सत्यमेव जयते

NATIONAL HEALTH MISSION
राष्ट्रीय स्वास्थ्य मिशन

Ministry of Health & Family Welfare
Government of India

2023

Neonatal Resuscitation

सुधांश पंत
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Secretary

सत्यमेव जयते

आज़ादी का अमृत महोत्सव

भारत सरकार
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Government of India
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MESSAGE

Today, the Indian healthcare network is among the largest in the world as it reaches out to every mother and child in the country through a continuum of care approach. India has made significant reductions in maternal, neonatal and child mortality rate in last decade and is committed to achieve Sustainable Development Goals (SDGs) by 2030.

The Government has put in various policies and programmes to ensure universal access to health and special attention is being given to those living in hard to reach and remote areas in the country. Improving the quality of newborn and child care is a critical challenge faced by every healthcare setting dealing in maternal and child health. This may be overcome by equipping the Doctors, Nurses and ANMs with appropriate knowledge and skills to improve the quality of service delivery. With the aim of delivering quality healthcare services for newborns, training package for Facility Based Newborn Care (FBNC) was developed which targets the capacity building needs of pediatricians, medical officers and nurses posted at SNCUs at District and Sub-district level and provide knowledge and skills of high order required for management of common conditions. With advances in healthcare and based on evidence, training package for FBNC has been revised with the latest guidelines so as to provide the updated knowledge and skills.

I wish that this will be instrumental in achieving desired outcome and improve overall health status of the children in our country.

Sudhansh Pant

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FOREWORD

Health system strengthening over the last decade has brought about a considerable improvement in the infrastructure, availability of human resources, drugs and equipment along with supportive services all across India. Efforts are also being made to improve the availability of specialists and trained medical officers dealing with sick newborns admitted in Neonatal Intensive Care Units (NICUs), Special Newborn Care Units (SNCU) and Newborn Stabilization Units (NBSUs).

The Ministry of Health and Family Welfare (MoHFW) has developed Facility Based Newborn Care (FBNC) training package in 2014 to strengthen clinical services in these units. Recently, the training package has been revised based on latest evidences and strengthening of public health system. These will be helpful in setting up better standards of care for our newborns and ensure that each newborn gets a better start of life with an equal opportunity to survive and thrive.

I hope that this revised training module for FBNC will be rolled out expeditiously all across the States and UTs, to ensure essential and emergency care to the children as a first step towards healthy childhood and adult life.

With best wishes!

(Ms. L S Changsan)

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PREFACE

Maternal and Newborn survival is one of the important agenda under National Health Mission (NHM) of Ministry of Health and Family Welfare (MoHFW) and this Ministry is committed to achieve targets of newborn mortality goals under National Health Policy (2017). Newborn and Child health is the central pillar in the Reproductive, Maternal, Newborn, Child, Adolescent Health and Nutrition (RMNCAH+N) strategy and inter-linkages of various RMNCAH+N life cycle stages have a significant impact on the further reduction of mortality and morbidity of children.

Under the NHM, many new interventions and service delivery platforms have been implemented in the child health programme over the last decade. In order to incorporate these new topics and skill sets based on the new evidences and practices that have emerged over the years and a review of existing training packages has been undertaken. Based on this revised Facility Based Newborn Care training package has been developed. The training package consists of three modules, Facility Based Newborn Care (FBNC) Training Module, Neonatal Resuscitation Module and a Facilitator Guide. The package emphasizes on the skill imparting techniques by the facilitators and ensures uniform messaging.

I am hopeful that by adopting this revised training package, the trainers along with service providers will feel more confident in carrying on their roles and responsibilities. I would also like to place on record my appreciation for the hard work and untiring efforts put in by the Child Health Division in revising and developing the training package.

I assure the States and UTs of full support by my team in taking this important initiative forward.

(Dr. P. Ashok Babu)

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ACKNOWLEDGEMENT

India has witnessed a huge transformation in the scenario of newborn's health evident by faster reduction in newborn mortality over the last decade as compared to global rates. This has been made possible by India's continued investments in the healthcare system including capacity building of healthcare providers with required skills at different levels to deliver quality newborn and child health services.

The Facility Based Newborn Care (FBNC) training package was first released in India in the year 2014 guiding appropriate management of newborn care in SNCUs, which has now been revised in the year 2023 in collaboration with National Collaborative Center, Kalawati Saran Children's Hospital (KSCH), New Delhi and other technical experts. The training package consists of three modules namely FBNC Training Module, Neonatal Resuscitation Module and a Facilitator Guide. Training package has been updated based on latest global practices and evidences to improve newborn survival with special focus on importance of Mother- Newborn Care Units (MNCUs) for Zero separation of mother-newborn; provisioning of respiratory support to neonates (CPAP); focus on newborn screening at delivery points and at newborn units; and evidence-based developmental supportive care for clinical and psycho-emotional support to vulnerable newborns, their families and health system.

Cont'd on next page

These training packages are a culmination of the work initiated by Ms. Vandana Gurnani as Ex Additional Secretary & Mission Director (NHM) and led by my previous colleague Dr. Sumita Ghosh, Ex Additional Commissioner & In-charge (C&AH) and technical consultants of the Child Health Division. I convey my sincere appreciation to Dr. Sushma Nangia (NCC, KSCH, New Delhi) and her team, Dr. S. Ramji (Ex Dean, MAMC) and support from academicians, Experts from NIPI, UNICEF, WHO and other Development Partners.

I am sure that this revised FBNC training package will help in equipping our healthcare providers with knowledge and skill to deliver essential and emergency newborn care services in NICUs/ SNCUs across the country.

Child Health Division will provide all the necessary support to the States/ UTs to roll out this training package at the earliest and contribute towards further improving neonatal health and survival.

I wish you the very best for your efforts and look forward to your continued support, as we move together on the mission to improve the quality of life of children and to attain the National Health Policy goals.

(Dr. Shobhna Gupta)

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Lesson 1

RESUSCITATION: OVERVIEW

About 10% of neonates require some assistance at birth to breathe and about 20% of all neonatal deaths are due to birth asphyxia. This neonatal resuscitation training will help you learn how to resuscitate newborns. Reading this book and practicing the skills during the training course will help you acquire the skills needed.

Learning Objectives

After reading this chapter you will learn

- The physiological changes that occur at birth
- The sequence of steps to be followed during resuscitation
- Risk factors that could predict which babies may need resuscitation
- Equipment and personnel needed for neonatal resuscitation

Table 1.1: Transitional changes at birth

	Intra uterine	Extra uterine
Temperature regulation	Maternal	Self
Oxygen status	Low oxygen	High oxygen
Gas Exchange	Placenta	Lung alveoli
Lungs	Fluid filled	Air filled
Pulmonary vessels	Constricted	Dilated
Pulmonary vascular resistance	High	Low
Pulmonary blood flow	Low	Increased
Alveolar type ll cells	Chloride secretion and lung liquid formation, synthesize surfactant	Sodium reabsorption and lung liquid clearance, increased surfactant release
Foramen ovale	Open, right to left shunt from right atrium to left atrium	Closed due to increased left atrial pressure
Ductus arteriosus	Patent, right to left shunt from pulmonary artery to aorta to bypass the lungs and reach placenta	Closed due to increase in oxygen and decrease in prostaglandins
Ductus venosus	Carries oxygenated blood from the placenta to the right atrium	Constricted due to reduction in umbilical venous flow

What are the transitional changes at birth which help the lungs to supply oxygen to the baby?

Oxygen is needed for survival both, during fetal life and after birth. Before birth the oxygen to the fetus is supplied by diffusion of oxygen across the placental membranes from the mother's blood supply. Most of the oxygenated blood from the placenta which enters the right side of the fetal heart flows through the low resistance ductus arteriosus into the aorta (Fig 1.1). This is because the constricted blood vessels in the fetal lungs offer increased resistance to blood flow. The fetal lungs are expanded and filled with fluid, not air, and do not play a major role in fetal oxygenation.

After birth, the placenta can no longer be a source of oxygen supply and the baby will have to depend on its lungs for oxygen supply. This transition has to happen within seconds. The major changes during this transition are:

1. **Absorption of fetal alveolar fluid** into pulmonary venous and lymphatic system and its replacement with air by the baby's initial breaths. Since air contains 21% oxygen, filling the alveoli with air provides oxygen that can diffuse into the blood vessels surrounding the alveoli.
2. **Closure of the umbilical vessels** by clamping the cord, removes the low resistance placental circuit and increases baby's systemic blood pressure.
3. As air fills the alveoli, the increased oxygen levels in alveoli **decreases the resistance in the blood vessels of the lungs**. This increases the blood flow into the lungs. The increase in systemic blood pressure results in decrease blood flow through the ductus arteriosus which also increases the blood flow into the lungs. The increase in oxygen levels also results in constriction of ductus arteriosus (Fig.1.2).

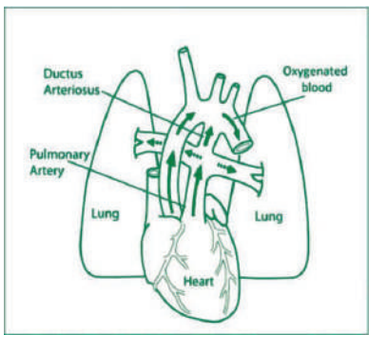


Fig. 1.1: Normal Fetal Circulation

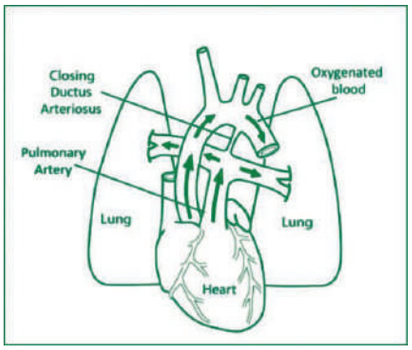


Fig. 1.2: Change in ductus arteriosus

Baby's initial breaths help to fill the lungs with air and allow the process of gas exchange to begin which is needed for survival. Although most of the transition takes place within a few minutes after birth, the process may take several hours for its completion. Studies have shown that it may take up to 10 minutes for babies to achieve oxygen saturation of 90% or more; functional closure of the ductus arteriosus may not occur up to 24 hours and complete relaxation of the lung blood vessels may take up to several months.

What can go wrong during transition at birth?

The baby may encounter difficulties either before labor, during labor or after birth. Problems before and during labor reflect compromised placental blood flow. Difficulties after birth usually reflect problems with baby's airway and/or lungs. Normal transition may be disrupted by the following problems:

- **Lungs do not fill with air** because either the baby does not initiate breathing or has inadequate spontaneous breaths, hence oxygen may not reach the baby's blood.
- **The expected increase in systemic blood pressure may fail to occur** either because of excessive blood loss or neonatal hypoxia; this may cause poor cardiac contractibility or bradycardia and result in hypotension.
- **Pulmonary arterioles may remain constricted** because of inadequate gaseous distention of the lungs or lack of oxygen. This results in decreased blood flow into the lungs and thus reduced oxygen supply to the tissues.

How does the fetus/newborn respond to interruption in transition?

When the normal transition is interrupted, the oxygen supply to tissues is decreased, and the baby may exhibit one or more of the following clinical signs:

- Poor muscle tone due to insufficient oxygen delivery to the brain, muscles and other organs
- Poor respiratory drive due to insufficient oxygen supply to the brain
- Bradycardia due to insufficient oxygen supply to the heart muscle or brainstem
- Low blood pressure from insufficient oxygen to the heart muscle or blood loss
- Tachypnea (fast breathing) due to failure to absorb fetal lung fluid
- Persistent cyanosis or low oxygen saturation on pulse oximeter, due to insufficient oxygen in blood

Which babies require resuscitation?

Approximately 10% of newborns need some assistance at birth to begin breathing and about 1% need intensive resuscitative measures (intubation, chest compressions and/or medications). The presence of risk factors can help identify those who may need resuscitation, but you must always be prepared to resuscitate, as even with no risk factors, some babies will require resuscitation. Every birth should be attended by someone who is trained in initiating neonatal resuscitation. Additional personnel should be available when intensive resuscitation is required. The diagram below (Fig.1.3.) illustrates the relationship between resuscitation steps and the proportion of newborns that need them. At the top are the resuscitative steps needed by majority of neonates who do not cry soon after birth while the steps at the bottom are needed by very few neonates.

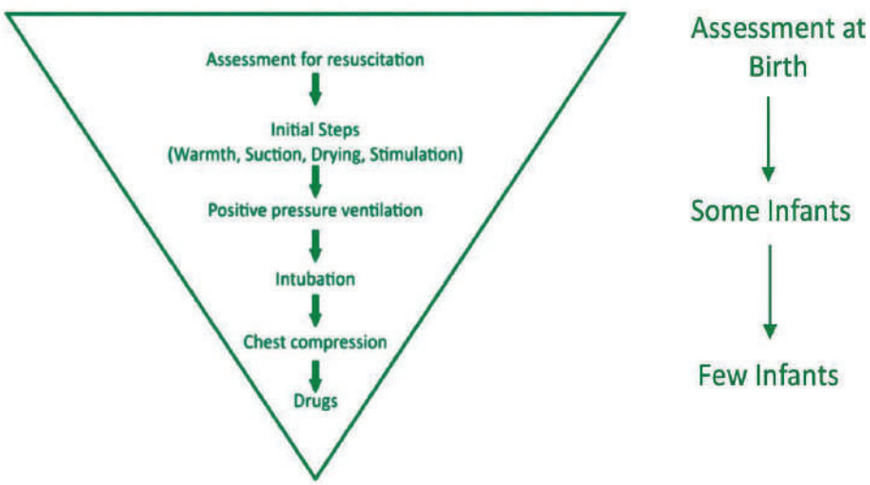


Fig. 1.3: Resuscitation steps and proportion of neonates needing them

The resuscitation flow diagram (Fig.1.4.)

The flow diagram describes the Neonatal Resuscitation Program-India (NRP-India). The diamonds indicate assessment and the rectangles show the actions that may be required based on the assessment. The flow diagram begins with the birth of the baby. As you read the description of each step, study the flow diagram too. You can use the flow diagram to help you remember the steps involved in resuscitation.

Initial assessment. At the time of birth, asses if the baby is breathing/crying? If "Yes", then the baby should stay with the mother. If the answer is "No", you should proceed to initial steps immediately after clamping and cutting the cord.

Section A (Airway) These are the initial steps that you should take to establish an **A**irway and begin resuscitating a newborn.
Provide warmth by placing the baby under a radiant warmer
Position the head to open the airway; clear airway as necessary
Dry the baby: remove wet linen
Stimulate the baby to breathe (if required)
Reposition the head to maintain an open airway

Evaluation of the effect of Section A. You should evaluate the newborn's respiration and heart rate simultaneously after these first interventions. If the baby is not breathing (is gasping or has apnea) or has a heart rate below 100 beats per minute (bpm), you should immediately proceed to Section B (left side). If the baby's respiration appears labored or is persistently cyanotic proceed to Section B (right side).

Section B (Breathing) If the baby has apnea or is gasping or has a heart rate below 100 bpm, you should assist the baby's breathing by providing positive pressure ventilation (PPV) with room air for babies who are ≥ 32 weeks and with 21-30% for babies who are < 32weeks.

If the baby is breathing, but has persistent respiratory distress (labored breathing), attach a pulse oximeter (if available) to consider need for supplemental oxygen. If the baby is preterm with labored respiration, consider administering continuous positive airway pressure (CPAP) by face mask (if facilities available). If pulse oximeter and/or CPAP are not available, initiate supplemental oxygen and shift baby to SNCU/NICU.

Evaluation of the effect of Section B. After 30 seconds of effective PPV, CPAP and/or supplemental oxygen, evaluate the newborn again to ensure that ventilation is adequate before moving to the next step. With appropriate ventilation, in almost all cases, the heart rate would rise to above 100 bpm. If the heart rate is below 60 bpm, you should proceed to Section C.

Section C (Circulation). You support **C**irculation by starting chest compressions while continuing PPV. At this stage, it is strongly recommended to perform endotracheal intubation (if skilled), if not done earlier. This is for more effective coordination of chest compressions and PPV.

Evaluation of the effect of Section C. After 60 seconds of coordinated chest compressions and PPV, evaluate the newborn again. If the heart rate is still below 60 bpm, proceed to Section D.

Section D (Drug). You administer epinephrine as you continue PPV and chest compressions.

Evaluation of the effect of Section D. If the heart rate remains below 60 bpm, the actions of Section C (circulation) are continued and D repeated every 3-5 minutes (lower curved arrow).

When the heart rate rises above 60 bpm, chest compressions are stopped. PPV is continued until the heart rate is above 100 bpm and the baby is breathing well.

Evaluation occurs after initiation of each action and is based on the following 2 signs:
Respiration
Heart rate

Oxygen saturation can be assessed with a pulse oximeter.
This process of evaluation, decision and action is repeated frequently throughout resuscitation.

Note the following important points about the flow diagram:

- There are 2 heart rates to remember: 60 bpm and 100 bpm. A heart rate below 60 bpm indicates that additional resuscitation steps are needed. A heart rate above 100 bpm usually indicates that resuscitation procedures beyond those in Section A can be stopped, unless the patient is apneic or has persistently low oxygen saturation levels.
- The primary actions in neonatal resuscitation are aimed at ventilating the baby's lungs (Sections A and B). Once this has been accomplished, heart rate, blood pressure and pulmonary blood flow will improve spontaneously. But, if blood and tissue oxygen levels are low, cardiac output may have to be assisted by chest compressions and epinephrine (Sections C and D) for blood to reach the lungs and to provide oxygenation.
- As soon as the baby is handed over to you, ask the initial questions, (baby breathing or crying). In case the baby is not breathing at birth perform initial steps. The first one minute is called the **"Golden Minute",** therefore it must be ensured that the baby is either breathing spontaneously or is being assisted to breathe by 60 seconds of birth. First golden minute includes assessment at birth, initial steps, reassessment and initiation of PPV.

What Risk factors may be associated with the need for resuscitation at birth?

Table 1.2 below lists some of the risk factors that may be associated with the need for neonatal resuscitation in the delivery room.

