.5 to 1 mL/kg) is the range.
7. If there is no improvement, suggest intravenous or intraosseous administration for successive doses.

After giving epinephrine you should expect that:

Approximately one minute after intravenous or intramuscular epinephrine delivery, heart rate should reach 60 beats per minute or greater.
Continue synchronized breathing and compressions if the heart rate is less than 60 beats after receiving the initial dose of IV or IO epinephrine.
Every 3 to 5 minutes, you can repeat the epinephrine dose. Consider raising subsequent doses if you started with the advised initial dose of 0.02 mg/kg or less.
If there is no reaction, think about other issues including hypovolemia and tension pneumothorax.
The first IV or IO dose can be administered immediately after an endotracheal dose if the heart rate is less than 60 beats per minute.
Following the placement of an intraosseous needle or umbilical venous catheter, all following doses should be administered through IV or IO.

A cardiac monitor should be utilized for the most accurate estimation of heart rate.

Chest movement demonstrates that the lungs are being sufficiently ventilated. The endotracheal tube is not dislodged, bent, or clogged by secretions. Chest compressions are being applied at the appropriate depth.

- Chest compression interruptions are kept to a minimum because each one lowers coronary artery perfusion.

After giving volume expander you should expect that:

Acute fetal-maternal hemorrhages, bleeding vasa previa, significant vaginal bleeding, placenta lacerations, fetal injuries, umbilical cord prolapses, tight nuchal cords, and blood loss from the baby's umbilical cord can all result in shock. The infant may have a heart rate that is consistently too low to react to chest compressions, adequate breathing, or epinephrine.

Babies may have weak pulses, pale skin, and delayed capillary refill.
If the infant responds, the capillary refill time will have improved, the infant will be pink, with palpable pulses.
If epinephrine and a volume expander have been administered, the infant has not improved? Try to evalu-

ate these issues with your team.

1. Does the infant breathe in and out via the chest?
2. Is the airway protected by a laryngeal mask or an endotracheal tube?
3. Are the 3 compressions and 1 ventilation supplied every 2 seconds coordinated?
4. Is the chest's AP diameter equal to the depth of compressions?
5. Is the PPV device used to provide 100% oxygen?
6. Was the appropriate amount of epinephrine intravenously administered?
7. Has the intraosseous needle or umbilical venous catheter moved from its original position?
8. Is there a pneumothorax?

Volume Expanders:

If the infant is not responding to the steps of resuscitation and there are indicators of shock or a history of severe blood loss, a volume expander is recommended.

A. Solution: type O Rh-negative blood or normal saline (NS).
B. Intravenous or intraosseous route
C. Syringe with a 30- to 60-mL capacity (labeled NS or O- blood)
D. Dose: 10 mL/kg.
E. Rate: More than five to ten minutes

The team and family should be consulted before stopping resuscitation efforts if there is a confirmed absence of heartbeat following the completion of all necessary actions.

Around 20 minutes after birth is a decent window to think about stopping resuscitation attempts, although the choice to carry on or stop should be made individually based on the patient and the situation.

Notes should be considered:

Instead of using the whole range, the recommended dose of epinephrine has been reduced to one dose: This suggested modification would streamline the dosage for better preparation and education. In an emergency, it will be simpler for NRP providers to recall, and it might encourage better teamwork.

A 1-mL flush volume may leave a sizable amount of epinephrine in the umbilical vein or liver instead of transporting it to the heart, according to animal studies that have increased the flush volume following intravascular epinephrine administration from 1 mL to 3 mL.

It is safe to specify the dose of emergency epinephrine as a mass (mg/kg) or a volume (mL/kg).

The IO needle does not need to be aspirated, especially in newborns. If the needle was properly put, it shouldn't "wiggle" but rather feel firmly held in the bone. The soft tissue surrounding the bone shouldn't bulge when fluid is given.

Increasing the resuscitation period from 10 to around 20 minutes: The International Liaison Committee on

CHAPTER 4

Resuscitation and Stabilization of Preterm Babies, Special Considerations, Post-Resuscitation Care and Ethical Consideration

Chapter Objectives:

When this chapter is finished, you'll be able to:

- Understand why preterm babies are at increased risk of morbidity and mortality
- Know how to prepare for safe and effective preterm delivery
- Understand the oxygen management and ways to deliver assist ventilation in preterm babies if needed
- Recognize ways to minimize lung and brain injuries for the preterm baby
- Know how to maintain normal body temperature in premature babies throughout the resuscitation
- Learn How to perform proper counseling to both parents before delivery of preterm baby
- Discuss the special disorders that may complicate the resuscitation efforts.
- Understand the management of special newborn disorders.

Resuscitation and Stabilization of Preterm Babies

- **Why Preterm babies are at increased risk of morbidity and mortality:**
  - Term baby is defined as delivery between 37–42 weeks of gestation, any delivery before completing 37 weeks gestation is considered a preterm baby.
  - When born prematurely there are additional challenges that make the transition from intrauterine to extrauterine life more difficult.
  - The more premature the baby (less gestational age) the more help will be required.
  - Preterm babies are so fragile and might be injured from the resuscitation procedures themselves therefore there should be a balance between starting resuscitation without delay and avoid unnecessarily invasive procedures.
  - The first few minutes of life of the preterm baby is important in decreasing the short- and long-term complications.
  - In preterm deliveries some of the complications might be related to the cause of this early delivery.
  - Preterm babies have thin skin, minimal subcutaneous adipose tissue, large surface area relative to body mass and poor metabolic response to cold which all will lead to hypothermia.
  - Immature and fragile blood vessels in the brain can't adjust to changes in blood flow and thus more vulnerable to bleed.
  - Thin and weak chest muscles, stiff lungs due to lack of Surfactant, infection of the amniotic

fluid and placenta (chorioamnionitis) which might be the cause of the preterm delivery and decreased efficiency of the respiratory center will increase the need for respiratory support after birth.

- Preterm babies are considered immunocompromised and more prone to infections.
- Small blood volume, limited metabolic reserve and ineffective compensatory mechanisms increase the risk of hypovolemia from blood loss and hypoglycemia.
- Generally, all immature tissues might be damaged either by excessive or shortage of oxygen supply.

- **How to prepare for safe and effective preterm delivery**
  - The most important step in successful resuscitation is readiness; mentally, physically and the resources needed.
  - Upon receiving the first call to attend high risk delivery you have to have a detailed history and clear plan including manpower, equipment, and the role of each member in the team.
  - Attend the delivery early enough to discuss the latest update with the obstetrician and to check your equipment and discuss the plan of the resuscitation with your team.
  - Additional resources for the preterm delivery (including skilled personnel, a hat, thermal mattress, a polyethylene plastic bag (for babies less than 32 weeks gestation), servo-controlled radiant warmer, preterm sizes of resuscitation masks and endotracheal tubes, size 0 and 00 laryngoscope blade, positive-pressure device capable of delivering continuous positive airway pressure (CPAP) and positive-end expiratory pressure (PEEP), and surfactant (if the baby is expected to be less than 30 weeks gestation) in addition to the equipment required for the resuscitation of term babies.
  - Three chest leads cardiac monitor or limb lead to provide heart rate if the pulse oximeter signal is difficult to get.
- **Understand the oxygen management and ways to deliver assist ventilation in preterm babies if needed**
  - Due to the immaturity of lungs of the preterm babies they are more susceptible to injuries and are difficult to ventilate.
  - Pulse oximeter with proper sensor sizes and oxygen blender should be available for all preterm births.
  - Respiratory equipment capable of providing Continuous Positive Airway Pressure (CPAP) and Positive-End Expiratory Pressure (PEEP) is preferred, like flow-inflating bag, a T-piece resuscitator or self-inflating bag with PEEP valve.
  - If positive-pressure ventilation (PPV) is needed, use the minimal peak inspiratory pressure (PIP) required to achieve and maintain heart rate response, preferably use a device capable of delivering PEEP.
  - If the preterm baby is breathing spontaneously and his heart rate is at least 100 beats/minutes but has low oxygen saturation or has labored respiration consider CPAP immediately.
  - Keep in mind that CPAP alone isn't effective in babies who are not breathing or their heart rate is less than 100 beats/minutes.
  - One of the most important measures to avoid intubation in preterm babies is the early use of

proper CPAP that is why respiratory devices capable of delivering effective CPAP should be available during the delivery of preterm babies.