Table 1.2: Resuscitation at birth: Risk factors

Risk Factors	
Maternal Risk Factors • Mother's age < 18/ >35 years • Inadequate Antenatal care • Significant intra-partum hemorrhage (Abruptio placentae, placenta previa) • Preeclampsia or eclampsia Maternal Hypertension • Maternal medical problems (cardiac, pulmonary, renal, thyroid, anemia, etc.) • Maternal pyrexia, Infection, Chorioamnionitis • Polyhydramnios, Oligo-hydramnios	**Fetal Risk Factors** • Preterm/Post-term • Previous fetal or neonatal deaths Fetal anemia • Fetal hydrops • Intrauterine growth restriction • Significant malformations or anomalies in fetus Fetal macrosomia • Intrauterine infection • Reduced fetal movements before onset of labor
Intrapartum Risk Factors	
• Abnormal fetal heart rate patterns (late and variable decelerations; Category II and III Fetal heart rate) • Meconium stained amniotic fluid Reduced fetal movements Precipitate labor • Prolonged labor • Breech or other non-vertex presentation Forceps/ vacuum deliveries	• Emergency cesarean section Maternal magnesium therapy Chorioamnionitis • Shoulder dystocia Cord prolapse • Narcotics administered to mother within 4 hours of delivery • Maternal general anesthesia/sedation

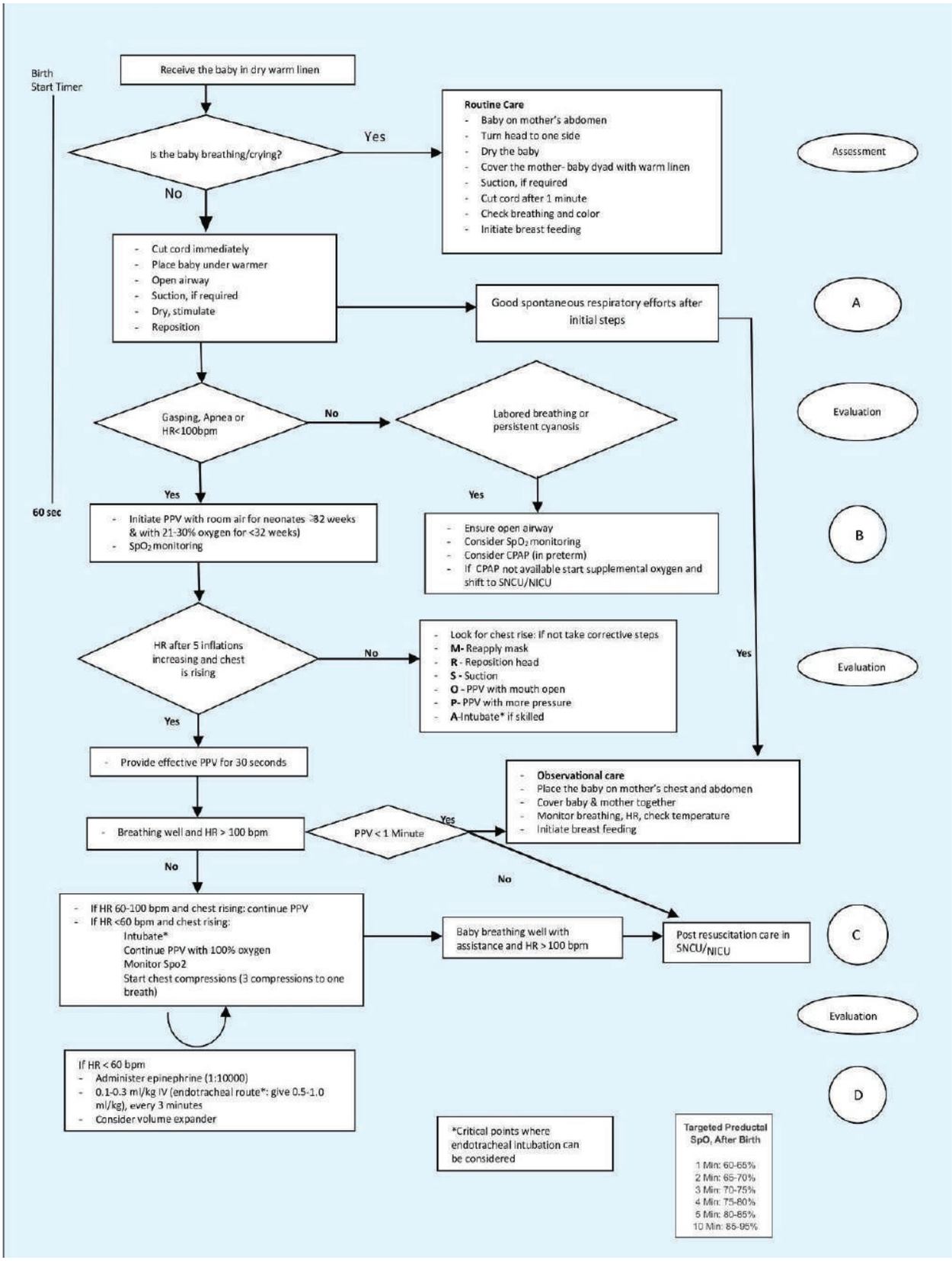


Fig. 1.4: Resuscitation Flow Diagram (NRP-India)

Equipment Checklist for resuscitation

All equipment necessary for complete neonatal resuscitation should be available in the delivery room and should be fully functional. A complete list of neonatal resuscitation equipment is given in Table 1.3

What equipment should be available?

Table 1.3: Equipment needed for neonatal resuscitation in delivery room

Temperature	• Radiant warmer • Clean prewarmed sheets - 2/3 • Room thermometer • Digital thermometer • Plastic wrap (For <32 weeks gestation) • Cap
Airway	• Suction device • Suction catheters (Size F 5, 6, 8, 10, 12, 14) • Oxygen source • Oxygen tubing • Minute specific oxygen saturation chart • Compressed air source* • Air-oxygen blender*
Breathing	• Self-inflating bag (240/450 ml) • Face mask (size 0, 1) • Feeding tube (size 6, 7, 8) • Pulse oximeter • Neonatal pulse oximeter probe • Laryngoscope with batteries and straight blade (size 0,1) • ET tubes (size 2.5, 3, 3.5mm) • Scissors • Oxygen Reservoir • T-piece resuscitator*
Circulation	• Syringes (1 cc, 2 cc, 5 cc, 10 cc, 20 cc) • Umbilical catheterization set (umbilical catheters 3.5, 4.0 and 5.0, sterile blade, gloves, alcohol swabs, cord ties, mosquito forceps, povidone iodine swabs) • 3 way stopcock • Adhesive tape • Sterile gauze • Needles 25, 21, and 18-gauge
Drugs	• Epinephrine (1: 10,000) • Normal saline (0.9%)
Miscellaneous	• Gloves • Timer • Extra laryngoscope bulb • Extra laryngoscope batteries • Scissors • Stethoscope • Cord clamp, Cord tie • Measuring tape • Transport incubator*

**Desirable*

Response to resuscitation:

The APGAR score (Table 1.4) is widely used to assess the cardio-respiratory status of the newborn in the delivery room. The 5 components of the APGAR score are- (1) color (2) heart rate (3) irritability (4) muscle tone; and (5) breathing. These are indicators of different physiologic responses. Of these, heart rate and breathing are the most important components. The score is reported at 1 minute and 5 minutes after birth for all infants and at 5-minute intervals thereafter until 20 minutes for infants with a score less than 7.

The APGAR score alone is not to be used to diagnose asphyxia. APGAR scores do not predict individual mortality or adverse neurologic outcome.

Table 1.4: APGAR score

Sign	Score			Minutes				
	0	**1**	**2**	**1**	**5**	**10**	**15**	**20**
Color	Blue, pale	Pink body, Blue extremities	All pink					
Heart Rate	Absent	< 100 bpm	>100 bpm					
Breathing	Absent	Slow, Irregular	Good Crying					
Irritability	No response	Grimace	Cough, Sneeze					
Muscle tone	Limp	Some flexion of extremities	Active motion					

What do you do after resuscitation?

Routine care: Almost 90% of newborns are vigorous at birth with no risk factors. They do not need to be separated from their mothers at birth and should be provided Routine Care. All newborns who cry immediately at birth should be placed prone on mother's abdomen with the head turned to one side. The skin to skin contact with the mother provides warmth to the baby. Clear the upper airway as necessary by wiping the baby's mouth and nose. Dry the baby with prewarmed linen & discard the wet linen. Cover the mother & baby dyad with clean, dry linen while continuing skin to skin contact. Cord should be clamped after at least 60 seconds. Assess breathing, color and activity periodically. (Fig 1.5).

Fig. 1.5: Baby on mother's abdomen for routine care

Delayed cord clamping

Clamping of the cord should be delayed as much as possible, preferably not earlier than 60 seconds after birth and the newborn should be continued to be nursed in prone position over mother's abdomen. Delayed cord clamping should be routinely done for all newborns – term and preterm- who breathe spontaneously at birth.

Delayed cord clamping is not recommended for babies who are depressed at birth and need resuscitation.

Table 1.5: Delayed Cord Clamping

DCC (Delayed Cord Clamping)	
Benefits	Decreased PVH/IVH, improved cardiovascular stability (higher blood pressure and blood volume, less need for transfusion) and less NEC
Risk	Higher chance of hyperbilirubinemia but not requiring phototherapy
Contraindication	Newborn requiring resuscitation, placenta previa, vasa previa, Cord avulsion

Observational care: Babies who have received initial steps and PPV for < 1 minute to help them initiate breathing can also be cared with their mothers. Monitor breathing, activity and color of these babies at least once every 30 minutes during the first 2 hours after birth, along with temperature and initiate breast feeding.

Post Resuscitation Care: Babies who have received PPV for more than 1 minute or more intensive resuscitation are at high risk of further deterioration. These babies should be managed in a Special Newborn Care Unit (SNCU) or Neonatal Intensive Care Unit (NICU) for post resuscitation care. Neonates with respiratory distress after birth or preterms in whom CPAP has been initiated in the delivery room also need to be shifted to SNCU/NICU.

Key to Successful Resuscitation

- Anticipation
- Preparation
- Call for help
- Able to work in coordination
- Communicate effectively
- Be gentle but quick
- Provide warmth, maintain hygiene, documentation/record keeping

Summary: Lesson 1

1. Most newborn babies are vigorous at birth. Only about 10% require some resuscitative assistance and about 1% need advanced resuscitative measures (intubation, chest compressions and/or medications) at birth.
2. The most important and effective action in neonatal resuscitation is to ventilate the baby's lungs.
3. Lack of ventilation of newborn lungs results in sustained constriction of pulmonary arterioles preventing oxygenation. Lack of perfusion and oxygenation to the baby's organs can lead to damage to the brain, other organs or death.
4. All delivery points should have a checklist of equipment. All equipment should be functional.
5. Many, but not all babies, who will need resuscitation at birth, can be identified by the presence of antepartum or intrapartum risk factors.
6. All newborns at birth need to be initially assessed to determine if they need resuscitation.
7. Every birth should be attended by at least 1 person who is capable of initiating resuscitation. When resuscitation is anticipated, additional personnel should be present in the delivery room to assist the resuscitation procedures.
8. Resuscitation should proceed rapidly as it is time bound and requires coordinated teamwork with a great degree of adaptability and good communication.
9. Evaluation and decision making are based primarily on respiration, heart rate and oxygen saturation.
10. The steps of neonatal resuscitation are as follows:
    A. Receive baby in prewarmed linen, cut the cord immediately and start with initial steps
        - Provide warmth by placing under the radiant warmer
        - Position head and clear airway as necessary
        - Dry baby and discard wet linen
        - Stimulate to breathe and reposition
        - Evaluate respirations, heart rate and oxygenation
    B. Provide positive pressure ventilation
    C. Provide chest compression and continue ventilation
    D. Administer epinephrine as you continue chest compression and assisted ventilation.

Lesson 2

INITIAL STEPS IN RESUSCITATION

Learning Objectives

In this lesson you will learn how to:

- Determine if a newborn needs resuscitation
- Perform initial steps
- Provide free flow oxygen

The following scenarios will help you understand the initial steps of evaluation and resuscitation. You are requested to imagine yourself as a part of the resuscitation team as you read through the scenarios.

Case Scenario 1:

A 28-year-old primigravida is admitted to the labor room in active labor. Her membranes ruptured on the way to the hospital, 2 hours back. The female attendant with the woman says that the amniotic fluid was clear. In the labor room the obstetrician notices that the cervix is dilating progressively and after 4 hours a baby girl is born vaginally by vertex presentation.

As soon as the baby is delivered, the "time of birth" is noted and she is received in a warm towel. On assessing, the baby is active and crying. The baby is immediately put on the mother's abdomen for skin- to- skin care. The face is turned to one side and no secretions are noted. The baby is dried, wet linen is discarded and the mother and baby are covered with prewarmed linen. The cord is cut after 1 minute of birth. The baby is allowed to continue transition as the color becomes increasingly pink. (Fig 2.1).

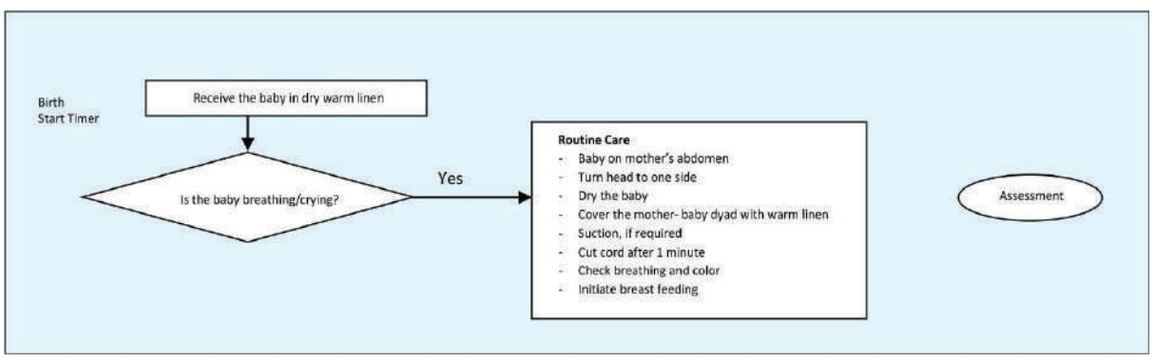


Fig. 2.1: Routine care

Case Scenario 2:

A 34 year old multi-parous woman is admitted to the labor room in early labor. After some time, the membranes rupture to reveal meconium stained amniotic fluid. The obstetrician looks at the fetal heart rate. She decides to allow a vaginal delivery.

Immediately after birth, the baby is observed to have minimal breathing efforts and poor tone. The cord of the baby is cut and the baby is taken under a preheated warmer. His oropharynx is cleared with a large bore suction catheter of size 14F. The baby is still having very poor respiratory efforts.

The baby is dried with a warm towel and stimulated to breathe by rubbing the back twice and the baby is repositioned to open his airway. He immediately begins to breathe more effectively. The heart rate is evaluated to be more than 120 beats per minute. The baby is placed on the mother's abdomen and covered with linen and monitored for breathing, heart rate and color. (Fig 2.2).

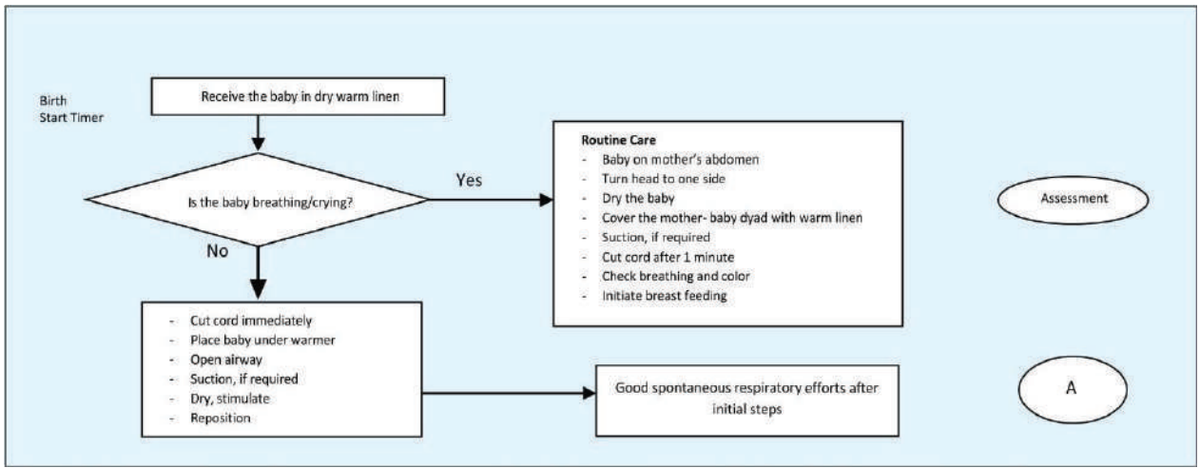


Fig. 2.2: Initial Steps

Determining if a baby needs resuscitation

The need for resuscitation in a baby is determined by looking at the breathing efforts of the baby. Breathing is evident by watching the baby's chest. Breathing is indicated if a baby is vigorously crying or has good rhythmic chest movements. One should not be misled by a baby who is gasping. Gasping baby takes a series of deep, irregular inspirations. Such breathing occurs when the baby is hypoxic and is indicative of severe neurologic and respiratory depression.

What are the initial steps and how are they administered?

Once it is decided that a baby needs resuscitation, the Initial steps should be initiated immediately. These are performed in a particular order. These steps should be applied throughout the resuscitation process wherever required.

Provision of warmth

The cord of the baby needing the initial steps should be cut (without delay) and the baby should be placed under the radiant warmer (Fig. 2.3). In all deliveries the warmer should be pre warmed prior to the delivery for at least 20 minutes in the manual mode. In this way the resuscitation team will have access to the baby and the heat loss is prevented by the radiant warmer. At this stage full visualization of the baby is needed and the baby should not be covered. In case of suspicion of severe birth asphyxia, due care should be taken not to overheat the baby. The resuscitator should stand at the head end of the baby.

Fig. 2.3: A baby placed in the radiant warmer for providion of warmth during Initial Steps

For Preterm babies less than 32 weeks gestation

Wrap the baby in a polythene plastic bag or wrap (Fig 2.4). Instead of drying the baby with towels, very premature newborns should be covered or wrapped up to their neck in polythene plastic bag or wrap immediately after birth. Drying the body is not necessary. You may use a food grade plastic bag, wrap or sheets of commercially available polythene plastic. If using a plastic sheet or food wrap, you may either wrap the baby in a single sheet or use 2 sheets and place the baby between the sheets.

Position

Fig. 2.4: Wrapping the baby in polythene plastic bag

The baby should be positioned on the back with the neck slightly extended in the "sniffing" position. Care should be taken to prevent hyper extension or flexion of the neck, since either may restrict air entry. To attain a correct posture, a rolled piece of cloth/gauze piece (shoulder

roll) may be placed under the shoulder of the baby (Fig. 2.5). This is particularly useful when there is a large occiput (back of head) resulting from molding or edema.

An appropriate position as described facilitates an unrestricted air entry by bringing the posterior pharynx, larynx and trachea in line. This alignment in the supine position is also the best position for assisted ventilation with mask or for the placement of an endotracheal tube.

Fig. 2.5: Positioning of the baby with shoulder roll in place

Clearing the Airway

After the baby is positioned well, the presence of secretions may prevent entry of air into the lungs. Hence, clearing of the airway, if required, should immediately follow once the newborn has been positioned. However, suction should not be done as a 'routine ritual' in all cases. Secretions may be removed from the airway with an oral mucous extractor or a suction catheter attached to a mechanical suction device. Before suctioning, set the suction pressure to 80-100 mm of Hg and turn the head of the baby to one side. Mouth should be suctioned before nose (Figure 2.6).