- The primary respiratory support for a spontaneously breathing preterm baby who is his /her heart rate at least 100 beats/minutes is **CPAP.**

Starting Positive Pressure Ventilation (PPV)

- Indications to start PPV in preterm babies are the same as for term babies which are:
  A. Apnea
  B. Gasping
  C. Heart rate is less than 100 beats/minutes

Within 30 seconds of birth despite the initial steps

- If PPV is indicated it is preferable to use a device that can provide Positive End Expiratory Pressure (PEEP):
  A. T-piece resuscitator
  B. Self-inflating bag with PEEP valve attached
- Start PEEP at 5 cm H2O
- Due to the immature lungs of preterm babies and their susceptibility to injuries if PPV is indicated you have to use the minimal inflation pressure needed to achieve and maintain heart rate of greater than 100 beats/minutes and gradually improves oxygen saturation.
- The best indicator of effective ventilation is increasing heart rate.
- Start PPV at an initial inflation pressure of 20–25 cm H2O which is adequate for most preterm babies and observe improvement in heart rate within 10 seconds.
- The amount of air required to ventilate the preterm baby's lungs is very small and may not result in perceptible chest movement.
- The maximum inflation pressure to be used during face-mask PPV in preterm babies is 30 cm H2O, if this pressure doesn't result in clinical improvement and you did your MR. SOPA ventilation corrective steps and didn't help then provide ventilation through the endotracheal tube which will allow you to decrease your inflation pressure and result in clinical improvement.
- You may also use a CO2 detector placed between the mask and the PPV device to ensure effective PPV.
- Face-mask leak is a common cause of ineffective face-mask PPV (MR.SOPA).

Administering surfactant

- Early (immediately after delivery) and proper use of CPAP in preterm babies significantly reduce the need for mechanical ventilation.
- Some experts still recommend the use of prophylactic surfactant administration therapy for babies less than 26 weeks gestation.
- Preterm babies who failed CPAP and required intubation and mechanical ventilation for respiratory distress syndrome should receive surfactant.
- Ways of administering surfactant:

A. Through the endotracheal tube and gradually wean the ventilator afterwards (The classical way).

B. While the baby on CPAP and through a thin tube passed through the vocal cords **(Less Invasive Surfactant Administration LISA)** OR **(Minimally Invasive Surfactant Treatment MIST)**.

C. Remove the endotracheal tube immediately after giving surfactant and return the baby back to CPAP (INtubate-SURfactant-Extubate INSURE).

- Each NICU has to develop its own definition of CPAP failure and when to mechanically intubate the bay and give surfactant.
- Surfactant administration should be given by expert personnel if not available in the resuscitation team we should wait for them.

Oxygen therapy in preterm babies

- Excessive oxygen can be very harmful for preterm babies because they developed in low-oxygen environment and most importantly their oxygen-associated injury protective mechanisms are not yet fully developed so they are more subjected to reperfusion injury.
- Nevertheless, most preterm babies will require oxygen to keep the oxygen saturation within the normal physiological levels compared to term babies (Table 4.2).
- During resuscitation you have to keep balance between low and high levels of blood oxygen
- For babies less than 35 weeks gestation it is currently recommended to start oxygen therapy at fractional inspired oxygen (FiO2) of at 21-30% and titrate according to the desired oxygen saturation in addition to the use of pulse oximeter and oxygen blender.
- We should never start resuscitation with 100% oxygen and an oxygen blender should be available in all delivery rooms.
- **Recognize ways to minimize lung and brain injuries for the preterm baby**
  - All systems and organs of the premature babies aren't yet well developed and therefore subjected to complications.
  - The respiratory and central nervous systems are among the two most common systems that can cause significant morbidities and mortalities.
  - Preterm babies who are less than 32 weeks gestation have a fragile network of capillaries in their brain that might rupture and cause significant brain bleeding which will cause brain tissue damage and lifelong disability.

Table 4.2 Ways to Minimize Lung And Neurological Injuries

Ways to minimize lung injuries	Ways to minimize neurological injuries
Use blended oxygen and pulse oximeter	Handle the baby gently
Avoid high PPV and CPAP pressures	Avoid positioning the baby's legs higher than the head (Trendelenburg position)
Take blood gases and adjust ventilation and oxygen concentration accordingly	Avoid rapid intravenous fluid infusions (normally between 5–10 minutes)

Start CPAP as early as possible to avoid endotracheal intubation and ventilation	Avoid rapid changes in blood CO_2 levels , blood pressure or blood volume
Avoid hypoxia and hyperoxia	Avoid hypoxia and hyperoxia
	Avoid noisy, painful or irritating stimuli
	Avoid multiple intubation attempts and frequent unnecessary tracheal suction
	Avoid high PPV and CPAP pressures (might cause pneumothorax, decrease venous return from the brain and increase the risk of bleeding)

- **How to maintain normal body temperature in premature babies throughout the resuscitation**
  - The relative lack of subcutaneous fat and the large body surface area in relation to weight make preterm babies at risk for hypothermia (body temperature below 36.5 °C).
  - Admission hypothermia can occur in up to 47 % of preterm babies less than or equal to 28 weeks gestation*.
  - Hypothermia in preterm babies is associated with significant morbidities and mortalities*.
  - The resuscitation room temperature should be 23-25 °C.
  - For babies less than 32 weeks gestation a polyethylene plastic bag or wrap and a thermal mattress should be prepared.

Applying plastic bag for preterm baby.

- Radiant warmer with servo-control and a temperature sensor should be available
- For term babies and some late-preterm babies drying with warm towels, skin-to-skin contact and early breastfeeding may be enough to maintain normal body temperature.
- For preterm babies the following measures has to be taken:
  1. Set resuscitation room temperature between 23-25 C
  2. Preheated radiant warmer
  3. Place a hat on the baby's head immediately after birth
  4. Heated towels to dry the baby thoroughly if more than 32 weeks gestation
  5. If 32 weeks gestation and less don't dry the baby and cover the baby with the polyethylene plastic bag or wrap
  6. Any commercially available plastic bag or wrap can be used to cover the body of the baby, in case if you need to insert UVC you can create a hall through the plastic bag.
  7. You might use thermal mattress for babies less than 32 weeks gestation
  8. Attach temperature sensor to the baby and the radiant warmer in servo-control
  9. Pre-warmed transport incubator should be ready for moving the baby from the resuscitation room to the NICU
  10. Keep baby's axillary temperature between 36.5 C and 37.5 C
  11. Monitor baby temperature closely overheating has been described in preterm babies.

Special precautions for the preterm babies:

A. Delayed cord clamping in preterm babies:

- Early cord clamping (less than 30 seconds)
- Delayed cord clamping (30-60 seconds)
- Early cord clamp may interfere with the normal smooth transition from intrauterine to extrauterine life as it leaves fetal blood in the placenta rather than in the baby's circulation.
- Delayed cord clamping in preterm babies is associated with less blood transfusions during the early neonatal period and probably improves the survival rates.
- Establish the timing of the umbilical cord clamping with the obstetrician before delivery.
- For vigorous preterm baby delay the cord clamping for 30-60 seconds meanwhile and while the cord is still attached you can do the initial steps of newborn care.
- For non-vigorous preterm baby there is no enough evidence to recommend delaying cord clamp but there might be some cord clamp delay while the obstetrician clears the

airway and do gentle stimulation.

- If the mother is hemodynamically unstable or the placental circulation is not intact (abruptio placenta, placenta previa with bleeding or cord avulsion, the cord should be clamped immediately after birth.
- Cord milking for babies less than 28 weeks gestation isn't recommended because it is associated with increased risk of intraventricular hemorrhage.

B. Monitor blood glucose

- Preterm babies have lower glucose stores in their body
- If resuscitation is required these stores will be depleted quickly and the baby will develop hypoglycemia
- Monitoring blood glucose and early start of intravenous fluid with dextrose is essential

C. Cardiopulmonary events (Apnea, Bradycardia and Desaturation ABDs)

- Preterm babies have immature respiratory center which might cause significant ABDs.
- During the stabilization phase monitor ABDs closely and act accordingly.

- How to perform proper counseling to both parents before delivery of preterm baby
  - Counseling both parents regarding the outcome of the pregnancy is their right
  - It should be done as early as you have the full information about the pregnancy
  - Counseling is important for both parents and the neonatal staff
  - Prenatal counseling is a great chance to give important information, build trusted relationship with the neonatal team and discuss goals of care which will all help in shared decision-making for the baby
  - Proper counseling around the time of delivery might be challenging because you have to give complex information in short period of time while the mother is in stressful situation
  - Accurate information about the available treatment options, short and long term outcomes and national and international outcome data should be presented to both parents
  - Ideally both the obstetric and neonatal providers should be available to talk to both parents
  - Generally, NICU consultation should be done for any potential NICU admission upon admitting the mother even if delivery isn't certain
  - Allow time for both parents to ask questions by doing the counseling early on before the delivery progresses or the mother be under the effect of medications
  - Counseling should be simple, clear, avoid giving numbers unless you have clear data and should be balanced and objective for the range of possible outcomes and avoid being excessively negative or unrealistically positive.
  - Try to encourage parents to ask questions even after the counseling and revisit them again if time allows.

- Counseling should be documented in the mother's file and the treatment plan should be distributed to the neonatal team.

Special Considerations

The objectives: -

When this chapter is finished, you'll be able to:

- When to suspect and manage pneumothorax or pleural effusion
- How to manage a newborn with upper airway obstruction
- How to manage congenital lung and heart diseases that complicate resuscitation
- How to manage the newborn complications due to maternal opiate or anesthesia
- How to manage a newborn with myelomeningocele
- How to manage a newborn with abdominal wall defects

In this lesson, we will cover fewer common conditions that you may encounter during neonatal resuscitation, it is crucial to recognize them early and respond quickly and efficiently.

- **When to suspect and manage pneumothorax or pleural effusion**

  A. Pneumothorax

  - Is the accumulation of air in the pleural space surrounding the lungs which prevent them from fully expanding resulting in severe respiratory distress and persistent bradycardia.
  - Pneumothorax can occur spontaneously but the risk increased if you are using Positive Pressure Ventilation PPV, in preterm babies, babies with meconium aspiration and babies with congenital lung anomalies (Congenital Diaphragmatic Hernia and Lung Hypoplasia)
  - Pneumothorax might be mild with minimal air leak into the pleural space and no or mild symptoms of respiratory distress, in such cases no drain of the air is needed, and it will resolve spontaneously but close monitoring clinically and radiologically is required.
  - If a large amount of air leaks into the pleural space, then the pressure from the trapped air can cause lung collapse, interferes with blood flow within the chest causing severe respiratory distress, oxygen desaturation and bradycardia, this is called Tension Pneumothorax.
  - Tension Pneumothorax is an emergency life threatening condition which requires urgent evacuation of the air within the pleural space. Pneumothorax will be suspected if the baby fails to improve despite all the resuscitative measures or suddenly the baby crashed with severe respiratory symptoms.

The definitive diagnosis of pneumothorax is by doing chest x-ray demonstrating air leaks into the pleural space but in cases of tension pneumothorax which is an emergency you shouldn't wait till you get the chest x-ray and you must clinically suspect and treat it.

- Breath sounds will be diminished on the side of pneumothorax, though you must be very careful in interpreting this specially in preterm babies where the chest is small and trans-

mitted sounds will make the appreciation of diminished breath sounds on either side is difficult.

- Keep in mind that a deep endotracheal tube going into the right main bronchus will cause diminished air entry on the left side of the chest with no pneumothorax. (Figure 4.1)

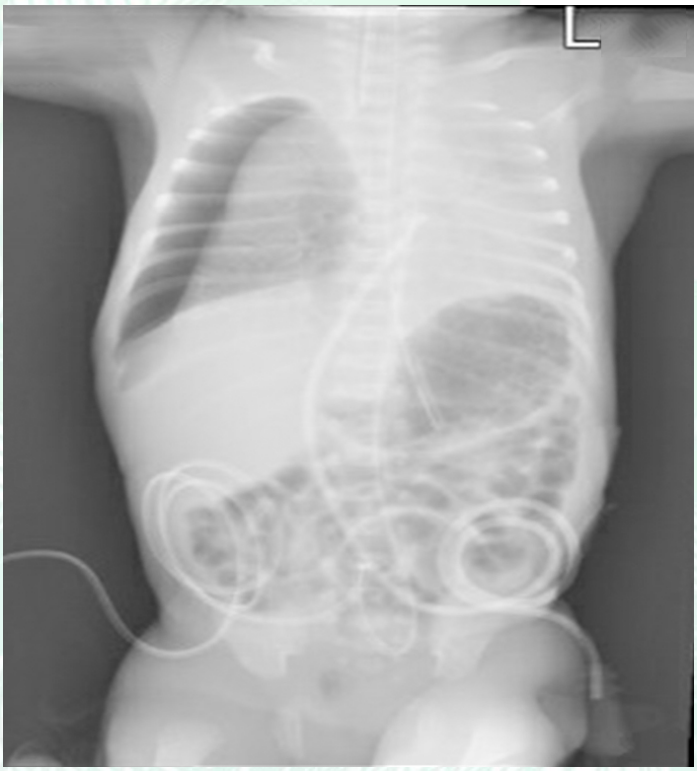


Figure 4.1 Pneumothorax

- Causes of diminished breath sounds are displayed in Table 4.2.

Table 4.2 Causes of diminished breath sounds
Ventilatory device failure
Inadequate ventilation techniques
Endotracheal tube malposition
Pneumothorax
Pleural effusion
Tracheal obstruction
Lung anomalies (CDH, lung hypoplasia and lung agenesis)
Severe cardiomegaly

- Transillumination of the chest using high-intensity fiber-optic light can help in diagnosing pneumothorax (Figure 4.2).
- In a dimmed room or guard placed over the baby's chest using the transillumination on both sides of the chest, the light on the side with pneumothorax will appear to spread further and glow brighter than the opposite side. Figure

- Caution must be taken in interpreting the results of the transillumination in very premature babies due to their thin skin which might cause the chest to shine more even in the absence of pneumothorax.
- If the transillumination isn't immediately available or the result isn't conclusive, but you have a strong clinical suspicion of pneumothorax proceed with the emergency treatment.

Figure 4.2 Transillumination

B. Pleural effusion

- Any type of fluid collection in the pleural space is called a pleural effusion (Figure 4.3).
- Pleural effusion can be caused by infection, lymphatic system leakage or due to generalized edema as part of hydrops fetalis where the baby will also have generalized skin edema, ascites, and pericardial effusion.
- Large pleural effusions should be diagnosed on routine antenatal ultrasound and might be associated with pregnancy complications of twin-twin transfusion, severe fetal anemia, congenital heart disease, cardiac arrhythmias, congenital infection and genetic syndrome.