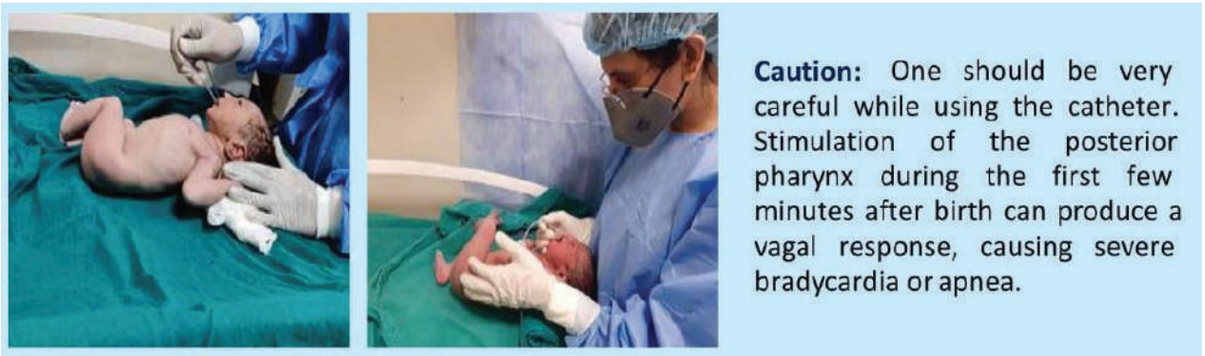


Fig. 2.6: Sequence of suction; mouth 'M' followed by nose 'N'

Table 2.1: Indications and procedure of suctioning

Indication	Visible secretions Need for PPV and secretions are blocking the airway No chest rise during ventilation To visualize vocal cords
Device	Mucous extractor, Suction catheter attached to machine or wall mounted suction
Size	10, 12(14G- for meconium or thick secretions)
Technique	Suction should be gentle and brief Turn head to one side Suction mouth before nose Apply suction while withdrawing catheter
Maximum suction pressure	80-100 mm of Hg
Risk	Hypoxia, apnea, mucosal injury, cyanosis

Drying: Drying is essential to prevent heat loss. It should be performed quickly starting from the head, upper extremity, torso, back and the lower extremity. The wet cloth should then be discarded.

Stimulation: Drying and suctioning stimulate a baby to breathe. For many newborns, these are sufficient to initiate respiration. If a baby does not have vigorous breathing, additional tactile stimulation may be required.

Stimulation may be useful not only to induce and begin breathing during the initial steps of resuscitation but also may be used to stimulate continued breathing after positive pressure ventilation (PPV).

The only safe and appropriate method of providing tactile stimulation is gently rubbing the back of the baby twice.

If a baby is in primary apnea, any form of stimulation will initiate breathing. Therefore, gently rubbing the back twice is sufficient.

Vigorous and prolonged stimulation is not helpful and can cause serious injury. Shaking the baby and holding the baby upside down should be strictly avoided.

If a baby remains apneic despite tactile stimulation, positive pressure ventilation should be immediately initiated (discussed in Lesson 3).

Fig. 2.7: Appropriate method of tactile stimulation

After initial steps, what do you do next?

Evaluate the baby (Table 2.2)

The next step is to evaluate the baby and assess if further resuscitation is required. The vital signs to be evaluated are 'Respiration' and 'Heart rate'. If the baby is apneic or has gasping respiration or the heart rate is less than 100 bpm, initiate positive pressure ventilation within 60 sec of birth.

Respiration

The baby is assessed for chest movements. Baby is said to have good respiration if, normal chest movement is present. The rate and depth of respiration should increase after few seconds of tactile stimulation.

In some babies especially preterm neonates, respiration may be labored. Such breathing should also be noted. These babies may require additional respiratory support and monitoring.

Heart Rate

The best way to rapidly determine the heart rate is by using a stethoscope. Tapping the table with each beat of the heart rate will assist other members of the team to know the heart rate. Count the heart rate for 6 seconds (multiply the number of beats in 6 seconds by 10 to provide a quick estimate of the beats per minute). The heart rate should be more than 100 bpm.

What do you do if the Heart Rate or Respiration are abnormal?

On evaluation of the breathing and the heart rate after initial steps, if the baby is apneic or has gasping respirations, or the heart rate is less than 100, one should proceed immediately to provide positive pressure ventilation (PPV).

Continuing to provide tactile stimulation or administering free flow oxygen to a non-breathing baby or a baby with a heart rate below 100 bpm, is harmful and delays appropriate management. The appropriate management is described in detail in Lesson 3.

Table 2.2: Evaluation and Action

Breathing	Heart rate	Action
Regular	>100 bpm	Routine Care
Labored breathing	>100 bpm	Open airway, Suction if required, Place pulse oximeter Consider CPAP in preterm
Dusky or Cyanotic	>100 bpm	Assess SpO_2, Provide oxygen if required
Apnea, Gasping	<100 bpm	Initiate positive pressure ventilation

If a baby is breathing well and heart rate is above 100 bpm BUT breathing is labored OR you think that the baby is persistently cyanotic:

On evaluation after initial steps, if the baby is breathing spontaneously and has a heart rate of more than 100 bpm, but has labored breathing or central cyanosis, additional respiratory support needs to be considered (especially if preterm) and tailored optimal oxygen delivery may be required. CPAP machine for respiratory support and

a blender with pulse oximeter for optimization of the oxygen delivery will be needed, but may not be available in the delivery room. In such circumstances these babies are started on supplemental oxygen and immediately shifted to the SNCU/NICU.

SPO_2 monitoring and Optimal Oxygen Delivery

The state of oxygenation of the baby can be suggested by the baby's skin color. Cyanosis, caused by low oxygen in blood, will appear as blue color over lips, tongue and trunk. Acrocyanosis (blue hue of the hands and feet) is often due to the decreased circulation of the extremities and is not, by itself, an indication of decreased blood oxygen levels.

- Studies have now shown that clinical assessment of skin color is not reliable, and may vary with the skin pigmentation.
- A baby who is undergoing a normal transition to extra uterine life, may take several minutes after birth to increase blood oxygen saturation from approximately 60% (normal in intrauterine state) to more than 90%, which is the normal for a healthy newborn.

Hence, if central cyanosis persists, it would be ideal to attach a pulse oximeter probe to determine if the baby's oxygenation is in the abnormal range. If the levels are below the saturation targets established for a normal baby during transition (Table 2.3) and are not increasing, one may need to provide supplemental oxygen.

Table 2.3 provides an easy to remember, accepted range of the pre-ductal (right hand or wrist) pulse oximetry oxygen saturation values, during the first 10 minutes, following birth of uncomplicated babies born at term.

Table 2.3: Targeted saturation after birth

Targeted Preductal SpO_2 After Birth
1 Min: 60-55%
2 Min: 65-70%
3 Min: 70-75%
4 Min: 75-80%
5 Min: 80-85%
10 Min: 85-90%

Administration of supplemental oxygen:

How?

Free flow oxygen can be given to a spontaneously breathing baby by using one of the following methods (Fig. 2.8):

- Oxygen tubing held close to the baby's nose and mouth
- Oxygen Mask
- T piece Resuscitator

Free flow oxygen cannot be given reliably by a mask attached to the self–inflating bag. However, free flow oxygen may be administered through the open reservoir ('tail') attached to some self-inflating bags.

When unregulated oxygen is administered to a baby who is cyanosed or when the oximeter readings are lower than the expected range, the oxygen levels may increase very quickly to levels that may be toxic to the baby at that time. The likelihood of this situation increases when the baby is preterm.

Thus, it is best to use an oxygen concentration ranging from 21% to 100% depending on the desired saturation. This will be possible only with the availability of a compressed air source and an oxygen blender.

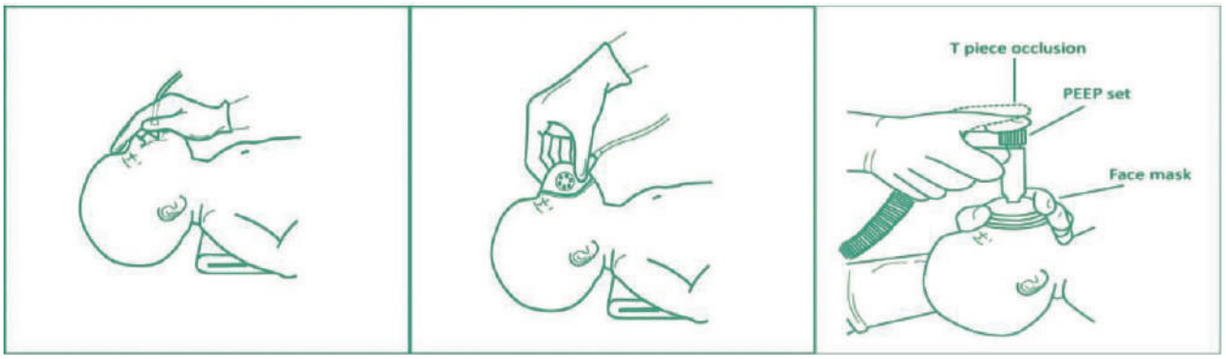


Fig. 2.8: Methods by which free flow oxygen can be administered to a baby – oxygen tubing, face mask and T piece resuscitator

How Much?

The normal intra-uterine saturation is 60%, which increases gradually to 90% only by about 10 minutes of birth. Because of this normal transition pattern and the possibility of oxygen toxicity there is an ongoing controversy as to how much oxygen is safe during resuscitation. It is best to give oxygen to maintain the saturation of the baby in the acceptable range. This will require the use of a blender and a compressed gas source for graded delivery of oxygen and, a good pulse oximeter for optimal monitoring of saturation in the earliest minutes of life. If these are not available in the delivery room, it is best to shift these babies to a SNCU/NICU for further management.

How Long?

The oxygen saturation of the baby should be used to decide the duration of oxygen delivery. In case oxygen is to be given for a longer time, it should be heated and humidified.

When central cyanosis improves and the oxygen saturation of the baby is above 90%, supplemental oxygen is gradually decreased. If the cyanosis or low oxygen saturation (less than 90%) persists in spite of giving free flow oxygen, the baby may have significant lung disease, and a trial of positive pressure ventilation (PPV) is justified. However, if ventilation is adequate and the baby still remains cyanotic, then a diagnosis of congenital cyanotic heart disease or persistent pulmonary hypertension of the newborn should be strongly considered.

Observational care: Babies who have received initial steps to help them initiate breathing, can also be cared with their mothers. The baby should be placed prone on the mother's chest and breast feeds should be initiated. Besides thermal control and breast feeding (as in routine care), breathing, activity and color of these babies should also be monitored at least once every 30 minutes during the first 2 hours after birth.

Observational care with Mother

- Warmth (skin to skin care)
- Initiate breastfeeding
- Monitor neonate (Temperature, heart rate, breathing and color every 30 minutes for 2 hours)

Summary: Lesson 2

1. Babies who do not cry/breathe well at birth should receive initial steps.
2. If the baby did not breathe or cry after birth then
   a. The cord should be clamped and cut immediately and the baby should be placed under a preheated radiant warmer
   b. Open the airway by positioning the newborn in the "sniffing" position
   c. Dry the baby immediately. Appropriate tactile stimulus involves gently rubbing the back of the baby twice
   d. Reposition the baby and then reassess
3. Continued use of tactile stimulation in an apneic baby wastes valuable time. For persistent apnea start positive pressure ventilation within 60 seconds of birth.
4. Acceptable methods for administering free flow oxygen are
   - Oxygen Mask
   - Oxygen tubing held close to the baby's nose and mouth
   - T piece Resuscitator
5. Free flow oxygen cannot be given reliably by a mask attached to a self- inflating bag.
6. Decisions and actions during newborn resuscitation are based on newborn's
   (a) Respiration
   (b) Heart rate
   (c) Oxygen saturation (by pulse oximeter)
7. If the baby is breathing well spontaneously and heart rate is above 100 bpm the baby should receive observational care with the mother.

Lesson 3

POSITIVE PRESSURE VENTILATION (PPV)

Learning Objectives

In this lesson you will learn:

- When to initiate positive pressure ventilation (PPV)
- What are the devices used for PPV
- How to check the PPV device for functionality
- How to select appropriate size bag and mask
- What is the technique for providing PPV and the expected response
- What to do if there is no desired response following PPV

The following case scenario will illustrate how positive pressure ventilation (PPV) is provided during resuscitation. Imagine yourself as a part of the team as you read through the case.

Case Scenario 3:

A 25 years old primigravida with non-progress of labor delivers a male baby at term gestation. The baby is limp, not breathing and has a large caput.

The cord is cut immediately and the baby is placed under a radiant warmer. The baby is placed in sniffing position to keep the airway open. A quick suction is done of the mouth followed by suction of the nose. The nurse then dries the baby with pre-warmed sheets and then removes the wet linen. A brief stimulation is done by rubbing the back of the baby. The head is repositioned.

The baby is still not breathing after these initial steps. The resuscitation team takes a decision to initiate positive pressure ventilation. A team member initiates positive pressure ventilation (PPV) with a bag and mask using 21% oxygen (room air) and calls for help. After 5 breaths, a second team member auscultates and reports heart rate as 70/min. The team member providing PPV takes ventilation corrective steps by reapplying the mask to the face and repositioning the baby's head to open the airway. Reassessment after 5 breaths shows that the chest is rising and the heart rate is increasing, hence, PPV is continued for 30 seconds. At the end of 30 seconds of positive pressure ventilation the baby still does not have spontaneous breathing, and the assistant reports that the heart rate has risen to 110/min. Ventilation is continued further, ensuring adequate chest rise with each breath for another 30 seconds. The baby is about 2 minutes old; has some spontaneous breaths, a heart rate of 140/min and is pink. PPV is continued and soon the baby starts crying. PPV is then gradually discontinued.

The baby's cord is tied and the baby is shown to the mother. The baby is then shifted to the SNCU for post-resuscitation care.

In the previous lesson (Lesson 2) you learnt how to determine whether the baby needs some form of resuscitation and how to perform the initial steps of resuscitation. In this lesson you will learn what to do next if the baby is not breathing effectively (apnea or gasping) or is bradycardic (HR <100 bpm) after initial steps of resuscitation.

When should you provide positive pressure ventilation?

PPV should be initiated if after providing initial steps of resuscitation-

- The infant is apneic or gasping or
- The heart rate is less than 100 bpm

What is the equipment available for PPV in newborns?

The types of equipment available for providing PPV in the newborn are:

- The Self inflating bag
- The T- piece resuscitator

The **Self-inflating bag** (240-500ml) is presently the most commonly used ventilation device (Fig. 3.1). The bag inflates following compression due to elastic recoil and does not need a compressed gas source to keep it inflated. It has a pressure limiting valve (pop off valve) regulated to limit inflation pressure to around 30-40 cm of water. The bag can be used with or without an attached manometer and/or oxygen reservoir (Fig.3.2). When squeezed, a self-inflating bag delivers a breath.

Table 3.1: Advantages and disadvantages of a self- inflating bag

	Self-inflating bag
Advantages	• Will always refill after being squeezed, does not require compressed gas source • Pressure limiting valve reduces risk of over-inflation
Disadvantages	• Will inflate even if there is no seal between mask and patient's face • Requires oxygen reservoir to provide high oxygen concentration • Cannot deliver free flow oxygen through face mask • Cannot be used to deliver continuous positive airway pressure (CPAP); can only deliver CPAP if positive end-expiratory pressure (PEEP) valve and pressurized gas is used.

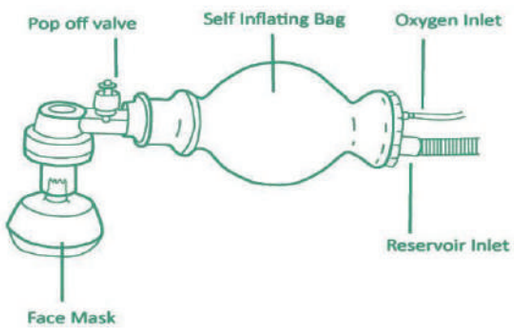


Fig. 3.1: Self inflating bag

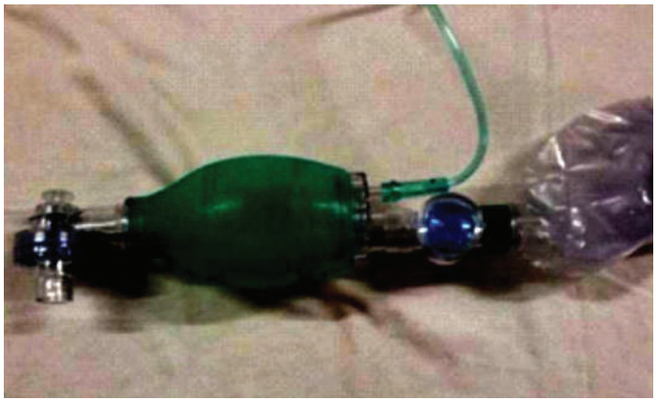


Fig. 3.2: Self inflating bag with oxygen tubing and reservoir

T-piece resuscitator is a flow-controlled pressure limited ventilator device (Fig.3.3). Piped compressed gas is delivered at one port of the T Piece. A preset peak inspiratory pressure (PIP), positive end expiratory pressure (PEEP), and maximum circuit pressure is set. With a T-piece device, gas flows into a face mask or endotracheal tube through a 'patient supply line'. Inflation is achieved by interrupting the escape of gas through an outlet hole on the T-piece using a thumb so that the pressure rises and is displayed by a manometer. Adjusting the PEEP valve varies positive end expiratory pressure (PEEP). Varying the duration of occlusion of the outlet hole alters the inflation time. The newborn is ventilated by placing a finger over the outlet aperture (hole in the PEEP valve) and removing it periodically at about 40-60 times a minute. The inspiratory and expiratory pressure settings can be altered upwards or downwards as needed during use, depending on the infant's response.

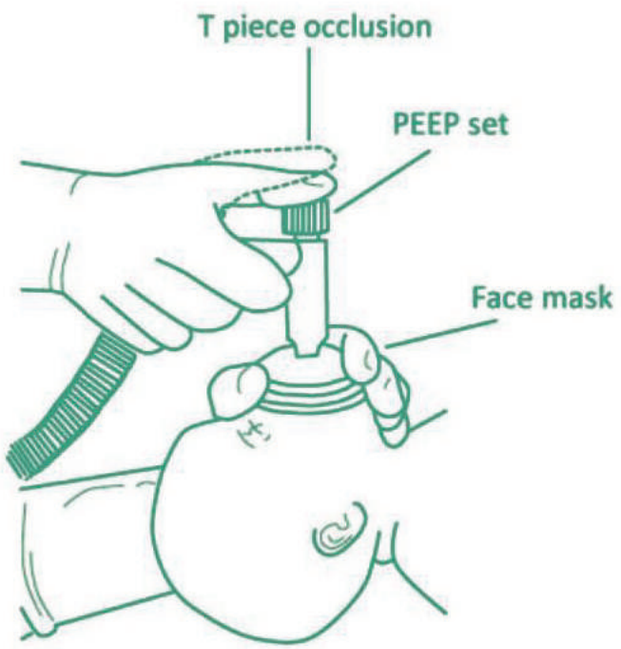


Fig. 3.3: T piece resuscitator

Table 3.2: Advantages and disadvantages of a T piece resuscitator

T piece resuscitator	
Advantages	• Consistent delivery of PIP and PEEP • Can be used to provide free flow oxygen reliably – 21-100 % (with blender) Provider does not get tired while providing ventilation
Disadvantages	• Needs compressed gas with a blender Requires pressures to be set prior to use • Changing inflation pressure during resuscitation is more difficult Risk of prolonged inspiratory time

A self-inflating bag should always be available as a back-up to flow-dependent devices in case of failure of compressed gas supply.

What are the important features of resuscitation equipment used in newborns?

The equipment should be designed for use in newborns and the following features must be given consideration:

Appropriate size face mask (Fig. 3.4a and b)

Masks come in a variety of shapes, sizes, and materials. An appropriate size face mask must seal around the mouth and nose but not cover the eyes or overlap the chin. It can be difficult to establish and maintain a good seal between the mask and the infant's face and it should not be assumed that just because the mask is on the face, there is a good seal. Masks with a cushioned rim and round shape are preferable. An ideal mask should extend from bridge of nose to tip of chin covering the nose without covering the eyes.

Fig. 3.4a: Two sizes of face masks (1 and 0) used in newborns

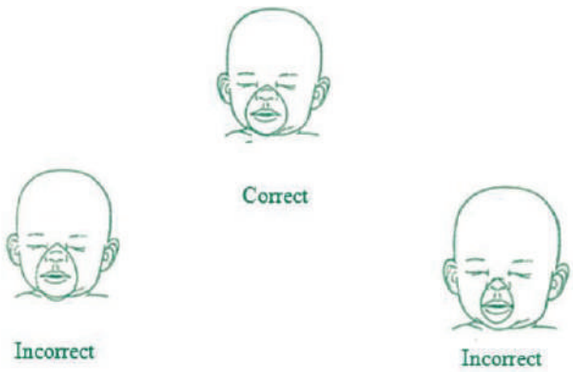


Fig. 3.4b: Appropriate size face mask

Appropriate size bag

Bags used for newborn resuscitation should have a volume between 240-500 ml. Term newborns require about 10-25 ml with each breath (4-6 mL/kg). Bags larger than 500 ml cannot deliver such small volumes and bags smaller than 240ml will not adequately re-inflate between breaths, when 40-60 breaths/min are given.

Safety features in PPV devices

Self-inflating bags should have a pressure relief valve (commonly known as a pop off valve) (Fig. 3.1) which is usually set at 30-40 cm H_2O by the manufacturer. If peak inspiratory pressure exceeds this limit, the valve opens limiting the pressure transmitted to the newborn lungs. There is no direct control for PEEP. Many self-inflating bags also are equipped with a pressure gauge or a port to attach a pressure gauge. The pressure manometer is used to adjust pressures.

A T-piece resuscitator has 2 controls. The inspiratory pressure control sets the amount of pressure delivered during a normal assisted breath. The maximum pressure relief control is a safety feature that prevents the pressure from exceeding a preset value (usually 40 cm H_2O, but is adjustable).

How to check functionality of self-inflating bag?

a. Assemble the device correctly.
b. Occlude the face mask of the self-inflating bag against the palm.
c. Look for following features as you squeeze the bag:
   - You should feel pressure against the palm. (Fig 3.5)
   - The fish mouth valve should open and close.
   - The pop off valve should make a hissing sound or move up and down.
   - The bag should recoil instantly when pressure is released.

Absence of any of the above features suggest malfunction.

Fig. 3.5: Checking for pressure against palm

Table 3.3: Steps of providing ventilation using self-inflating bag?

Step 1	Choose the correct size bag (240 -500ml)
Step 2	Choose the correct size mask
Step 3	Assemble the bag & mask and ensure valves are present and appropriately placed
Step 4	Test the functionality of bag and mask
Step 5	Create an airtight seal between the mask and infant's face
Step 6	Assess for effective ventilation

How do you provide ventilation using self-inflating bag? (Table 3.4)

- Complete the initial steps (warm, position and clear the airway, if necessary, dry and stimulate, reposition), re-evaluate the infant.
- Assess condition (heart rate [HR] and breathing) and begin positive pressure ventilation (PPV) **within first 60 seconds of birth, if the baby is apneic/gasping or HR is< 100bpm.**
- Ensure the device is assembled correctly and is functional.
- Ensure oxygen source, oxygen tubing, reservoir and additional help is available.
- Call for HELP as you decide to provide PPV.

Positioning

- Place the baby on firm, flat and clean surface.
- Position the head of the baby in a neutral position to open the airway.
- The rescuer should stand at the head end of the baby.
- Use of shoulder roll may be required in presence of large caput or in preterm infants.
- Apply the face mask firmly and gently covering the chin, mouth and nose to achieve an air tight seal.

Applying face mask (Fig 3.6, 3.7 3.8)

- The mask usually is held on the face with the thumb, index, and/or middle finger encircling much of the rim of the mask using the non-dominant hand.
- Ensure that the mask does not extend on the eyes or beyond the chin.

Fig. 3.6: Applying face mask

Fig. 3.7: Applying face mask

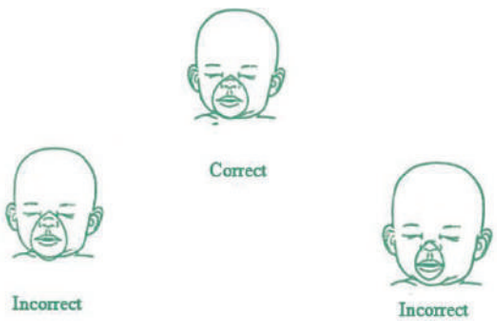


Fig. 3.8: Applying face mask

Providing Ventilation (Fig. 3.9)

- Squeeze the bag between thumb and two fingers using the dominant hand.
- Deliver at a rate of 40-60 breaths per minute – call loudly "squeeze, two, three". Deliver a breath when you call squeeze and allow the bag to recoil during calling "two-three".
- Apply gentle pressure to achieve chest rise.
- Provide five breaths and look for increase in heart rate. If there is no increase in HR, look for chest rise.
- Ventilate uninterruptedly for 30 seconds from the time you get chest rise.
- Ensure gentle chest rise.
- Reassess HR at the end of 30 seconds of effective PPV.

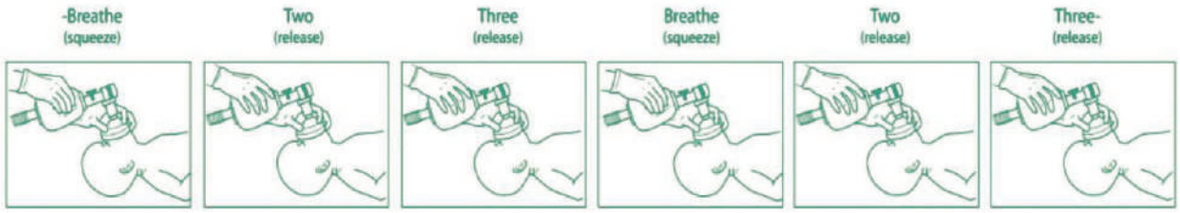


Fig. 3.9: Delivering 40-60 breaths using self-inflating bag. If one is using a T-piece resuscitator, occlude the PEEP valve when saying "squeeze" and release it while saying "two, three".

Oxygen delivery with self-inflating bag

- For babies born ≥ 32 weeks gestation, it is best to begin resuscitation with room air rather than 100% oxygen. In babies < 32 weeks gestation, start resuscitation with 21-30% oxygen. Begin with room air if blender is not available.

Assessing effectiveness of ventilation

- Provide 5 manual breaths and watch for chest rise with each breath.
- Ask assistant to check for heart rate.

If there is no chest rise or there is no rise in heart rate take ventilation corrective measures. (Table 3.4)

Table 3.4: Techniques to improve PPV using bag and mask (Ventilation corrective steps- MRSOPA)

	Problem	Remedial step
M	Inadequate seal	Mask adjusted to ensure airtight seal
R	Inappropriate position	Reposition the head in sniffing position
Try PPV and Reassess Chest Movement*		
S	Blocked airway	Suction the airway
O		Open baby's mouth and ventilate
Try PPV and Reassess Chest Movement*		
P	Inadequate pressure	Increase Pressure by squeezing the bag with more pressure till a chest rise is visible
Try PPV and Reassess Chest Movement*		
A	No improvement with above steps	Consider Alternative airway (endotracheal intubation laryngeal mask airway, if expertise present)
Try PPV and Reassess Chest Movement*		

Remember to follow the corrective steps in the sequence indicated in the table

* At any stage of re-assessment, if the chest rise is visible, no further corrective steps are required and PPV is given for 30 seconds beginning from this point.

- Provide un-interrupted effective ventilation for 30 seconds and assess for spontaneous breathing. If spontaneous breathing is present, gradually discontinue PPV.

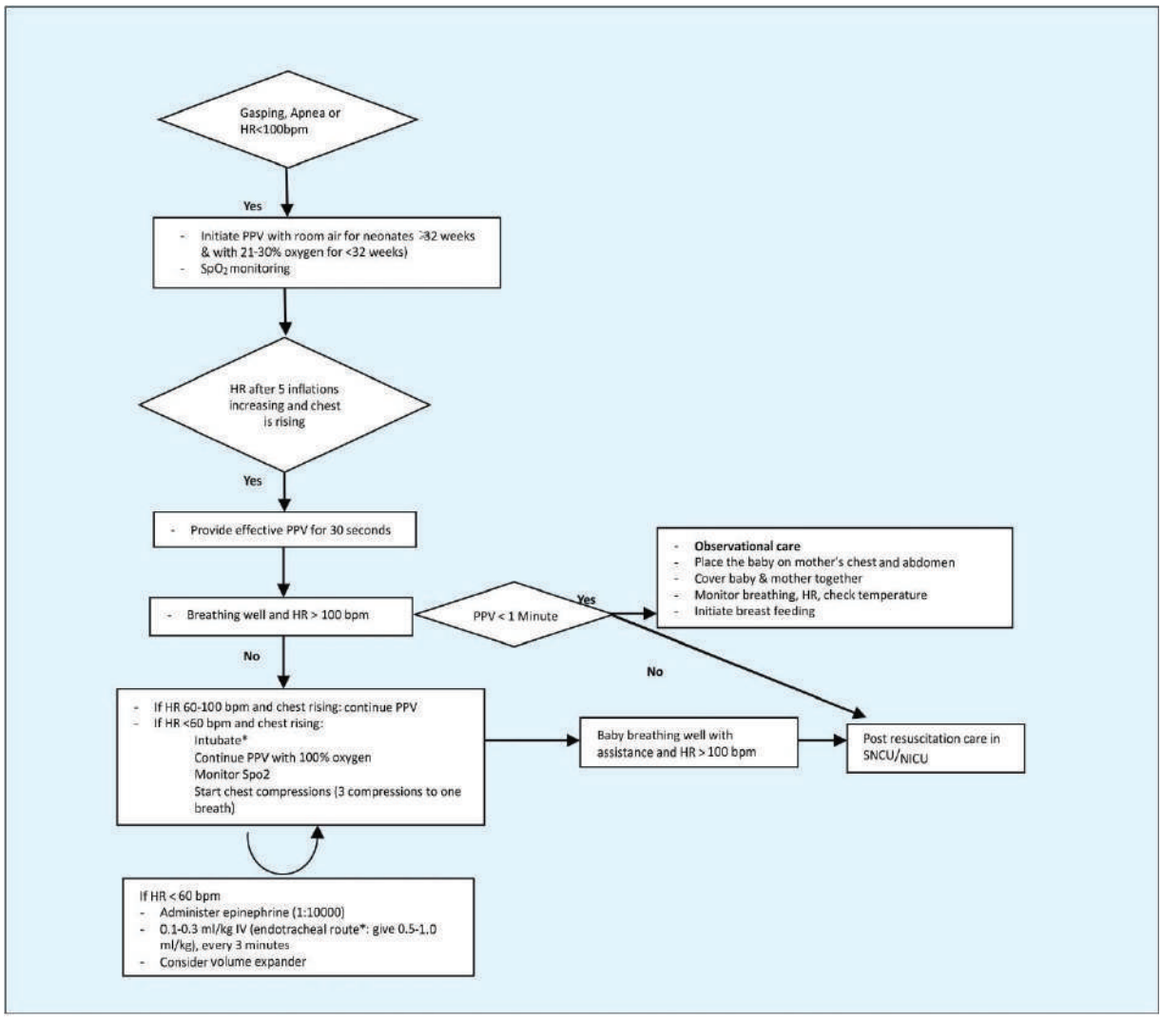
What is effective ventilation?

- Prompt increase in heart rate with chest rise is the best indicator of adequacy of ventilation.
- Additional signs of effective ventilation include appearance of spontaneous breathing, improving saturation and muscle tone.

What to do if baby is not improving?

You have so far done the following:

- Initiated PPV at a rate of 40-60 breaths/minute
- Called for assistance
- If chest rise or rise in heart rate was not evident after 5 breaths, you had initiated ventilation corrective steps and provided effective ventilation for 30 seconds.



Now evaluate heart rate:

- **If the heart rate is more than 60 bpm** but less than 100 bpm, continue PPV. Ensure effective ventilation.
- Reassess respiratory effort, heart rate every 30 secs (oxygen saturation may be monitored continuously if pulse oximeter is available).
- If PPV is prolonged over several minutes place an orogastric tube to prevent distention of stomach with air which may interfere with ventilation.

If the baby's heart rate is below 60 bpm despite 30 seconds of effective PPV (chest rise with ventilation), your next step will be to initiate chest compression (This will be described in lesson 4).

Increase oxygen concentration to 100% when you initiate chest compressions.

When to stop PPV?

PPV can be discontinued when:

- When the heart rate is above 100 bpm
- Sustained spontaneous breathing is present

Observational care with Mother

Newborn infants requiring PPV for less than 1 minute should be provided observational care with the mother.

Observational care with Mother

- Warmth (skin to skin care)
- Initiate breastfeeding
- Monitor neonate (Temperature, heart rate, breathing and color every 30 min for 2hr)

Post Resuscitation care

Preterm infants with labored breathing should be shifted to SNCU/NICU for considering CPAP. Newborns requiring PPV for more than 1 minute or needing intubation, chest compressions or medications should be shifted to SNCU/NICU for post-resuscitation care.

Summary: Lesson 3

- Establishing effective ventilation is the key to nearly all successful neonatal resuscitation.
- Be very familiar with the type of resuscitation device(s) you are using.
- Ensure the ventilation device is in working order before every delivery.
- The primary measure of adequate ventilation is prompt improvement in heart rate. Chest wall movement should be assessed if heart rate does not improve.
- Resuscitation should begin with room air for term babies and preterm babies ≥ 32 weeks. For babies < 32 weeks, begin resuscitation at 21-30% FiO2.
- A common source of error is inadequate seal of mask with the face; hence always ensure optimal seal.
- Perform ventilation correction steps **(MRSOPA)**, if HR does not increase or there is no chest rise after 5 breaths of initial PPV.

Lesson 4

CHEST COMPRESSIONS

Learning Objectives

In this lesson you will learn:

- When to start chest compressions
- How to perform chest compressions
- How to coordinate chest compression with positive pressure ventilation
- When to stop chest compressions

The following case scenario will illustrate how chest compressions are provided as a part of advanced resuscitation. Imagine yourself as a member of the team as you read through the case. The details of chest compressions will be described later in this lesson.

Case Scenario 4:

A primigravida woman with term pregnancy was admitted in labor with poor fetal movements. The obstetric team notified the pediatric team to be available in the delivery room at the time of delivery. The radiant warmer was turned on and resuscitation equipment is checked.

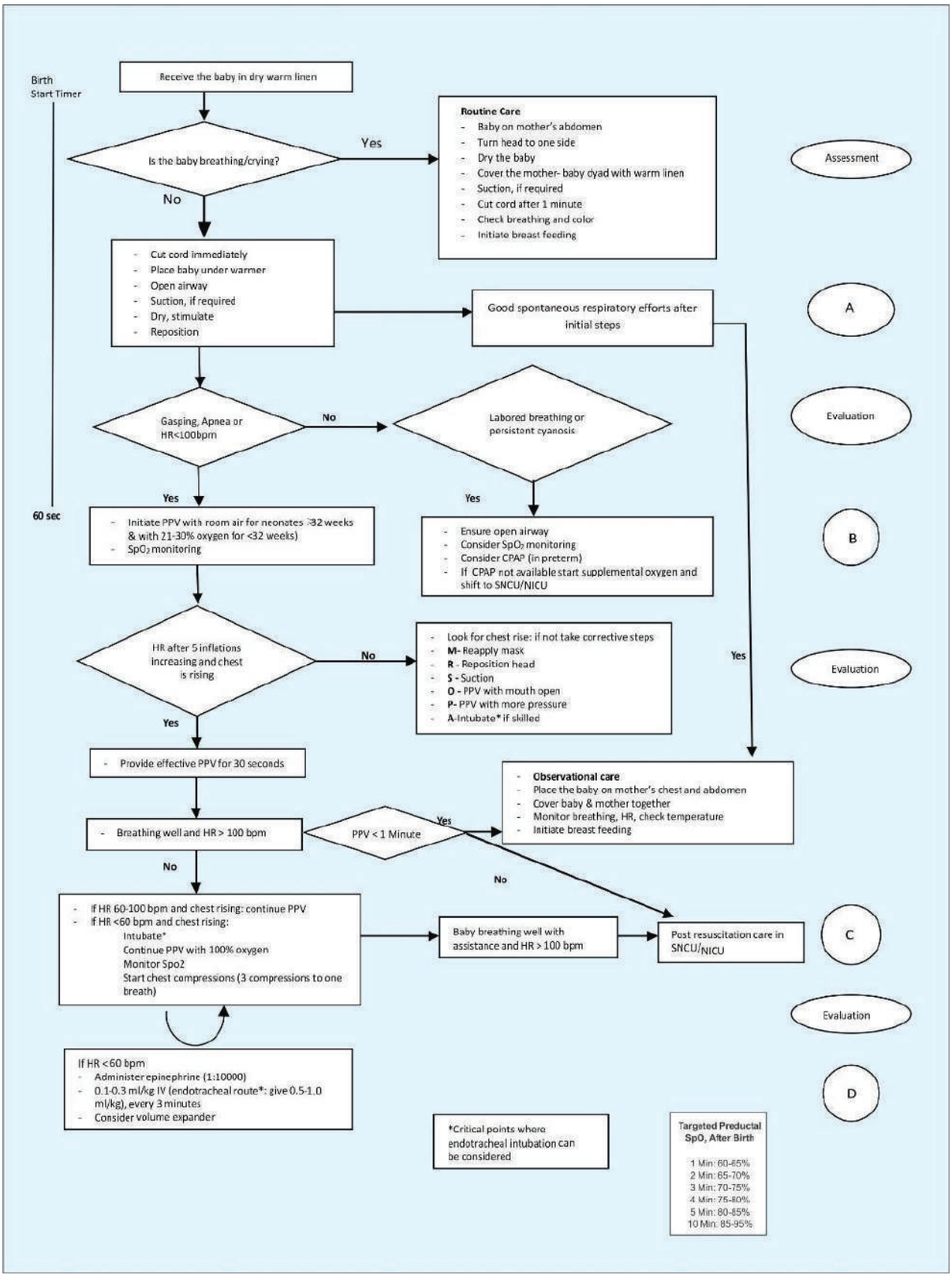
The woman delivered a limp and apneic baby. The cord was clamped and cut and the baby was immediately transferred by the resuscitation team to the radiant warmer. The baby was properly positioned, suctioned, dried and stimulated by rubbing the back. But the baby was still limp, apneic and cyanotic.

One member of the team initiated positive pressure ventilation with bag and mask using room air. Another member checked the heart rate by a stethoscope. After 5 breaths the baby had a heart rate below 60 bpm and there was no chest rise. The care provider performing PPV checked the mask for its seal, repositioned the head and continued PPV. Now on reassessment, the chest was rising with each breath.

After 30 seconds of effective ventilation the baby's heart rate was below 60 bpm, so the baby was intubated, 100% oxygen was added to PPV and the second team member begins chest compressions coordinated with PPV using 3:1 ratio of compressions to ventilation. After another 60 seconds, the baby had gasping breathing efforts; the heart rate was more than 60 bpm but less than 100 bpm.