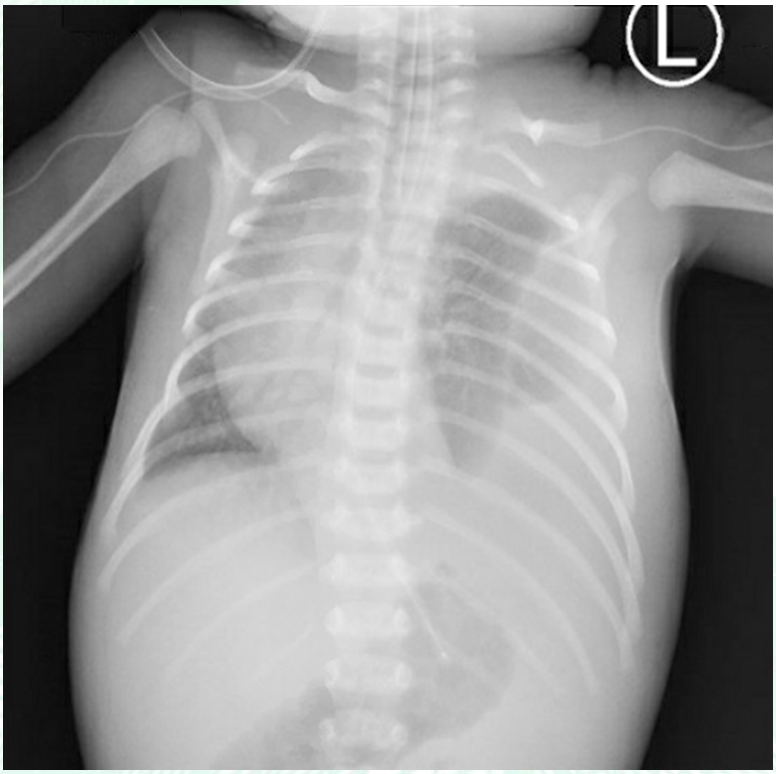
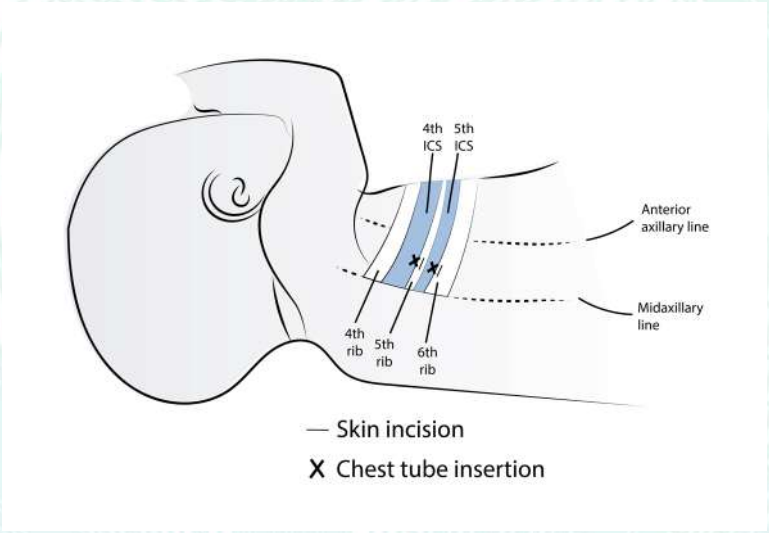


Figure 4.3 Pleural Effusion

- Presence of large amount of fluid within the pleural space will prevent the lungs from expanding normally, impair their blood flow and gas exchange and resulting in severe respiratory distress and oxygen desaturation.
- Breath sounds on the affected side will be diminished.
- Minimal amount of pleural effusion in asymptomatic baby or mild symptoms requires no intervention but close observation and looking for the cause of this pleural effusion.
- Definitive diagnosis of pleural effusion is made by chest x-ray or chest ultrasound.
- If there are significant respiratory symptoms despite intubation and PPV, the fluid must be drained out of the pleural space.
- If feasible, large pleural effusions can be drained antenatally by the obstetrician.

- **Management of pneumothorax and pleural effusion**
  - Minimal pneumothorax or pleural effusion in asymptomatic or mild symptomatic baby requires no drain but very close observation of the baby and providing oxygen to keep normal saturation
  - Large pneumothorax or pleural effusion in symptomatic baby requires inserting a catheter to drain the air or fluid in the pleural space on the affected side which is called thoracentesis.
  - Thoracentesis is performed under sterile technique with proper pain control in non-emergency situations however in emergency conditions such as tension pneumothorax it should be done as fast as possible to save the baby's life.

- Thoracentesis for pneumothorax is done by inserting a needle either through the fourth intercostal space at the anterior axillary line or the second intercostal space at the mid-clavicular line (Figure 4.4), place the baby in supine position with the affected side directed slightly upwards to allow air to accumulate in the area to drain.
- Thoracentesis for pleural effusion is done by inserting a needle in the fifth or sixth intercostal space along the posterior axillary line (Figure 4.5), place the baby on their back for the fluid to be collected in the posterior part of the chest.
- Prepare the drain site with topical antiseptic agents, sterile towels and if (non-emergency drain) with local anesthesia.
- Use 18 or 20-gauge percutaneous catheter-over-needle device or small "butterfly" needle perpendicular to the chest wall and above the upper part of the rib (to avoid puncturing the blood vessels located under each rib)
- For pneumothorax the catheter should be directed slightly upwards toward the front of the chest while for pleural effusion it should be directed slightly downward toward the back.
- Once you entered the pleural space, the needle is removed, and a large syringe (30-60 ml) connected to a 3-way stopcock is attached.
- You should know how to use the 3-way stopcock to drain the air or fluid.
- After thoracentesis is done, obtain chest x-ray to document the drain of the pneumothorax or the pleural effusion.
- A plastic tube (thoracostomy) may need to be inserted into the chest cavity and removed after a few days.



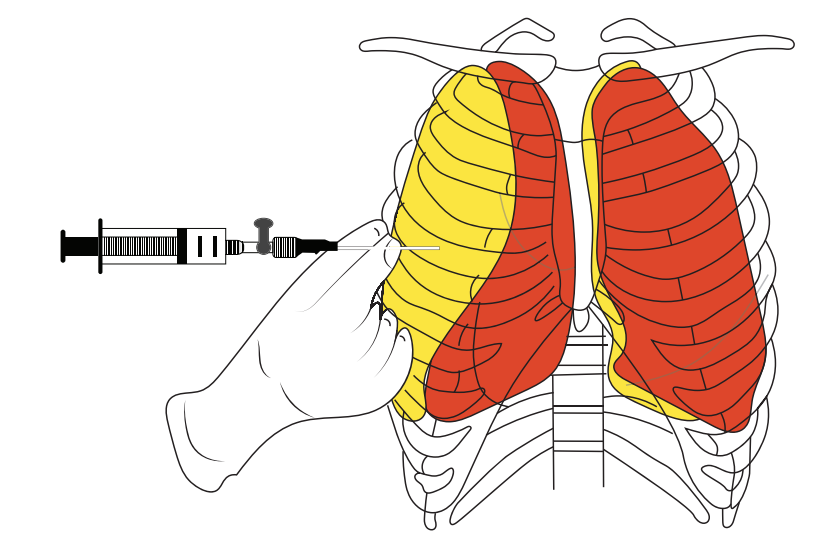


Figure 4.4 Thoracentesis for pneumothorax

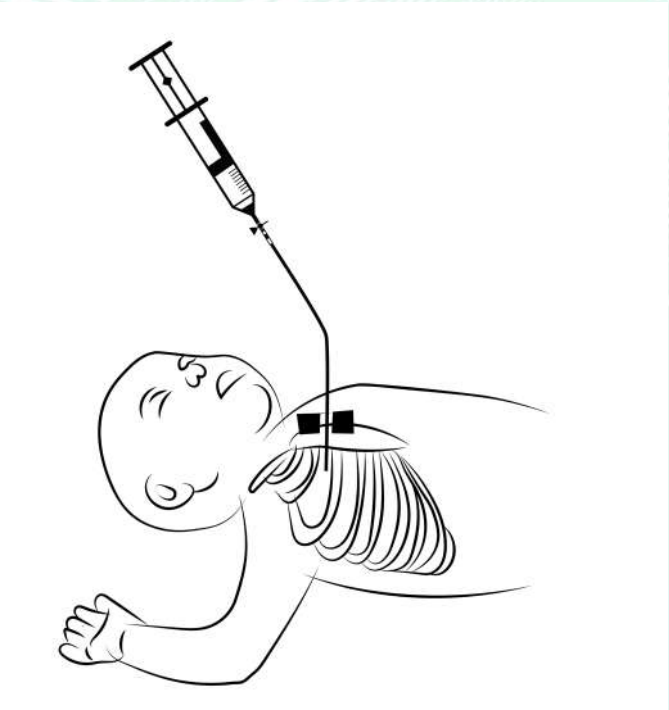


Figure 4.5 Thoracentesis for pneumothorax

- **How to manage a newborn with upper airway obstruction**
  - One of the most frequent life-threatening conditions in neonates is airway blockage, which provides a diagnostic and therapeutic challenge to neonatologists.
  - Upper airway obstruction can be due to:

A. Thick secretions

B. Anatomic obstructions

A. Thick secretion

- Thick secretions such as meconium, blood, mucus, or vernix may cause complete tracheal obstruction.
- If you are attempting positive pressure ventilation and the baby isn't improving and there is no chest movement then you have to apply your ventilation corrective steps (MR.SOPA) till the baby is improving.
- After successful insertion of the endotracheal tube and you can't get chest movement then the trachea may be obstructed by thick secretions.
- You may try to clear the secretions by a suction catheter (5F-8F) inserted through the endotracheal tube.
- If the secretions are thick enough to completely obstruct the airway the small suction catheter may not be able to remove the secretions, in such case use the endotracheal tube itself as a suction catheter with the help of the tracheal aspirator. (Figure 4.6)

Figure 4.6 Tracheal Aspirator

- Set the suction pressure to 80-100 mm Hg, connect the suction tubing to the aspirator and

then to the endotracheal tube and apply suction while removing the endotracheal tube to remove all the secretions Slowly within 3-5 seconds, afterward insert a new endotracheal tube to ventilate the baby.