The team stops chest compression but continues PPV for another 30 seconds. The baby now had evidence of spontaneous breathing and the heart rate was now above 100 bpm. The rate of PPV was gradually slowed down and on observation the baby was found to be breathing regularly, the heart rate was 120 per minute, and was pink. The baby was then shifted to the SNCU for post- resuscitation care.

Resuscitation Flow Diagram (NRP-India)



Why are chest compressions required?

Chest compressions are required to ensure that the heart is able to pump the blood being oxygenated in the lung by mechanical ventilation, to the body. In babies with a heart rate below 60 bpm despite PPV, the oxygen level drops to cause acidosis and significant myocardial dysfunction. Chest compressions are performed to supplement the mechanical ability of the heart to maintain circulation till the time the myocardium is oxygenated to function adequately and deliver oxygen to the brain. Bag and mask can be used to provide ventilation but to make it more effective during chest compressions, endotracheal intubation should be performed.

What are chest compressions?

Chest compressions :

- Are rhythmic compressions of the sternum that compress the heart between the sternum and spine
- Increase the intrathoracic pressure
- Pump blood into the circulatory system during compression and when pressure from the sternum is released, blood enters the heart from the veins

When to initiate Chest compressions?

Chest compressions are initiated if after 30 seconds of effective PPV, the heart rate remains below 60 bpm.

What should be done before starting chest compressions?

Call for help
Resuscitate with 100% oxygen
Endotracheal Intubation
Attach Pulse Oximeter if not done earlier

Technique of Chest Compressions:

The technique used for chest compressions is the thumb technique.

Thumb technique (Fig. 4.1): The two thumbs are used to depress the sternum while the hands encircle the chest and fingers support the spine. The distal phalanx of the thumb should be at right angle to the chest to achieve adequate pressure.

Fig. 4.1: Technique of chest compressions

The thumb technique provides:

- Constant pressure
- Better control of depth of compression

Site of compressions (Fig. 4.2)

The site of compression is the lower third of the sternum in the midline. The area lies between xiphoid and a line drawn between nipples. This can also be located by running one's fingers along the costal margin and localizing the xiphoid and placing the thumbs above the xiphoid. The thumbs should be alongside each other but can overlap if the baby is very small.

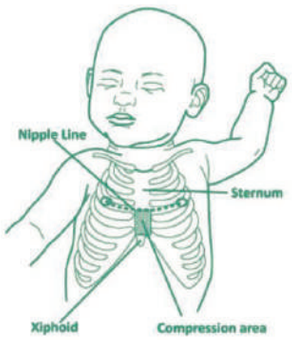


Fig. 4.2: Landmarks for chest compression

The provider stands at the foot end of the baby. Chest compressions can also be delivered from head end to permit access to umbilical vessels (Fig. 4.3 A and B).

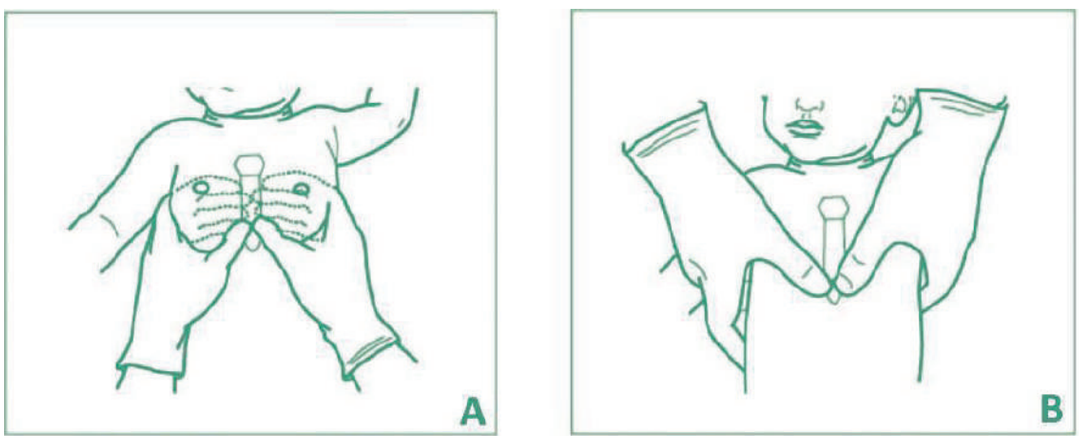


Fig. 4.3: Thumb technique of chest compressions administered from(A)foot end, from head end (B)

What is the pressure required for Compression?

The sternum should be depressed to a depth of approximately one third the anterior – posterior diameter of the chest **(Fig. 4.4)**.

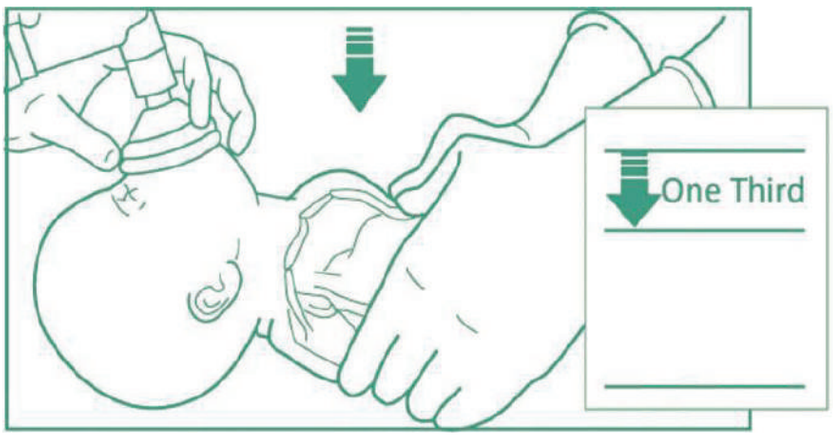


Fig. 4.4: Compression depth should be approximately one-third of the antero -posterior diameter of the chest

Duration of downward stroke is shorter than the duration of release to permit the heart to fill. On complete release, the thumbs should maintain contact with the chest to avoid relocating compression area and loss of control over compression.

Table 4.1: Chest compressions- indications and technique

Indication	HR less than 60 bpm despite effective ventilation
Rescuer position	The person providing ventilation is at the head end of the baby. The chest compression provider stands at the side or at the foot end of the baby. For ease of vascular access, chest compression may be provided from head end and ventilation from the side of the baby.
Site	Lower 1/3 of the sternum
Depth	1/3 the AP diameter of the chest
Ratio	3 compressions to 1 ventilation 90 compressions to 30 breaths per minute 120 events per minute
Technique	Two thumb technique Rescuer's hands (thumbs) should not leave contact with the chest Avoid simultaneous compression with breath Avoid interruptions Ensure adequate ventilation
Counting	One (Chest compression); and (release) Two (Chest compression); and (release) Three (Chest compression); and (release) followed by Squeeze (Ventilation breath)
Duration	Un-interrupted for 60 sec

What are the dangers which may be associated with Chest Compressions?

Chest compressions can cause trauma to the baby. Improper placement of the thumbs can cause:

- Damage to xiphoid
- Injury to internal organs like liver, spleen or lungs
- Fracture of ribs

What should be the rate of Compression and how is it coordinated with PPV?

Chest compressions should always be accompanied by positive pressure ventilation. Avoid giving compressions and ventilation simultaneously, they need to be coordinated. For every 3 compressions 1 breath is delivered (hence in a minute, 90 compressions and 30 breaths are given) **(Fig. 4.5).**

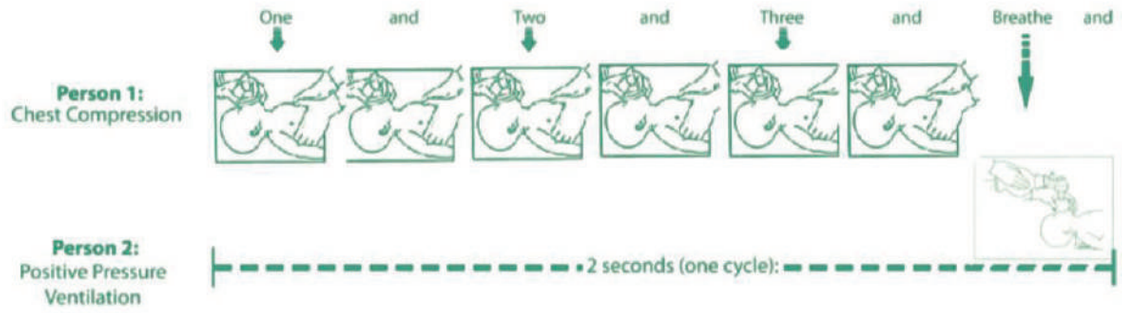


Fig. 4.5: Coordination of chest compression and ventilation

The person compressing should call out the counting sequence of **"One and Two and Three and Breathe and"**. The person ventilating squeezes the bag during "Breathe and" and releases during "One and".

Practicing rhythm of chest compression and ventilation

Imagine yourself as the person giving chest compressions. Repeat the sequence 'One and Two and Three and Breathe and" loudly and move your hands to compress at "One and", "Two and" and "Three and" but not at "Breathe and". Practice this several times so that you can do 5 cycles in 10 seconds.

Since chest compression has to be coordinated with ventilation, now imagine yourself as the person giving ventilation. Repeat the sequence 'One and Two and Three and Breathe and" loudly but do not move hands when you say "One and", "Two and" and "Three and" but squeeze the bag only when you say "Breathe and". Practice this several times so that you can do 5 cycles in 10 seconds.

When to stop chest compressions?

Reassess after 60 seconds of coordinated PPV and chest compression. The heart rate should be above 60 bpm to stop chest compressions but the PPV is continued. After stopping the chest compression, effective ventilation is delivered at 40-60 breaths/minute. Then ventilation is gradually stopped after the heart rate goes above 100 bpm and the baby begins to breathe spontaneously. The baby is then shifted to SNCU/NICU for post resuscitation care as described in Lesson 3.

If the infant is not improving

Questions to be asked when heart rate is not improving with compressions and ventilation
(Mnemonic CARDIO)

1. Chest movement: Is the chest moving with each breath?
2. **A**irway: Is the airway secured with an endotracheal tube or laryngeal mask?
3. **R**ate: Are 3 compressions coordinated with 1 ventilation being delivered every 2 seconds?
4. **D**epth: Is the depth of compressions one-third of the AP diameter of the chest?
5. **I**nspired Oxygen: Is 100% oxygen being administered through the PPV device?

If you cannot intubate, make sure you call someone who is skilled in endotracheal intubation. In the meantime, continue PPV with bag and mask. The technique of endotracheal intubation will be described in lesson 5.

If the baby's heart rate remains below 60 bpm after 60 seconds of coordinated PPV with chest compressions, you should insert an umbilical catheter and give epinephrine (Described in lesson 6).

Summary: Lesson 4

- The compression ventilation ratio is 3:1 and in a minute 90 compressions are delivered for 30 PPV.
- It is preferable to intubate the baby at this stage so as to provide effective ventilation.
- Ventilate with 100% oxygen while performing chest compressions
- Give coordinated PPV and Chest compression for 60 seconds and then reassess
- If the heart rate is above 60 bpm, stop chest compressions.
- Insert umbilical catheter if heart rate remains below 60 bpm after 60 seconds of coordinated chest compressions and positive pressure ventilation and give epinephrine.

Lesson 5

ENDOTRACHEAL INTUBATION

Learning Objectives

In this lesson you will learn:

- The indications for endotracheal intubation during resuscitation
- How to select and prepare the appropriate equipment for endotracheal intubation
- How to use the laryngoscope to insert an endotracheal tube
- How to determine if the endotracheal tube is in the trachea
- How to use the endotracheal tube to administer positive-pressure ventilation

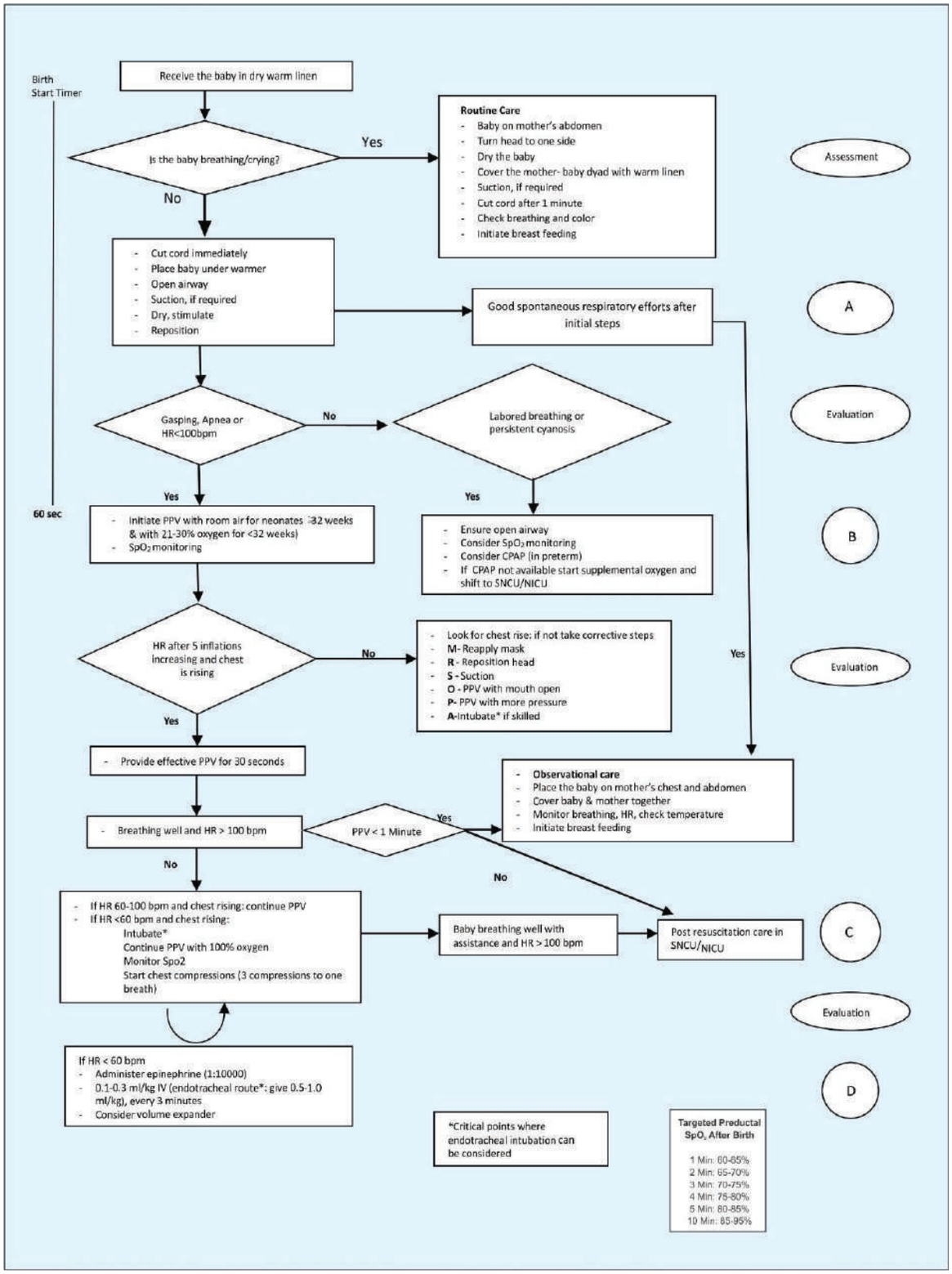
When is endotracheal intubation required?

Endotracheal intubation may be performed at various points during a resuscitation as indicated by the asterisks (*) in the resuscitation algorithm.

Indications for endotracheal intubation are:

- If positive-pressure ventilation is not resulting in adequate clinical improvement i.e., if the heart rate is not increasing or if the chest rise is not good.
- If there is a need for positive-pressure ventilation for more than a few minutes.
- If chest compressions are required, endotracheal intubation may be performed to improve the efficiency of positive pressure breaths.
- For special situations, such as giving endotracheal medications and in cases of suspected or antenatally diagnosed diaphragmatic hernia.

Resuscitation Flow Diagram (NRP-India)



What equipment and supplies are needed?

The supplies and equipment necessary to perform endotracheal intubation should be kept together and should be readily available. Each delivery room should have at least one complete set of the following items (Figure 5.1):

- Laryngoscope with an extra set of batteries and extra bulbs
- Blades: No. 1 (term newborn), No. 0 (preterm newborn), No. 00 (optional for extremely preterm newborn). Straight rather than curved blades are preferred.
- Endotracheal tubes with inside diameters of 2.5, 3.0 & 3.5
- Suction apparatus with suction catheters 10F, 12F and 14F
- Stethoscope (neonatal head preferred)
- Self- inflating bag with oxygen reservoir
- Oxygen source and tubing
- Scissors and adhesive tape for fixing endotracheal tube

This equipment should be available at a specified place near the newborn care corner. It should be so placed that it is readily accessible when required. Intubation is best performed as a clean procedure. Use disposable endotracheal tubes. The laryngoscope blades and handles should be cleaned after each use.

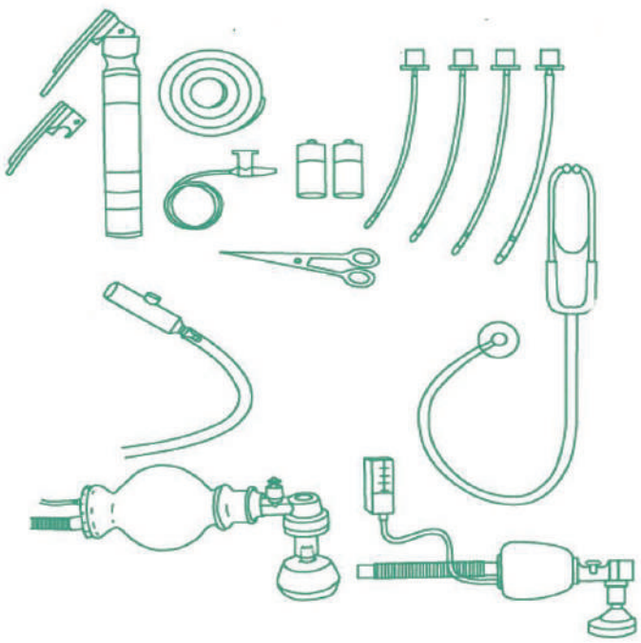


Fig. 5.1: Neonatal resuscitation equipment and supplies

What kind of endotracheal tubes are best to use?

Endotracheal tubes are supplied in sterile packages and should be handled with clean technique. ET tubes with uniform diameter throughout the length of the tube should be used (Figure 5.2).

Most endotracheal tubes for newborns have a black line near the tip of the tube, which is called a "vocal cord guide" (Figure 5.3). The vocal cord guide is placed at the level of the vocal cords. This usually positions the tip of

the tube above the bifurcation of the trachea (carina). One should remember that the length of the trachea in a premature newborn is less than that in a term newborn.

Use non cuffed ET tubes for neonatal resuscitation.

Most endotracheal tubes made for newborns come with centimeter markings along the tube, identifying the distance from the tip of the tube is explained later in this chapter.

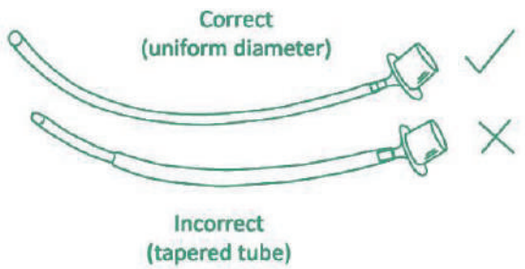


Fig. 5.2: Type of endotracheal tube preferred in neonates

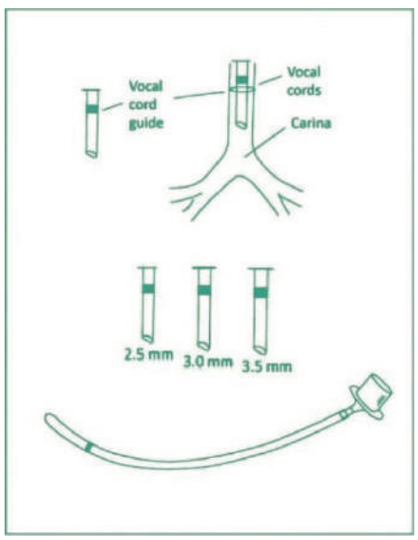


Fig. 5.3: Endotracheal tube sizes with vocal cord guide

How do you prepare the endotracheal tube for insertion?

Select the appropriate-sized tube.

Table 5.1. Endotracheal tube sizes for babies of different weights/gestations

Weight (g)	Gestational age (weeks)	Tube size (mm) (Internal diameter)
Below 1000	Below 28	2.5
1000 - 2000	28 - 34	3.0
Above 2000	Greater than 34	3.5

Endotracheal tube size for babies of various weights and gestational ages should be available. One should not waste time once the resuscitation is underway. Therefore, preparation of equipment before a high-risk delivery is important. The approximate size of the endotracheal tube is determined from the baby's weight. Table 5.1 gives the tube size for various weight and gestational age categories. It may be helpful to post the table in each delivery room near the radiant warmer.

Consider cutting the tube to a shorter length

Many endotracheal tubes are much longer than necessary for orotracheal use. The extra length increases the resistance to airflow. Some clinicians find it helpful to shorten the endotracheal tube before insertion (Figure 5.4). The endotracheal tube may be shortened to 13 to 15 cm to make it easier to handle during intubation and to reduce the chance of inserting the tube too far. A 13-15 cm tube will provide enough tube length extending beyond the baby's lips for adjusting the depth of insertion if necessary and to properly secure the tube to the face. Remove the connector and then cut the tube diagonally to make it easier to reinsert the connector back to the tube. Replace the endotracheal tube connector. The fitting should be tight so that the connector does not inadvertently separate during insertion or use. Ensure that the connector and the tube are properly aligned so that kinking of the tube is avoided. Connectors are made to fit a specific size tube. They cannot be interchanged between tubes of different sizes.

Some prefer to leave the tube long initially and cut it to the desired length after insertion.

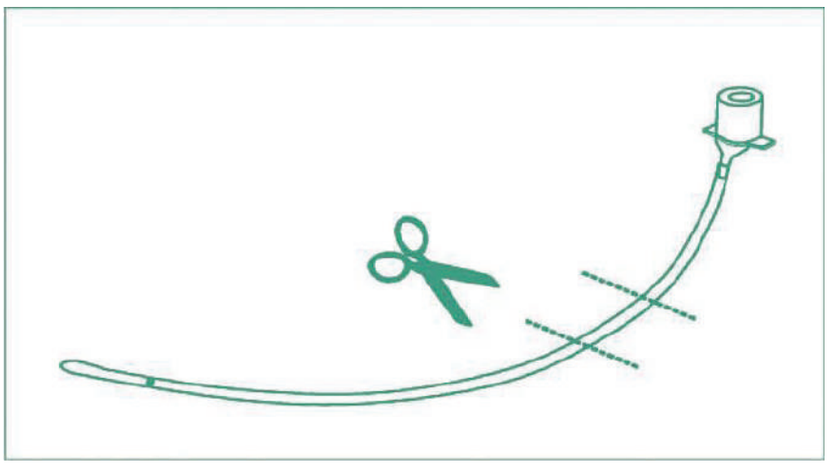


Fig. 5.4: Where to cut endotracheal tube to shorten it

How do you prepare the laryngoscope and additional supplies?

Select the blade and attach it to the handle. First, select the appropriate-sized blade and attach it to the laryngoscope handle.
No 00 for extremely preterm
No 0 for preterm newborn
No 1 for term newborn

Next, check working of the laryngoscope, turn on the light by clicking the blade into the "open" position to determine that the batteries and bulb are working. Check to see that the bulb is screwed tightly to ensure that it will not flicker or fall out during the procedure.

Prepare suction equipment. Suction equipment should be available and ready for use.

Adjust the suction pressure to 80- 100 mm Hg by increasing or decreasing the level of suction while occluding the end of the suction tubing.

Connect a 10F (or larger 12-14 F for meconium) suction catheter to the suction tubing so that it will be available to suction secretions from the mouth and nose.

Smaller suction catheters (5F, 6F, or 8F, depending on the size of the endotracheal tube) should be available for suctioning the endotracheal tube, if required. Appropriate sizes are listed in Table 5.2.

Table 5.2: Suction catheter sizes for various endotracheal tube sizes

Gestation	Weight	ETT size Internal diameter (mm)	ETT suction catheter size (F)
< 28 weeks	< 1 kg	2.5	5 – 6
28 – 34 weeks	1 – 2 kg	3.0	
14 – 38 weeks	2 – 3 kg	3.5	6 – 8
> 38 weeks	3 – 4 kg	3.5	

Tip:

- ETT internal diameter in millimeters can be calculated by gestational age in weeks divided by 10 and rounded to the nearest tube size (in multiples of 0.5), e.g. 30 weeks gestation neonate will require ET tube of size 3
- Catheter size to be no more than half the internal diameter of ETT

Preparing the device for administering positive-pressure ventilation

A resuscitation bag and mask capable of providing 90% to 100% oxygen should be available to ventilate the baby between intubation attempts or if intubation is unsuccessful. The resuscitation device without the mask will be required to ventilate the baby after intubation to initially check correct tube placement and to provide continued ventilation if necessary. Check the operation of the PPV device as described in Lesson 3.

Turn on oxygen. The oxygen tubing should be connected to an oxygen source and be available to deliver up to 100% free- flow oxygen and should be connected to the resuscitation bag. The oxygen flow should be turned on to 10 L/min.

A stethoscope will be required to check for air entry.

What anatomy do you need to know to insert the tube properly?

The anatomic landmarks that relate to intubation are labeled in Figures 5.5 and Figure 5.6. Study the relative position of these landmarks using the figures, because each landmark is important for better understanding of the intubation procedure.

Epiglottis – A lid like structure overhanging the entrance to the trachea.
Vallecula – A pouch formed by the base of the tongue and the epiglottis.
Esophagus – The food passageway extending from the throat to the stomach.
Cricoid – Cartilage of the larynx.
Glottis – The opening of the larynx leading to the trachea, flanked by the vocal cords.
Vocal cords – Mucous membrane covered ligaments on both sides of the glottis
Trachea – The windpipe, extending from the throat to the main bronchi.
Main bronchi – The two air passageways leading from the trachea to the lungs.
Carina – Where the trachea branches into the two main bronchi.

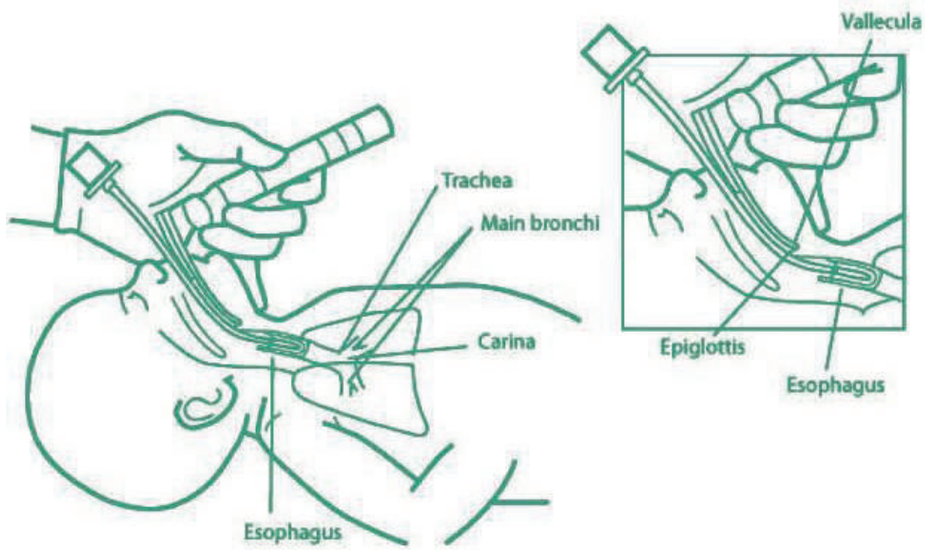


Fig. 5.5: Diagram of upper airway showing position of laryngoscope and endotracheal tube

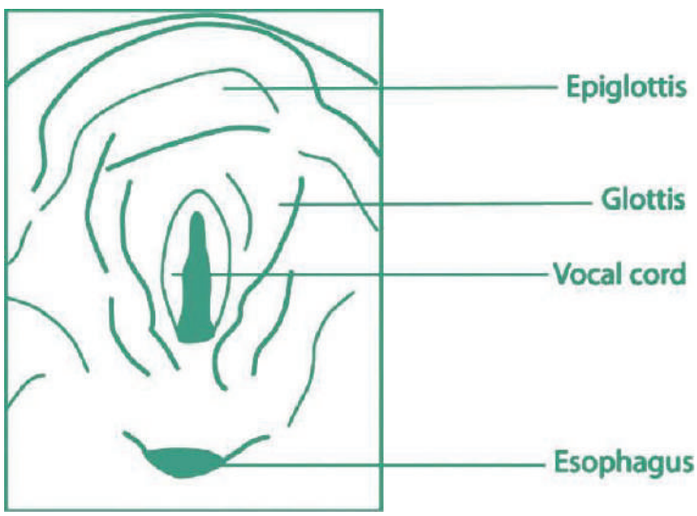


Fig 5.6: Diagram showing the glottis and structures around it

How should you position the newborn to make intubation easiest?

The correct position of the newborn for intubation is the same as for bag and mask ventilation – on a flat surface with the head in a midline position and the neck slightly extended. It may be helpful to place a roll under the baby's shoulders to maintain slight extension of the neck. This "sniffing" **position** aligns the trachea for optimal viewing by allowing a straight line of sight into the glottis once the laryngoscope has been properly placed. It is important not to hyperextend the neck, because this will raise the glottis above your line of sight and narrow the trachea. If there is too much flexion of the head towards the chest, you will be viewing the posterior pharynx and may not be able to directly visualize the glottis.

How do you hold the laryngoscope?

Turn on the laryngoscope light and hold the laryngoscope in your left hand, between your thumb and first two or three fingers, with the blade pointing away from you (Figure 5.7). One or 2 fingers should be left free to rest on the baby's face to provide stability. The laryngoscope is designed to be held in the left hand – by both right-and left-handed persons. Turn on the light by clicking the blade to an open position. You will hear a click as the blade gets locked with the handle.

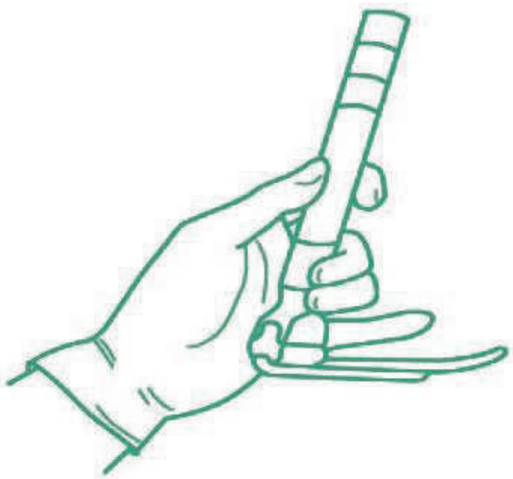


Fig. 5.7: Correct method of holding a laryngoscope

How do you visualize the glottis and insert the tube?

The next few steps will describe the insertion of an endotracheal tube in detail. However, during an actual resuscitation, they will need to be completed very quickly-within approximately 30 seconds. The baby will not be ventilated during this process, so quick action is essential.

Steps for Endotracheal intubation:

Firstly, stabilize the baby's head with your right hand (Fig. 5.8). It may be helpful to have a second person hold the head in the desired "sniffing" position. Free-flow oxygen should be delivered throughout the procedure.

Note: The important consideration here is that the procedure should be accomplished as quickly as possible (within 30 seconds). If the patient appears to be compromised, it is usually preferable to stop, resume positive-pressure ventilation with a mask, and then try again.

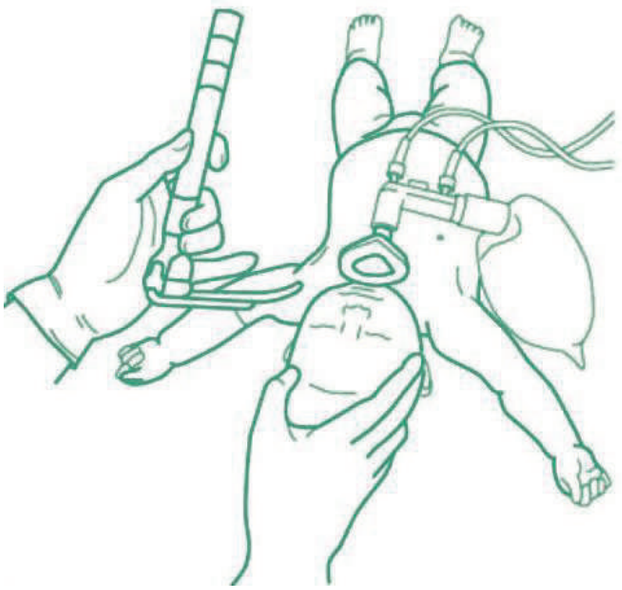


Fig. 5.8: Stabilizing the neonate's head prior to intubation

Secondly, slide the laryngoscope blade over the right side of the tongue, pushing the tongue to the left side of the mouth and advance the blade until the tip lies in the vallecula, just beyond the base of the tongue (Fig. 5.9). You may need to use your right index finger to open the baby's mouth to make it easier to insert the laryngoscope.

Note: Although this lesson describes placing the tip of the blade in the vallecula, some prefer to place it directly on the epiglottis, gently compressing the epiglottis against the base of the tongue.

Third, lift the blade slightly, thus lifting the tongue out of the way to expose the pharyngeal area. When lifting the blade, raise the entire blade by pulling up in the direction the handle is pointing (Fig. 5.10).

Do not elevate the tip of the blade by using a rocking motion and pulling the handle towards you. Rocking rather than elevating the tip of the blade will not produce the view of the glottis you desire and will put excessive pressure on the alveolar ridge.

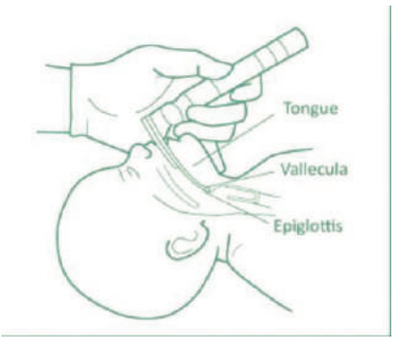


Fig. 5.9: Correct method of inserting the laryngoscope blade

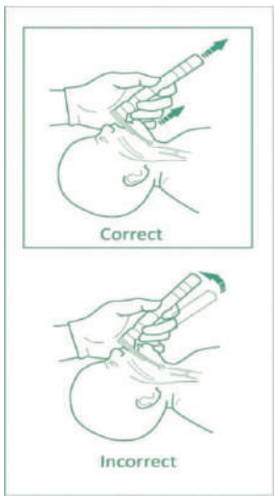


Fig. 5.10: Correct (top) and Incorrect (bottom) method for lifting laryngoscope blade to expose the larynx

Fourth, look for landmarks (Fig. 5.11). If the tip of the blade is correctly positioned in the vallecula, you should see the epiglottis at the top, with the glottis opening below. You also should see the vocal cords appearing as vertical stripes on each side of the glottis or as an inverted letter "V" (Fig. 5.11). If these structures are not immediately visible, quickly adjust the blade until the structures come into view. Applying downward pressure to the cricoid (the cartilage that covers the larynx) may help bring the glottis into view (Fig. 5.12). The pressure may be applied with your own little finger or by an assistant. Suctioning of secretions may also be helpful to improve your view. Inadequate visualization of the glottis is the most common reason for unsuccessful intubation.

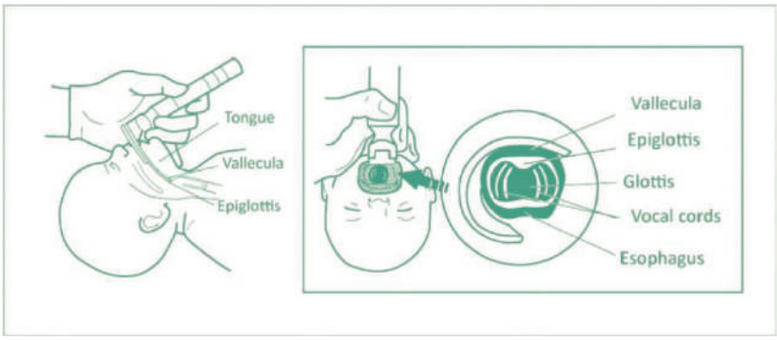


Fig. 5.11: Visualization of anatomic landmarks before intubating the newborn

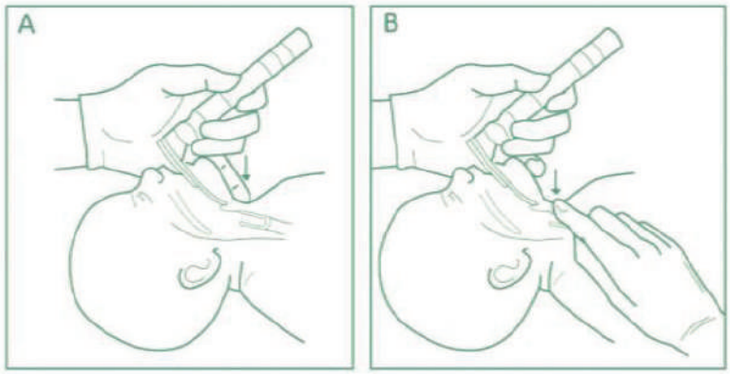


Fig. 5. 12: Improving visualization of larynx with pressure applied to cricoid

Next, insert the tube (Fig. 5.13). Holding the tube in your right hand, introduce it into the right side of the baby's mouth with the curve of the tube lying in the horizontal plane. This will prevent the tube from blocking your view of the glottis. Keep the glottis in view and, when the vocal cords are apart, insert the tip of the endotracheal tube until the vocal cord guide is at the level of the cords.

If the cords are together, wait for them to open. Do not touch the closed cords with the tip of the tube because it may cause spasm of the cords. Never try to force the tube between closed cords. If the tube could not be inserted, abandon the procedure and continue to ventilate with a bag and mask. After the heart rate and color have improved, you can then try again.

Be careful to insert the tube only so far as to place the vocal cord guide at the level of the vocal cords. This positions the tube in the trachea approximately halfway between the vocal cords and the carina. Note the markings on the tube that align with the baby's lip.