B. Anatomic obstructions

1. Choanal Atresia

- Except when they cry, babies don't typically breathe through their mouths, they are obligate nose breathers
- Choanal atresia is a condition where the nasal airway is obstructed by bone or soft tissue (Figure 4.7)

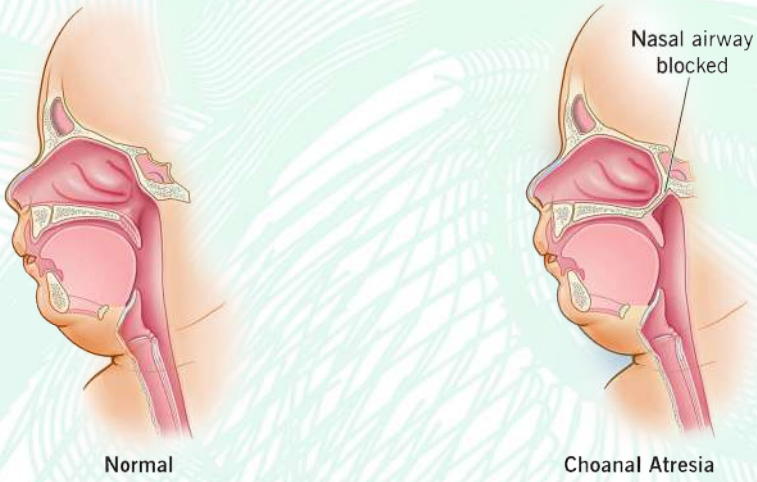


Figure 4.7 Choanal Atresia

- In most cases the obstruction is only on one side and doesn't cause significant symptoms in newborn period.
- Bilateral choanal atresia can cause significant symptoms immediately after birth where the baby will have severe respiratory distress and cyanosis when quiet and resolving when the baby start crying.
- The presence of meconium or mucus in the nasal airway can be a sign of choanal atresia.
- Insertion of a thin suction catheter through both nostrils can be diagnostic
- Managing babies with bilateral choanal atresia include insertion of a pacifier modified by cutting off the end (McGovern nipple) or inserting an oral airway or endotracheal tube inserted into the posterior pharynx.
- If isolated the outcome of choanal atresia is excellent.

2. Robin Sequence

- Is a combination of facial anomalies due to the underdevelopment of the lower jaw, the lower jaw is small and set back compared to the upper jaw and the tongue is positioned posteriorly obstructing the airway (Figure 4.8)

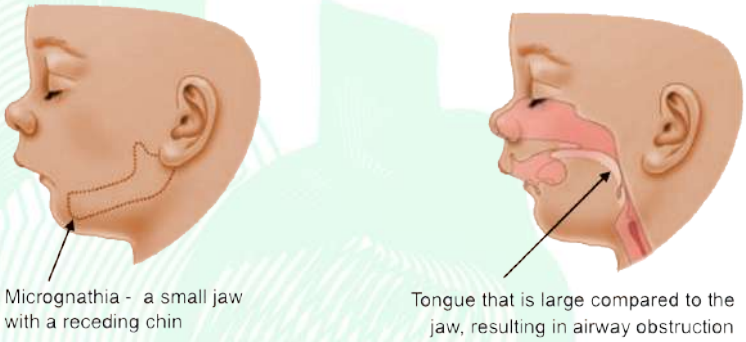


Figure 4.8 Robin Sequence

- Robin sequence may have cleft palate and could be part of genetic syndrome or isolated.
- If the baby has mild symptoms of labored breathing, place the baby in prone position which might cause the tongue to move forward and open the airway.
- If didn't help you may insert a small endotracheal tube (2.5 mm) into the posterior pharynx past the base of the tongue to bypass the obstruction
- If the baby has severe breathing difficulties, bag and mask ventilation or even endotracheal intubation might be difficult and the laryngeal mask may provide a lifesaving rescue airway.

3. Other rare conditions
   - Rare conditions such as oral, nasal, neck masses, laryngeal and tracheal anomalies may be challenging
   - If you are aware antenatally about the possibility of upper airway obstruction then pediatric ENT should attend during the delivery with the expertise to perform emergency tracheostomy in case it is needed.

How to manage congenital lung and heart diseases that complicate resuscitation

1. Congenital diaphragmatic hernia
   - The diaphragm, a tissue with a dome shape that divides the thoracic chamber from the abdominal cavity, plays a crucial role in respiration.
   - Congenital diaphragmatic hernia (CDH) is when the diaphragm has a defect that permits some abdominal organs to protrude into the thoracic cavity and prevents the lungs from developing normally (ipsilateral and contralateral) (Figure 4.9)
   - Ideally CDH should be diagnosed antenatally, and the delivery should be planned at a high-risk center.
   - Newborn babies with CDH will present with scaphoid abdomen, severe respiratory distress, and hypoxia
   - Immediate endotracheal intubation after birth, insertion of a large orogastric tube (10F) to deflate the stomach, and avoidance of face-mask positive pressure ventilation are the fundamentals in managing babies with CDH.

- Persistent pulmonary hypertension of the newborn (PPHN) and pneumothorax are common in CDH.

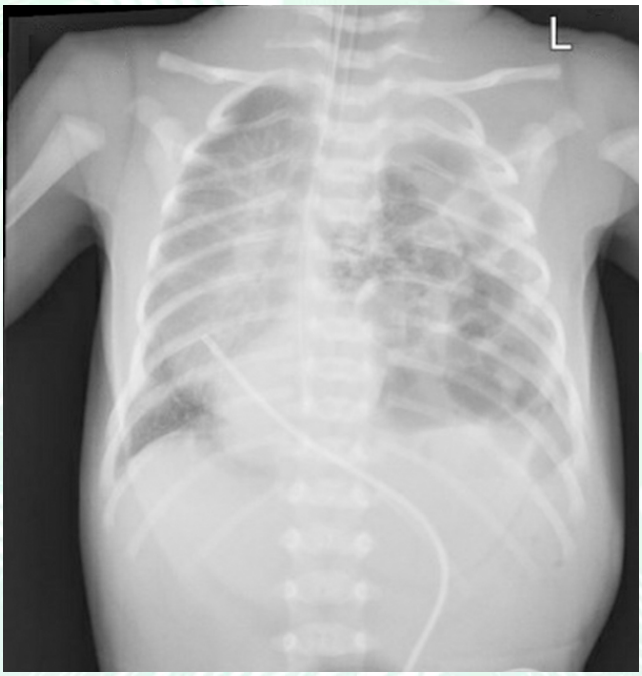


Figure 4.9 Congenital Diaphragmatic Hernia (CDH).

2. Pulmonary hypoplasia
   - Any condition that occupies space in the chest or cause severe decrease in amniotic fluid will cause the lungs to be incompletely developed which is called pulmonary hypoplasia.
   - Examples of pulmonary hypoplasia; CDH, obstruction or absence of both kidneys with no or minimal amniotic fluids
   - High inflation pressures may be required to inflate the hypoplastic lungs and hence increase the risk of pneumothorax.
   - Severe pulmonary hypoplasia may be incompatible with life.

3. Meconium aspiration syndrome
   - Meconium is the first intestinal discharge from newborns, a viscus, dark-green substance composed of intestinal epithelial cells, lanugo, mucus, and intestinal secretions such as bile.
   - Water is the major constituent, comprising 85-95% of meconium; the remaining 5-15% consists of solid constituents, primarily intestinal secretions, mucosal cells, and solid elements of swallowed amniotic fluid, such as proteins and lipids.
   - Meconium is sterile and does not contain bacteria, which is the primary factor that differentiates it from stool.
   - Intrauterine fetal distress in term and late preterm babies can lead to the passage of meconium into the amniotic fluid before birth.

- Meconium may cover the baby's umbilical cord, nail beds, or skin, giving them a greenish yellow hue.
- Meconium aspiration syndrome (MAS) is the aspiration of stained amniotic fluid, which can occur before, during, or immediately after birth.
- The NRP team should be notified immediately if there is meconium-stained amniotic after rupturing mother's membranes.
- Not all babies with meconium-stained amniotic fluid will develop MAS
- Pathophysiology of MAS:
  - Mechanical obstruction of the airways by the meconium
  - Surfactant inactivation
  - Chemical pneumonitis
- Chest x-ray of MAS showed areas of atelectasis and hyperinflation (Figure 4.10), which increases the chance of pneumothorax.

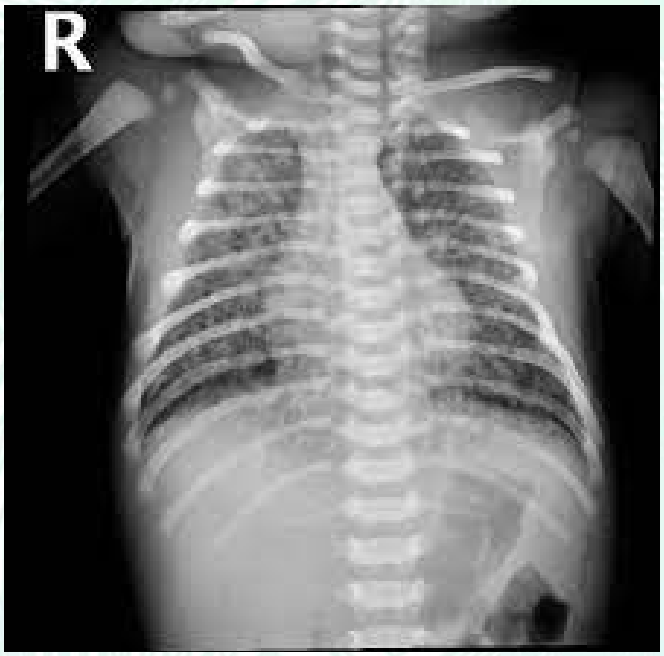


Figure 4.10 Chest x-ray of Meconium aspiration syndrome (MAS)

- Babies with MAS will have symptoms of severe respiratory distress, cyanosis, and oxygen desaturation like many other respiratory diseases in neonatal period but the clue here is the presence of the meconium-stained amniotic fluid.
- Most affected neonates survive; however, the disease can be deadly if severe particularly if it results in prolong pulmonary hypertension.
- Mechanical ventilation, inhaled nitric oxide, surfactant administration therapy, inotropes and sedation may be needed in the management of MAS.
- MAS in newborns may increase the likelihood of developing asthma later in life.

- Babies born through meconium-stained amniotic fluid "even if vigorous at birth" should be closely observed, not necessarily in the NICU, with a high index of suspicion for any respiratory symptoms and act accordingly.
- Antibiotics therapy in MAS isn't always required.

4. Congenital Heart Disease (CHD)
   - It is uncommon for structural congenital heart disease to cause complications during neonatal resuscitation.
   - CHD cause is multifactorial involving both environmental risk factors and genetic predisposition.
   - Regular and early antenatal visits to the obstetrician is crucial for the wellbeing of the mother and her fetus.
   - Major structural CHD should be diagnosed antenatally during the detailed ultrasound scan before the beginning of the second trimester.
   - Pregnant women with babies with major CHD should deliver in a tertiary center capable of dealing with such babies.

- **How To Manage The Newborn Complications Due To Maternal Opiate Or Anesthesia?**
  - Opiates can cross the placenta to the fetus.
  - Opiates when reached the fetus can cause decrease in activity and inhibits the respiratory drive.
  - In newborn babies with respiratory depression after maternal opiate exposure, you have to manage the newborn's airway and provide respiratory support with PPV, if there is prolonged apnea, insertion of endotracheal tube or laryngeal mask might be needed for ongoing respiratory support.
  - Naloxone, an opioid antagonist was used in this setting previously, but there is insufficient evidence to evaluate the safety and efficacy of this practice in newborn babies.
  - Naloxone pharmacology in newborn babies isn't well understood and in some animal studies the use of naloxone was associated with pulmonary edema, cardiac arrest, and seizures.
  - If the mother didn't receive an opiates, general anesthesia or magnesium sulfate during labor and there is no neonatal spontaneous breathing but PPV results in a normal heart rate and oxygen saturation, then other causes of neonatal respiratory depression should be considered like medication self-administered by the mother, hypoxia, severe acidosis, structural brain anomaly or a neuromuscular disorder.
  - There are no medications to reverse the effects of drugs that can cause neonatal respiratory depression and the focus should be to provide airway support, effective ventilation and close observation till the medication weans off.
- **How To Manage A Newborn With Myelomeningocele?**
  - Myelomeningocele is a type of neural tube defect which affects the spinal cord and the vertebrae.

- It occurs during the first few weeks of fetal development when the neural tube does not completely close and form a sac of fluid.
- This sac contains nerves and part of the spinal cord which will protrude through an opening in the baby's back, the sac should be protected from trauma which might lead to its rupture and introduction of infection. (Figure 4.11)

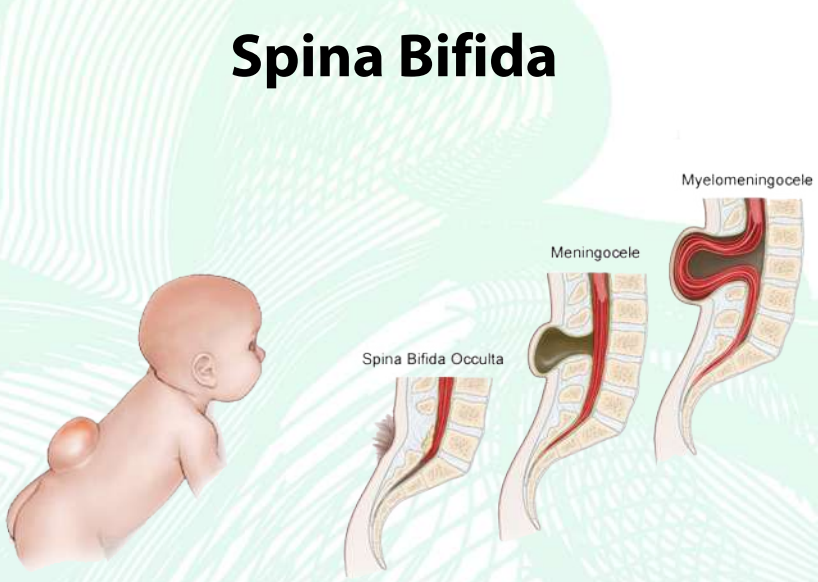


Figure 4.11 Newborn with spina bifida and its different types including Myelomeningocele.

- Hydrocephalus and defects in brainstem and cerebellum (Arnold Chiari malformation) may be associated with myelomeningocele.
- Myelomeningocele should be diagnosed antenatally, before delivery proper counseling to both parents must be done including the labor and delivery management, the surgery, and the long-term complications.
- Before birth, prepare a "donut" with a towel in case you need to put the baby in supine position then the defect will be placed in the donut hole.
- After birth, place the baby on their side in a prone position, if you need to put the baby in supine position then use the donut with the defect placed in the donut hole to avoid pressure on the sac and its contents.
- Extra caution must be taken during the initial steps of resuscitation not to rupture the sac.
- Cover the sac with transparent plastic wrap if available or sterile gauze soaked with warm normal saline.