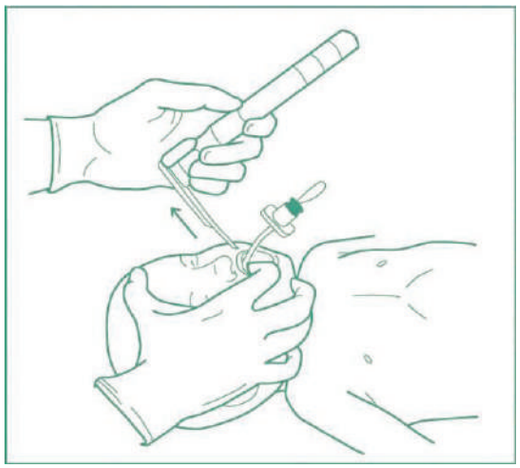


Fig. 5.13: Inserting the endotracheal tube through the vocal cords

Stabilize the tube with one hand, and remove the laryngoscope with the other (Fig. 5.14). With the right hand held against the face, hold the tube firmly at the lips and/or use a finger to hold the tube against the baby's hard palate. Use your left hand to carefully remove the laryngoscope without displacing the tube.

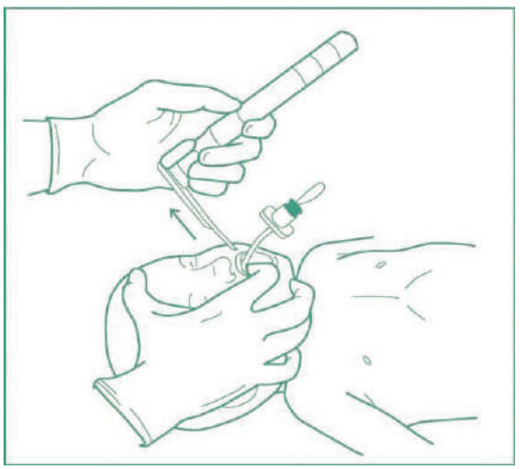


Fig. 5.14: Stabilizing the endotracheal tube while laryngoscope is withdrawn

Although it is important to hold the tube firmly, be careful not to press the tube so tightly that the tube gets compressed and obstructs the airflow. You are now ready to use the tube for the reason you inserted it.

To ventilate the baby, quickly attach a self-inflating bag to the tube, take steps to ascertain that the tube is in the trachea, fix the endotracheal tube (Figure 5.15 ABCD) while continuing to provide positive pressure ventilation.

Fig. 5.15 (A, B, C, D): Fixing the Endotracheal Tube

How do you check to be sure that the tube is in the trachea?

Watching the tube pass between the cords, watching for chest movement following application of positive pressure, listening for breath sounds are all helpful signs to suggest that the tube is in trachea rather than esophagus. However, these signs can be misleading. An increasing heart rate is the primary method for confirming endotracheal tube placement.

If the tube is positioned correctly, you should observe the following:

- Improvement in heart rate and color
- Breath sounds heard over both lung fields but decreased or absent sound over the stomach
- No gastric distention with ventilation
- Vapor condensing on the inside of the tube during exhalation
- Symmetrical movement of chest with each breath

When listening to breath sounds, be sure to use a small stethoscope and place it laterally and high on the chest wall (in the axilla). A large stethoscope, or a stethoscope placed too central or too low, may transmit sounds from the esophagus or stomach. Observe for absence of gastric distension and movement of both sides of the chest with each ventilated breath. Listening for bilateral breath sounds and observing symmetrical chest movement with positive-pressure ventilation provide secondary confirmation of correct endotracheal tube placement in the airway with tip of the tube positioned above the carina. A rapid increase in heart rate is indicative of effective positive- pressure ventilation.

Be cautious when interpreting breath sounds in newborns. Since sounds are easily transmitted, those heard over the anterior part of the chest may be coming from the stomach or esophagus. Breath sounds can also be transmitted to the abdomen.

What do you do if you suspect that the tube may not be in the trachea?

Be certain that the tube is in the trachea. A misplaced tube is worse than having no tube at all. The tube is not likely to be in the trachea if:

- The newborn remains bradycardic and cyanotic despite positive-pressure ventilation.
- No breath sounds are heard over the lungs.
- The abdomen appears to be distended.
- Air sounds are heard over the stomach.
- There is no mist in the tube.
- The chest is not moving symmetrically with each positive-pressure breath.

If you suspect the tube is not in the trachea, you should do the following:

Use your right hand to hold the tube in place while you use your left hand to reinsert the laryngoscope so that you can visualize the glottis and see if the tube is passing between the vocal cords.

And/or

Remove the tube, use a self-inflating bag and mask to stabilize the heart rate and color, and then repeat the intubation procedure.

How do you know if the tip of the tube is in the right location within the trachea?

1. **Tip-to-lip measurement:** To estimate if the tube has been inserted to the correct distance (Table 5.3). Adding 6 to the baby's weight in kilograms will give you a rough estimate of the correct distance from the tube tip to the vermillion border of the upper lip. (Note: This rule is unreliable in those babies who have congenital anomalies of the neck and mandible (e.g. Pierre Robin syndrome).

Table 5.3: Estimated depth of insertion of ET tube by tip to lip distance (Based on birth weight)

Weight (kg)	Depth of insertion (cm) (tip to lip distance)
1	7
2	8
3	9
4	10

2. **Nasal Tragus Length (NTL) measurement:** The NTL is a method that has been validated in both full-term and preterm newborns. It uses a calculation based on the distance (cm) from the baby's nasal septum (Fig.5.16 (a)) to the ear tragus (Fig.5.16 (b)). Use a measuring tape to measure the NTL (Fig.5.16 (c)). The estimated insertion depth (cm) is NTL + 1 cm. Place the endotracheal tube so that the marking in the tube corresponding to the estimated insertion depth is adjacent to the baby's lip.

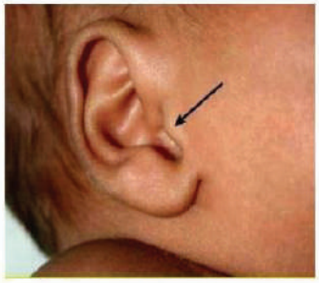




Fig. 5.16: (a) Nasal septum *(b) Tragus* *(c) Measuring NTL*

3. **Gestational Age:** Recent studies have also shown that the gestational age is an accurate predictor of the correct insertion depth and has the advantage of being known before birth.

Table 5.4: Depth of insertion of endotracheal tube according to gestational age

Gestation (weeks)	Endotracheal tube insertion depth at lips (cm)	Baby's Weight (grams)
23 – 24	5.5	500 – 600
25 – 26	6.0	700 – 800
27 – 29	6.5	900 – 1000
30 – 32	7.0	1100 – 1400
33 – 34	7.5	1500 – 1800
35 – 37	8.0	1900 – 2400
38 – 40	8.5	2500 – 3100
41 – 43	9.0	3200 – 4200
Adapted from Kempley ST, Momeira JW, Petrone FL. Endotracheal tube length for neonatal intubation. Resuscitation. 2008+ 77(3):369-373		

All these methods (Tip to Lip distance, NTL method and ET insertion based on gestational age) are only an approximation of the correct distance at which the tube is inserted. You should listen to the breath sounds over both axillae after positioning the endotracheal tube. If properly positioned, you should be able to hear breath sounds over both axillae with equal intensity.

If the tube is inserted too far, you will hear breath sounds that are louder on one side than the other (usually the right). If that is the case, pull back the tube very slowly while listening to the left side of the chest. When the tip reaches the carina, you should hear equal breath sounds.

After you have ensured that the tube is in the correct position, take note of the centimeter marking that appears at the upper lip. This can help you maintain the appropriate depth of insertion.

How do you continue resuscitation while you intubate?

Ventilation must be discontinued while intubating because the bag and mask has to be removed from the airway during the procedure. Chest compressions generally must be interrupted because compressions cause movement and prevent you from seeing landmarks. Therefore, you should make every effort to minimize the amount of hypoxia imposed during intubation.

The following steps will be helpful to prevent hypoxia during intubation:

Pre-oxygenate before attempting intubation

Oxygenate the baby appropriately with bag and mask before beginning intubation and between repeated intubation attempts. This will not be possible when intubation is being performed to improve ineffective positive-pressure ventilation.

Deliver free-flow oxygen during intubation. Hold free-flow oxygen by the baby's face while the health care provider is clearing the airway and trying to visualize the landmarks. This will provide oxygen-enriched air for the baby to inhale in case he/she makes any spontaneous respiratory efforts during the procedure.

Limit attempts to 30 seconds. Don't try to intubate for longer than approximately 30 seconds. If you are unable to visualize the glottis and insert the tube within 30 seconds, remove the laryngoscope and attempt to oxygenate the baby with bag-and- mask. Ensure that the baby is stable, then try again.

What can go wrong while you are trying to intubate?

Poor visualization of the glottis also may be caused by not elevating the tongue high enough to bring the glottis into view. Sometimes, pressure applied to the cricoid, which is the cartilage covering the larynx, will help to bring the glottis into view. This is accomplished by using the fourth or fifth finger of the left hand or by asking an assistant to apply the pressure. Practice intubating a manikin enough times so that you can find the correct landmarks quickly, thus allowing you to insert the tube within 30 seconds.

You may inadvertently insert the tube into the esophagus instead of the trachea. An endotracheal tube in the esophagus will be worse than having no tube at all, since the tube will tend to obstruct the baby's pharyngeal airway without providing an artificial airway. Therefore:

- Be certain that you visualize the glottis before inserting the tube.
- Watch the tube enter the glottis between the vocal cords.
- Look carefully for signs of esophageal intubation after the tube has been inserted.
- Check air entry over chest and epigastrium.
- If you have concerns that the tube may be in the esophagus, visualize the glottis and tube with a laryngoscope and/or remove the tube, oxygenate the newborn with a bag and mask, and reintroduce the tube.

Signs of endotracheal tube in the esophagus instead of the trachea:

- Poor response to intubation (bradycardia, cyanosis, etc.)
- No audible breath sounds
- Air heard entering the stomach
- Gastric distention may be seen
- No mist in tube
- Poor chest movement

You may inadvertently insert the tube too far into the trachea, down the right main bronchus. If the tube is inserted too far, it usually will pass into the right main bronchus. When you insert the tube, it is important to remember, to see the vocal cord guide on the tube and to stop advancing the tube as soon as the vocal cord guide reaches the cords.

Signs of the tube being in the right main bronchus include:

- Baby's heart rate or color shows no improvement
- Breath sounds heard over the right but not over the left side of the chest
- Breath sounds are louder on the right side of the chest than on the left side
- If you think the tube may be down the right main bronchus, first check the tip-to-lip measurement or use NTL method to see if the number at the lip is higher than the estimated measurement. Even if the measurement appears to be correct, if breath sounds remains asymmetric, you should withdraw the tube slightly while you listen over the left side of the chest to hear if the breath sounds improve.

Common complications associated with endotracheal intubation (Table 5.5): Some of the common complications associated with endotracheal intubation, their possible causes and their preventive/corrective actions are tabulated below:

Table 5.5: Common complications associated with endotracheal intubation

Complication	Possible Causes	Prevention or Corrective Action to be Considered
Hypoxia	Taking too long to intubate Incorrect placement of tube	Pre-oxygenate with bag and mask. Provide free-flow oxygen during procedure. Stop intubation attempt after 30 seconds. Reposition the tube
Bradycardia/apnea	Hypoxia Vagal response from laryngoscope or suction catheter	Pre-oxygenate with bag and mask Provide free-flow oxygen during procedure. Oxygenate after intubation with bag and tube. Be quick and gentle during the procedure.
Pneumothorax	Overventilation of one lung due to tube in right main bronchus or excessive ventilation pressures	Place the tube correctly. Use appropriate ventilating Pressures. Consider transillumination or needle aspiration if pneumothorax is suspected
Contusions or lacerations of tongue, gums or airway	Rough handling of laryngoscope or tube. Inappropriate "rocking" rather than lifting of laryngoscope Laryngoscope blade too long or too short.	Obtain additional practice/ skill Select appropriate equipment
Perforation of trachea or esophagus	Too vigorous insertion of tube	Handle tube gently
Obstructed endotracheal tube	Kink in tube or tube obstructed	Try to suction the ET tube with an appropriate size suction catheter
Infection	Introduction of organisms via hands or equipment	Pay careful attention to clean/sterile technique

Summary: Lesson 5

- A person experienced in endotracheal intubation should be available to assist every delivery.
- Indications for endotracheal intubation include the following:
  - Ineffective ventilation
  - Prolonged ventilation
  - Better coordination between chest compressions and bag and mask ventilation
  - To administer drugs
  - To provide positive pressure ventilation in cases with suspected diaphragmatic hernia
- The laryngoscope is always held in the operator's left hand.
- The correct-size laryngoscope blade for a term newborn is No. 1. The correct-size blade for a preterm newborn is No. 0.
- Choice of proper endotracheal tube size is based on weight or gestational age.
- The intubation procedure ideally should be completed within 30 seconds. The steps for intubating a newborn are as follows:
  - Stabilize the newborn's head in the "sniffing" position. Deliver free-flow oxygen during procedure.
  - Slide laryngoscope over the right side of the tongue, pushing the tongue to the left side of the mouth, and advancing the blade until the tip lies just beyond the base of the tongue.
  - Lift the blade slightly. Raise the entire blade, not just the tip.
  - Look for landmarks. Vocal cords should appear as vertical stripes on each side of the glottis or as an inverted letter "V". Suction, if necessary, for visualization.
  - Insert the tube into the right side of the mouth with the curve of the tube lying in the horizontal plane.
  - If the cords are closed, wait for them to open. Insert the tip of the endotracheal tube until the vocal cord guide is at the level of the cords.
  - Hold the tube firmly against the baby's palate while removing the laryngoscope.
- Correct placement of the endotracheal tube is indicated by:
  - Improved vital signs (heart rate & color)
  - Breath sounds heard over both lung fields but decreased or absent sound over the stomach
  - No gastric distention with ventilation
  - Vapor seen in the tube during exhalation
  - Chest movement is visible with each breath
  - Measurement of depth of insertion includes:
    - Tip-to-lip measurement (add 6 to newborn's weight in kilograms) or use NTL length +1 or use the gestational age method
    - Direct visualization of the tube passing between the vocal cords

Lesson 6
MEDICATIONS

Learning Objectives

In this lesson you will learn:

- What medications to be given during resuscitation
- When to give medications during resuscitation
- How to give medications during resuscitation
- How to insert an umbilical venous catheter
- How to administer epinephrine
- When and how to administer fluids intravenously to expand blood volume during resuscitation

The following case scenario will illustrate how medications may be used during resuscitation. Imagine yourself as a part of the team as you read through the case. The details of how to administer medications will be described later in this lesson.

Case Scenario 5:

A woman with term pregnancy was admitted to the delivery ward in early labor with profuse vaginal bleeding. A diagnosis of placental abruption is made. Fetal heart rate tracings show late deceleration. The obstetric team decides to deliver the fetus by emergency cesarean section and notifies the pediatric team. The radiant warmer was turned on and resuscitation equipment checked (including medications and umbilical vascular catheters) before the delivery. A limp and apneic baby, weighing about 3 kg was delivered; the baby was immediately transferred by the resuscitation team under the radiant warmer. The baby was positioned, suctioned, dried and stimulated by rubbing the back. But, the baby was still limp, apneic and cyanotic. Positive pressure ventilation with bag and mask using room air was initiated. Another member checked the heart rate. After 5 breaths the baby had a heart rate below 60 bpm. The care provider performing PPV checked the mask for its seal, ensured that the head is positioned properly, if the airway was clear, and the chest was rising with each breath. Despite these steps after 30 seconds of effective ventilation the baby's heart rate was below 60 bpm, so 100% oxygen was added to PPV and the second team member begins chest compressions coordinated with PPV using 3:1 ratio of compressions to ventilation. After another 60 seconds, the baby's heart rate has not increased. The baby is intubated and 1.5 mL of 1: 10,000 epinephrine is instilled into the endotracheal tube while another member of the team prepares to insert an umbilical venous line. Coordinated PPV and chest compressions are continued while monitoring the heart rate every 60 seconds. At 5 minutes the umbilical venous catheter has been inserted and checked to be in place by observing free flow of blood on aspiration. The heart rate is undetectable and the baby is pale. A dose of 0.6 mL of 1: 10,000 epinephrine is given as a rapid bolus into the umbilical catheter as PPV and chest compressions are continued. Heart sounds become audible, but the HR is still below 60 bpm after 1 minute. Because of persistent bradycardia and possible blood loss due to maternal bleeding, 30 mL of normal saline is given via the umbilical catheter. The heart rate gradually increased. At 8 minutes the baby makes its initial gasp and the heart rate is

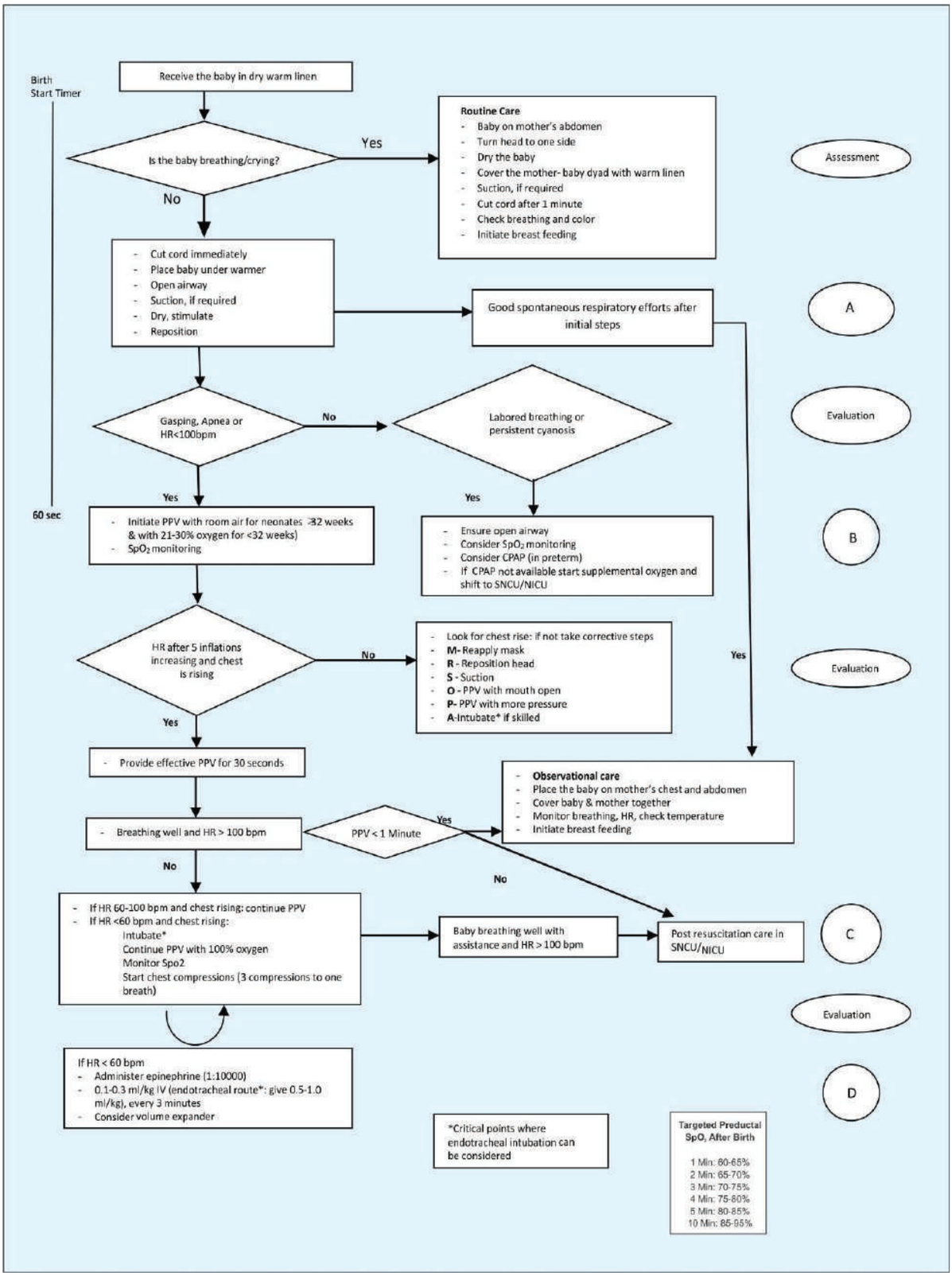
over 60 bpm. Chest compression is stopped but PPV is continued. The heart rate rises to over 100 bpm and color improves and the baby begins to breathe spontaneously. Now, the PPV is gradually stopped. The baby was then shifted to the SNCU/NICU for post-resuscitation care.