- **How to manage a newborn with abdominal wall defects**
  - The most common abdominal wall defects are Gastroschisis and Omphalocele.
  - Abdominal wall defects should be diagnosed antenatally, and the delivery must be planned in higher centers.

- Gastroschisis is a defect in the abdominal wall where the baby's bowel will protrude through an opening in the abdominal wall to the right side of a normal appearing umbilicus. (Figure 4.12)
- It is usually isolated with no other anomalies
- Omphalocele is a defect in the abdominal wall that includes the umbilical cord with a membranous sac that contains the abdominal organs, this sac might rupture before or after delivery, exposing the abdominal contents. (Figure 4.12)

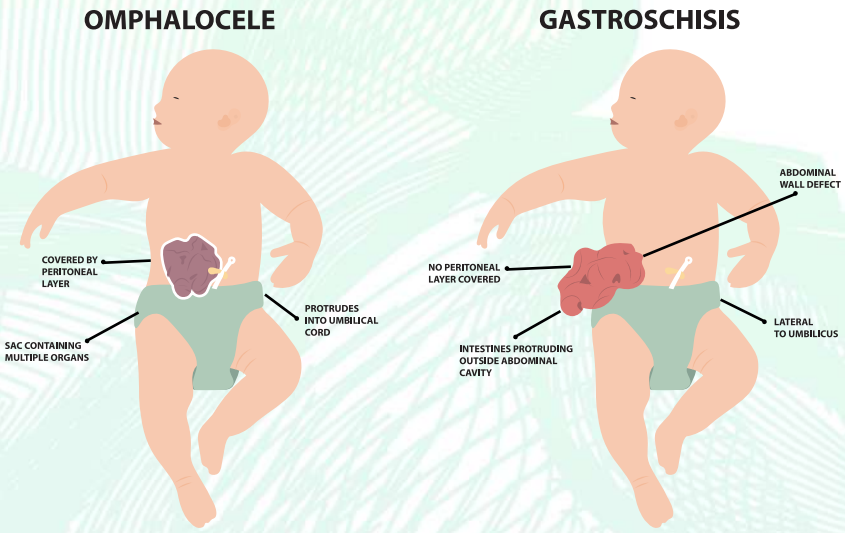


Figure 4.12 Newborn with Omphalocele and Gastroschisis

- Babies with omphalocele may have other congenital anomalies or genetic syndromes.
- Labor and delivery management of abdominal wall defects: -
  - Place the baby and the defect in clear and sterile plastic bag and secure it.
  - Position the baby to the right side to optimize perfusion
  - Cardiac monitor leads on the upper chest and arms should be placed
  - Insert large orogastric catheter (8F or 10F) with intermittent or continuous suction to prevent gaseous distension of the bowel.
  - Avoid prolonged face-mask ventilation, if assisted ventilation is still needed, consider endotracheal intubation to prevent air distending the bowel.
  - Handle abdominal wall defects gently and frequently assess the color and perfusion of the abdominal defect contents.
  - For gastroschisis ask the obstetrician to cut the umbilical cord 10-20 cm from the body because cord may be needed for the surgical repair, however it might be used for emergency conditions.
  - For omphalocele clamp and cut the cord well above the defect and it cannot be used in emergency conditions, if emergency access is required an intraosseous needle can be used.

- The exposed defect will increase heat and fluid losses and careful attention to temperature management and fluid administration is necessary.

- **Post-Resuscitation Care**
  - **What Is Post-Resuscitation Care? Why Do We Need It?**
  - **Medical Conditions That May Occur Post-Resuscitation**
  - The transition from intrauterine to extrauterine life continues for several hours after birth, resuscitation may cause problems in this transition even after vital signs appear to return normal.
  - The infant is sent to post-resuscitation care after being successfully revived. Those infants who required resuscitation must have close monitoring of their vital signs, oxygen saturation, blood glucose, serum electrolytes, urine output, and neurologic status and typically are transferred to the neonatal intensive care unit.
  - Post-resuscitation medical complications may involve multiple organ systems and can be anticipated and promptly addressed by appropriate monitoring.

- **Medical conditions that may occur post-resuscitation**
  - Temperature Instability
  - After resuscitation, babies may develop hypo or hyperthermia. Premature babies are associated more with hypothermia which has been associated with increased mortality.
  - Techniques used to Maintain normal body temperature mainly in premature babies are described in previous lessons.
  - Overheating should be avoided after resuscitation and if indicated therapeutic hypothermia must be initiated.
  - Studies have shown that in term and late preterm babies with moderate to severe hypoxic ischemic encephalopathy (HIE) therapeutic hypothermia will reduce the risk of death and/or neurodevelopmental delay.
  - Each institution must have their own guidelines to initiate therapeutic hypothermia, if this treatment option isn't available in your hospital referred the baby to the nearest available hospital with this treatment option available within a window of maximum six hours.

- **Hypotension**
  - Hypotension may occur after resuscitation due to the following causes: -
    1. Decrease cardiac contractility and blood vessel tone due to low oxygen levels.
    2. Hypovolemia if there is significant blood loss
    3. Dilation of peripheral blood vessels due to sepsis

  - Blood pressure should be closely monitored post-resuscitation, if there is significant history of hypovolemia then volume expanders with a crystalloid solution or blood transfusion may be needed.
  - Routine volume expanders use in the immediate post-resuscitation period without evidence of hypovolemia is not recommended and in fact it might be harmful.

- Other babies may need medications like dopamine, dobutamine or epinephrine to improve cardiac output and systemic blood flow .

- **Hypoglycemia**
  - Glucose is essential fuel for brain metabolism, prolonged hypoglycemia episodes in neonates can lead to severe brain injury.
  - During resuscitation anaerobic metabolism (metabolism without adequate oxygen) can take place which increases the consumption of glucose and lead to hypoglycemia.
  - Perinatal stress which lead to the need for resuscitation can deplete glucose stores rapidly leading to low serum glucose.
  - Blood glucose levels should be monitored soon after resuscitation and on regular intervals until it remains stable.
  - Intravenous glucose infusion may be required to keep normal glucose levels and avoid hypoglycemia.

- **Central nervous System Abnormalities:**
  - Hypoxic Ischemic Encephalopathy (HIE) is a non-specific brain dysfunction associated with hypotension, hypoxemia, and acidosis.
  - Initially babies with HIE will have hypotonia, lethargy, poor respiratory effort, or even apnea few hours later seizures might appear.
  - Proper neurological assessment is essential and anticipation of the complications is useful tool
  - Lethargy, apnea, and seizures might be due to other conditions like maternal narcotics exposure, electrolyte disturbances, infection, and inborn error of metabolism.

- **Respiratory problem: -**
  - Neonatal pneumonia and aspiration is uncommon immediately after birth, babies will present with tachypnea, nasal flaring, hypoxia, grunting and retractions similar to the symptoms of respiratory distress syndrome.
  - Mechanical respiratory complications including but not limited to, endotracheal tube obstruction or dislodgement, displacement or even the development of pneumothorax.
  - During fetal life the pulmonary blood vessels are constricted, after delivery they relax causing more blood to flow into the lungs and higher partial pressure of oxygen is achieved causing the pulmonary blood vessels to relax more and more.
  - If pulmonary blood vessels remain constricted after delivery, with super systemic pulmonary blood pressure then this condition is called Persistent Pulmonary Hypertension of the Newborn (PPHN).
  - Post-resuscitation, pulmonary vascular bed is very labile, and many factors can cause PPHN including, hypothermia, hypoxemia, excessive stimulation, and acidosis.
  - Through hypoxia might induce PPHN, hyperoxia on the other hand can be harmful and of no benefit.
  - History of resuscitation, pre- and post-ductal oxygen saturation differences, arterial

blood gas and echocardiography will help in establishing the diagnosis of PPHN.

- PPHN can be managed with oxygen, conventional mechanical ventilation, HFOV, inhaled nitric oxide and ExtraCorporeal Membrane Oxygenation (ECMO).

- **Metabolic acidosis: -**
  - During resuscitation tissues receive insufficient oxygen which leads to the production and accumulation of acids and subsequently metabolic acidosis.
  - Metabolic acidosis will compromise heart function and worsen pulmonary hypertension.
  - Once you restore the respiratory and cardiac functions, the metabolic acidosis will improve by itself and no need give base, the most important thing is to correct the cause of metabolic acidosis.
  - If metabolic acidosis persists despite restoring of the respiratory and cardiac functions then look for other causes of metabolic acidosis (sepsis, inborn error of metabolism).
- **Electrolytes disturbances:**
  - Post-resuscitation hyponatremia and hypocalcemia are frequently present.
  - Serum electrolytes should be sent to detect and treat any electrolytes disturbances with intravenous supplementation.
- **Renal failure:**
  - Hypoxia, acidosis, and hypotension during resuscitation can decrease blood flow to the kidneys and cause renal failure.
  - Acute tubular necrosis (ATN) which is a form of temporary renal failure causing fluid retention, low urine output and electrolytes disturbances may follow aggressive resuscitation.
  - Restoration of the respiratory and cardiac functions, fluid restriction, avoidance of nephrotoxic medications is usually all what is needed to treat ATN.
  - During the recovery phase the baby will have very high urine output and might need additional fluids.
- **Feeding problems: -**
  - Because of hypoxia, decrease blood flow to the intestine, acidosis, and hypotension post resuscitation; the gastrointestinal tract might be affected leading to vomiting, feeding intolerance, decrease motility, bleeding and even perforation of the intestinal wall.
  - In addition, the coordination between sucking, swallowing, and breathing will be affected depending on the degree of central nervous system insult.
  - Enteral feeding will be delayed till the baby is ready and other alternative methods for providing nutrition will be required during this interval.
- **Ethics and care at the end of life**
  - The ethical principles of neonatal resuscitation are the same as old child and adult.
  - Regarding when to start or stop resuscitation there are no clear legal or ethical rules,

physicians and parents will make most of these decisions.

- Parents usually the decision maker for their own baby and to be able to fulfill this responsibility they must have complete comprehensive, relevant, up to date information.
- If the most responsible physician thinks that there is no chance for survival of the newborn baby either due to non-viable fetus or complex congenital anomalies then initiation of resuscitation should not be offered to parents.
- "What is best for the newborn" is the role whenever you discuss treatment options.
- In case of high risk of mortality or significant morbidity, treatment options including initiation or withholding of resuscitation should be discussed with the parents and consider their wish of either option.
- Informed consent should be taken from the parents in most cases but in life-threatening medical emergencies when there is inadequate time to obtain it proceed with the procedure.
- Discussion with the parents about major decisions regarding their baby should be well planned and started antenatally as soon as the medical team has enough information.
- If possible, enough time should be allowed for parents to take their final decision. more than one interview may be needed to explain fully the condition, answer their questions and to understand what is going with their baby.
- When there is uncertainty about the extent of congenital anomalies, the actual gestational age and the likelihood of survival, initial decision may be taken according to the best knowledge at this time, it is acceptable to reevaluate the baby's condition again after delivery with detailed medical examination and investigation, initial decision might change with this new information and according to the baby's best interest.
- It is ethical not to initiate resuscitation in cases of extreme prematurity less than the point of viability, lethal anomalies, and severe congenital anomalies.
- Humane, compassionate, and culturally sensitive palliative care should be provided for all babies whom resuscitation wasn't successful or wasn't initiated.
- Whenever the medical team is in doubt about the baby's outcome, all resuscitative measures should be done pending further assessment and decision.
- Once you have resuscitated a baby, you are not ethically obligated to continue life-sustaining therapies.
- In a baby who is dying the most important point is to minimize suffering by providing humane and companionate care.
- Family members of babies who are very sick and dying should have support from the medical and religious staff.
- Staff members who participated in the care of the baby who passed away need support.
- Do Not Resuscitate (DNR) and withhold of life support are medical decisions and parents should be informed.

References

https://www.Who.int/news-room/fact-sheets/detail/level-and-trends-in-child-mortality-report-2021

- Al-Hindi M Y, Al Sayari T A, Al Solami R, et al. Association of Antenatal Risk Score with Maternal and Neonatal Mortality and Morbidity. Cureus 2020;12(12): e12230. doi:10.7759/cureus.12230
- Aziz K, Chadwick M, Baker M, Andrews W. Ante- and intra-partum factors that predict increased need for neonatal resuscitation.Resuscitation. 2008; 79:444–452. doi: 10.1016/j.resuscitation.2008.08.004
- Khalid Aziz, Henry C. Lee, Marilyn B. Escobedo, Amber V. Hoover, Beena D. Kamath-Rayne, Vishal S. Kapadia, David J. Magid, Susan Niermeyer, Georg M. Schmölzer, Edgardo Szyld, Gary M. Weiner, Myra H. Wyckoff, Nicole K. Yamada and Jeanette Zaichkin. Originally published21 Oct 2020. https://doi.org/10.1161/CIR.0000000000000902Circulation. 2020;142:S524–S550
- Little MP, Järvelin MR, Neasham DE, Lissauer T, Steer PJ. Factors associated with fall in neonatal intubation rates in the United Kingdom–prospective study. BJOG. 2007; 114:156–164. doi: 10.1111/j.1471-0528.2006.01188.xCrossrefMedlineGoogle Scholar
- Niles DE, Cines C, Insley E, Foglia EE, Elci OU, Skåre C, Olasveengen T, Ades A, Posencheg M, Nadkarni VM, Kramer-Johansen J. Incidence and characteristics of positive pressure ventilation delivered to newborns in a US tertiary academic hospital.Resuscitation. 2017; 115:102–109. doi: 10.1016/j.resuscitation.2017.03.035CrossrefMedlineGoogle Scholar
- Søreide E, Morrison L, Hillman K, Monsieurs K, Sunde K, Zideman D, Eisenberg M, Sterz F, Nadkarni VM, Soar J, Nolan JP; Utstein Formula for Survival Collaborators. The formula for survival in resuscitation. Resuscitation. 2013; 84:1487–1493. doi: 10.1016/j.resuscitation.2013.07.020
- Part 5: Neonatal Resuscitation: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care
- https://www.msdmanuals.com/professional/pediatrics/perinatal-problems/neonatal-resuscitation
- Weiner GM, ed: Textbook of Neonatal Resuscitation, ed. 7. Elk Grove Village, American Academy of Pediatrics and the American Heart Association, 2016
- Australian Resuscitation Council. (2021). ANZCOR Guideline 13.4 –Airway Management and Mask Ventilation of the Newborn. P1-18.
- Wyckoff MH, Wyllie J, Aziz K, de Almeida MF, Fabres JW, Fawke J, et al. Neonatal Life Support 2020 International Consensus on Cardiopulmonary Resuscitation and
- Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation. 156: A156- A87.
-
- Aziz K, Lee HC, Escobedo MB, Hoover AV, Kamath-Rayne BD, Kapadia VS, Magid DJ, Niermeyer S, Schmölzer GM, Szyld E, Weiner GM, Wyckoff MH, Yamada NK, Zaichkin J. Part 5: Neonatal Resuscitation: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020 Oct

20;142(16_suppl_2):S524-S550. doi: 10.1161/CIR.0000000000000902. Epub 2020 Oct 21. PMID: 33081528.

- Berg RA, Kern KB, Hilwig RW, et al. Assisted ventilation does not improve outcome in a porcine model of single-rescuer bystander cardiopulmonary resuscitation. Circulation 1997;95:1635–41.
- Berkowitz ID, Gervais H, Schleien CL, et al. Epinephrine dosage effects on cerebral and myocardial blood flow in an infant swine model of cardiopulmonary resuscitation. Anesthesiology 1991;75:1041–50.
- Berg RA, Sanders AB, Kern KB, et al. Adverse hemodynamic effects of interrupting chest compressions for rescue breathing during cardiopulmonary resuscitation for ventricular fibrillation cardiac arrest. Circulation 2001;104:2465–70.
- Kern KB, Hilwig R, Ewy GA. Retrograde coronary blood flow during cardiopulmonary resuscitation in swine: intracoronary Doppler evaluation. Am Heart J 1994; 128:490–9. 9. Wyckoff MH, Berg RA. Optimizing chest compressions during delivery-room resuscitation. Semin Fetal Neonatal Med 2008;13:410–5.

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Saudi Heart Association

National Life Support Committee