When to give Medications during resuscitation?

Most newborns requiring resuscitation will improve without the need for medications if timely and effective resuscitation steps are carried out. Fewer than 2 per 1000 births would need medication during resuscitation. Before administering medications, one should check the effectiveness of ventilation several times, ensuring good chest movement and audible bilateral breath sounds with each breath, and providing 100% oxygen for positive-pressure ventilation. Ideally an endotracheal tube should be put in place to ensure a good airway and effective coordination of chest compressions and positive- pressure ventilation.

If the heart rate remains below 60 bpm despite administration of 60 seconds of coordinated ventilation and chest compressions, one should ensure that ventilation and compressions are being given optimally and 100% oxygen is being used. If still the heart rate is low, consider use of medications.

Resuscitation Flow Diagram (NRP-India)



How do you establish intravenous access during resuscitation of a newborn?

The umbilical vein is the quickest venous access for neonatal resuscitation. If the need for epinephrine is anticipated you need an additional member in the resuscitation team, who is competent to insert an umbilical venous catheter, while others continue with PPV and chest compressions.

Steps of Umbilical venous catheterization

1. Clean the cord with an antiseptic solution. Place a loose tie of umbilical tape/sterile thread around the base of the cord. This tie can be tightened if there is excessive bleeding after you cut the cord.
2. Pre-fill a 3.5F or 5F umbilical catheter with normal saline using a 2 mL syringe connected to a stopcock. The catheter should have a single end-hole. Close the stopcock to the catheter to prevent fluid loss and air entry.
3. Using sterile technique cut the cord with a scalpel below the clamp and about 1 to 2 cm from the skin line. Make the cut perpendicular rather than at an angle.
4. Locate the umbilical vein: It is seen as a large, thin-walled structure, usually at the 11 to 12 o'clock position. The 2 umbilical arteries have thicker walls and usually lie close together somewhere at the 4 to 8 o'clock position. However, the arteries coil within the cord. Therefore, longer the cord stump below your cut, the greater the likelihood that the vessels will not lie in the position described.
5. Insert the catheter into the umbilical vein (Figure 6.1). The course of the vein will be up, toward the heart, so this is the direction you should point the catheter. Continue inserting the catheter 2 to 4 cm (less in preterm babies) until you get free flow of blood when you open the stopcock attached to the syringe and gently aspirate. For emergency use during resuscitation, the tip of the catheter should be located only a short distance into the vein– only to the point at which the blood can be aspirated. If the catheter is inserted further, there is a risk of infusing solution into the liver and possibly causing damage to the liver.
6. Inject the appropriate dose of epinephrine or volume expander followed by 3 mL of normal saline flush to clear the drug from the catheter into the baby.

Once the baby has been fully resuscitated, either suture the catheter in place or remove the catheter, tighten the cord tie, and complete the knot to prevent bleeding from the umbilical stump. Do not advance the catheter once the sterile field has been violated.

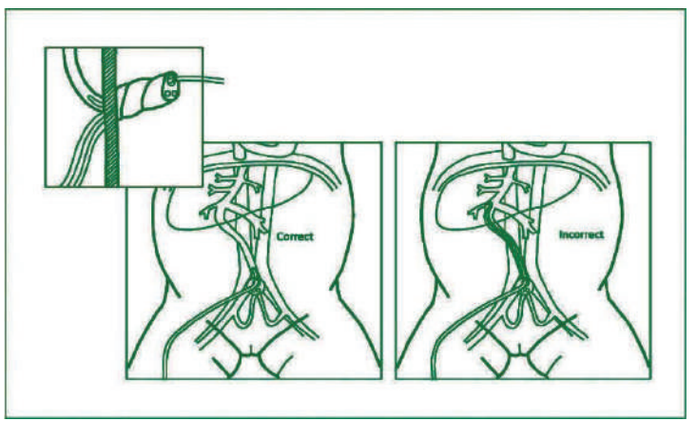


Fig. 6.1: Correct (left) and incorrect (right) placement of umbilical venous catheter

What medication to use and why?

Epinephrine is the most effective medication used during resuscitation. Babies who have a heart rate of less than 60 bpm despite adequate resuscitation with PPV and chest compressions for 60 seconds are likely to have low cardiac output. This is insufficient to meet the oxygen requirement of vital organs. Epinephrine improves cardiac contractility, thus increasing cardiac output which improves blood supply and oxygen to vital organs.

Epinephrine is not indicated before you have established adequate ventilation.

Epinephrine will increase workload and oxygen consumption of the heart muscle, which, in the absence of available oxygen, may cause unnecessary myocardial damage.

Table 6.1: Drugs in newborn resuscitation

	Epinephrine	Normal Saline
When	HR < 60 bpm despite ongoing chest compressions with ventilation	No response to resuscitation, signs of shock and h/s/o blood loss
Route	IV, ET, IO	IV, IO
Dose	0.1-0.3 cc/kg iv, 0.5 – 1cc/kg ET, 1:10,000	10 cc/kg
Rate	Quickly	Over 5-10 min

How to prepare epinephrine?

Epinephrine is available as 1ml ampoule of 1:1,000 concentration, however for neonates, take one ml of 1:1000 solution and add 9 ml of normal saline. This makes 10 ml of 1:10,000 concentration.

How to administer epinephrine?

Epinephrine should be given intravenously. If there is a delay in placement of intravenous access, the endotracheal route may be used to administer the drug. But the endotracheal route results in lower and unpredictable blood levels that may not be effective. Some clinicians may choose to give a dose of endotracheal epinephrine while venous access is being established.

Table 6.2: Dose of Epinephrine

Approximate weight	Epinephrine (1:10,000)	
	IV	**ET**
1kg	0.2 ml	1 ml
2 kg	0.4 ml	2 ml
3 kg	0.6 ml	3 ml
4 kg	0.8 ml	4 ml

What is the dose of epinephrine during neonatal resuscitation?

The recommended intravenous dose in newborns (Table 6.2) is 0.1 to 0.3 mL/kg of a 1: 10,000 solution (equal to 0.01 to 0.03 mg/kg). You will need to estimate the baby's weight after birth. In the past, higher intravenous doses had been suggested for adults and older children when they did not respond to a lower dose. However, there is no evidence that this results in a better outcome and there is some evidence that higher doses in babies may result in brain and heart damage.

Animal and adult human studies demonstrate that, when given via the trachea, significantly higher doses of epinephrine than the intravenous doses are required to show a positive effect. If you decide to give a dose endotracheally while intravenous access is being obtained, consider giving a higher dose (0.5 to 1 mL/kg of 1:10,000 epinephrine) (Table 6.2) by endotracheal route. However, the safety of these higher tracheal doses has not been studied. **Do not give high doses intravenously.**

While giving epinephrine by endotracheal tube, be sure to give the drug directly into the tube, be careful not to leave the drug deposited in the endotracheal tube connector or along the walls

of the tube. Some people prefer to use a catheter to give the drug deeply into the tube. Because you will need to give a higher dose endotracheally, you will be giving a relatively large volume of fluid into the endotracheal tube (upto 1mL/kg). You should follow the drug with several positive- pressure breaths to distribute the drug throughout the lungs for absorption.

Table 6.3: Epinephrine Routes

	IV	ET
Choice	Preferred	If no vascular access
Concentration	1: 10,000	1: 10,000
Dose	0.1-0.3 mL/kg	0.5-1 mL/kg
Post dosing	Flush with NS	No flush
Repeat dose	• Every 3-5 min • Immediately after iv access (not to wait for 3- 5 min, if first dose is given by ET tube)	Not recommended

When the drug is given intravenously through a umbilical venous catheter, you should follow the drug with a 3mL flush of normal saline to be sure that the drug has reached the blood.

How should you give epinephrine during neonatal resuscitation?

Administer epinephrine rapidly - as quickly as possible.

What is the expected response after giving Epinephrine?

Check the baby's heart rate 60 seconds after administering epinephrine. As you continue positive-pressure ventilation and chest compressions, the heart rate should increase to more than 60 bpm within 60 seconds after

you give epinephrine. If this does not happen, you can repeat the dose every 3 to 5 minutes. **However, any repeat doses should be given intravenously if possible.** In addition, ensure that:

- There is a good air exchange as evidenced by adequate chest movement and presence of bilateral breath sounds.
- Chest compressions are given to a depth of one third the AP diameter of the chest and are well coordinated with ventilation.

Strongly consider placement of an endotracheal tube, if not done earlier. Once in place, ensure that the tube remains in the trachea during cardiopulmonary resuscitation activities. If the baby is pale and there is evidence of blood loss, and there is a poor response to resuscitation, you should consider the possibility of volume loss.

What should you do if the baby is in shock, there is evidence of blood loss, and the baby is responding poorly to resuscitation?

Babies in shock appear pale, have delayed capillary refill and weak pulses. They may have a persistently low heart rate, and circulatory status often does not improve in response to effective ventilation, chest compressions, and epinephrine.

If the baby appears to be in shock and is not responding to resuscitation, administration of a volume expander may be indicated.

What can you give to expand blood volume? How much and how to give it?

The recommended solution for treating hypovolemia is an isotonic crystalloid solution. Acceptable solution is 0.9% NaCl ("Normal saline").

O Rh-negative packed red blood cells should be considered as a part of volume replacement when severe fetal anemia is documented or expected. If timely diagnosis permits, the donor unit can be cross-matched with the mother who would be the source of any problematic antibody. Otherwise, emergency-release of O-Rh negative packed cells may be necessary.

What is the dose of volume expander?

The initial dose is 10 mL/kg. However, if the baby shows minimal improvement after the first dose, you may need to give another dose of 10 mL/kg. In an unusual case of large blood loss additional dose might be considered.

How to give volume expander?

A volume expander must be given into the vascular system. The umbilical vein is usually the most accessible vein in a newborn, although other routes (intraosseous) can be used. If hypovolemia is suspected, fill a large syringe with normal saline and give it via umbilical venous route while the other members of the team continue resuscitation.

How rapidly to give volume expander?

Acute hypovolemia, resulting in a need for resuscitation should be corrected fairly quickly, although some clinicians are concerned that rapid administration in a newborn may result in intracranial hemorrhage, particularly in preterm infants. No clinical trials have been conducted to define an optimum rate, but a steady infusion rate over 5 to 10 minutes is reasonable.

What should you do if there is still no improvement?

If the baby has been severely compromised and all resuscitation efforts have gone smoothly, you should have reached the point of giving epinephrine relatively quickly. By this time, you have performed these 4 steps in the following order:

- Assessment and initial steps
- Positive-pressure ventilation
- Positive-pressure ventilation and chest compressions
- Positive-pressure ventilation, chest compressions and epinephrine

Endotracheal intubation should preferably have been performed. You would have checked the efficacy of each of the steps, and you would have considered the possibility of hypovolemia. If the heart rate is detectable but remains below 60 beats per minute, it is still likely that the baby will respond to resuscitation, unless the baby is either extremely immature or has a lethal congenital malformation. If you are certain that effective ventilation, chest compressions, and medications are being provided, you might then consider mechanical causes of poor response, such as an airway malformation, pneumothorax, diaphragmatic hernia, or congenital heart disease. If the heart rate is absent, or no progress is being made in certain conditions, such as extreme prematurity, it may be appropriate to discontinue resuscitative efforts. You should be confident that effective resuscitative measures have been provided for a minimum of 20 minutes and there has been no response to resuscitation and the APGAR score remains 0 even at 20 minutes, before considering a decision to stop or withdraw the resuscitation process.

Summary: Lesson 6

- Epinephrine, a cardiac stimulant, is indicated when the heart rate remains below 60 beats per minute, despite 60 seconds of coordinated chest compressions and ventilation.
- Recommended epinephrine concentration: 1:10,000 (0.1 mg/mL)
- Route: Intravenous or endotracheal.
- Endotracheal administration may be considered while intravenous access is being established. Dose: 0.1 to 0.3 mL/kg intravenously (consider higher dose, 0.5 to 1mL/kg, for endotracheal route only).
- Preparation: 1:10,000 solution
- Rate: Rapidly-as quickly as possible
- Epinephrine should be given by umbilical vein. The endotracheal route is often faster and more accessible than placing an umbilical catheter, but is associated with unreliable absorption and may not be as effective as the intravenous route.
- Indications for volume expander include:
    - Baby who is not responding to resuscitation

AND

Baby appears in shock (pale color, weak pulses, persistently low heart rate, no improvement in circulatory status despite resuscitation efforts

AND

There is a history of a condition associated with fetal blood loss (e.g., extensive vaginal bleeding, abruptio placentae, placenta previa, twin-to-twin transfusion, etc.).

- Recommended volume expander:
  Solution: Normal saline, or O-Rh negative blood.
  Dose: 10 mL/kg
  Route: Umbilical vein
  Preparation: Correct volume drawn into a large syringe
  Rate: Over 5 to 10 minutes

RESUSCITATION OF PRETERM BABY

Birth of a preterm neonates poses additional challenges that makes the transition to extra- uterine life more difficult. Generally, the degree of prematurity determines the extent of support required to achieve this transition smoothly. Preterm neonates need additional resuscitative measures due to the presence of large body surface area, immature organ system, fragile brain capillaries, weak chest muscles coupled with immature lungs and a frail immune system. Special skills including gentle handling are required to prevent neurologic injury and heat loss, optimize oxygenation, provide respiratory support and prevent infection during resuscitation of these vulnerable neonates.

Problems associated with a preterm neonate in the delivery room	
Problem	**Contributing factors**
Hypothermia	Less subcutaneous brown fat, thin skin, large surface area relative to body mass, limited thermal response
Asphyxia	Poor respiratory drive, poor muscle tone, immature brain control
Breathing difficulty	Immature & surfactant deficient lungs, weak breathing muscles, immature respiratory drive
Hypovolemia	Smaller blood volume loss can increase the risk of hypovolemia
Hypoglycemia	Limited reserve and immature compensatory mechanism
Sepsis	Immature immune system

Preterm specific resuscitation interventions	
Step	**Intervention**
Thermal Care	• Ensure room is draft free and warm (26°C) • Early skin to skin contact, if breathing well (≥32 weeks) • Maintain temperature between 36.5°C and 37.5°C • Record temperature at the end of resuscitation and on admission • Avoid hyperthermia (>38°C) • Use plastic wrap/food grade bag, if available for neonates <32 weeks
Delayed cord clamping	• Perform cord clamping for all well preterm babies between 1-3 minutes to facilitate placental transfusion
Initial steps	• Place infant under pre heated warmer • Cover the head with a cap • Place the baby in plastic bag/wrap/food grade bag (< 32 weeks) immediately at birth without drying • In case a plastic bag/wrap is used, the entire resuscitation is done with the plastic bag in situ
Respiratory Support	• Avoid routine suction. Use gentle suction • Place a roll below the shoulders to open the airway • Consider delivery room CPAP (PEEP of 5-8) in spontaneously breathing baby with respiratory distress • If fails to initiate spontaneous breathing consider PPV via face mask (PIP of 20-25, PEEP of 5 cm of H2O) • Prefer T piece resuscitator over self-inflating bag to deliver adequate tidal volume • Avoid high tidal volumes • Look for visible chest rise
Oxygen	• Ensure use of air oxygen blender and pulse oximeter • Use room air for ≥ 32 weeks with PPV • Use 21-30% for < 32 weeks with PPV • Place the pulse oximetry probe on the right wrist to titrate oxygen delivery based on targeted oxygen saturation • If blended air and oxygen is not available commence resuscitation with room air in preference to 100% oxygen • Avoid hypoxia and hyperoxia
Chest compression	• Consider use of ECG, if available
Drugs	• Avoid rapid infusions of fluid • Surfactant can be administered in the delivery room to those preterm neonates who had severe RDS, such as severe chest retractions and high FiO_2 requirement
Handling	• Handle gently to prevent neurological injury • Maintain head in neutral position • Avoid head high or head low position
Transport	• Transport incubator for providing warmth • Blended oxygen and saturation monitoring by pulse oximeter should ideally be provided during transport

APPENDIX

PRETEST /POST-TEST

Neonatal Resuscitation

Time: 20 Minutes

Name: **Date:** _____

1. At birth, a baby's strong breathing efforts causes _____ to be absorbed from the lungs and replaced with _____.

2. Mention the question of initial assessment which must be asked for all newborns.

_____

3. What care should be provided to a baby who is breathing/crying at birth?

_____

4. Which of the following are recommended ways of providing tactile stimulation in an attempt to initiate respiration?
   - Squeeze the ribcage
   - Slapping or flicking the soles of feet
   - Rubbing the back
   - Force things on to abdomen
   - Apply a cold compress

5. List the two indications for positive pressure ventilation

_____

_____

6. List in order, the three signs on which an infant' s condition is primarily evaluated

   1.

   2.

   3.

7. When a suction catheter is used to clear the meconium from an oropharynx, the appropriate size of the catheter to be used is _____ to _____ F.

8. By what time should you begin PPV in a baby who has not started breathing or crying after initial steps?
_____

9. When selecting a face mask, make sure that the rim covers the tip of the_____, the_____ and the _ _ _ _but does not cover the eyes.

10. In a 34 week baby, who has not started breathing after initial steps, will you start PPV with room air or with 21-30% oxygen?
_____

11. What is the purpose of using an oxygen reservoir with a self-inflating bag?
_____

12. The rate at which a neonate should be ventilated using bag valve mask device is _____ per minute.

13. What is the maximum permissible suction pressure while suctioning the airway?
_____

14. What type of care is provided to a baby who has received PPV for less than one minute and is now breathing spontaneously? _____

15. You must hold the resuscitation bag so that you can see the newborn's_____and_____ _____.

16. At what pressure should the safety pop off valve give way in bag and mask ventilation?
_____

17. After placing the mask in position and ventilating for 5 breaths, you do not observe any appropriate rise of the chest. What could be the three reasons?
_____
_____
_____

18. The correct depth of chest compression is approximately _____of the anterior- posterior diameter of the chest.

19. The ratio of compression to ventilation is_____ to _____ .

20. At what heart rate should chest compressions be discontinued?
_____per minute.

21. Chest compressions should be accompanied by_____ .

22. The following is the 6 seconds count of heart rate obtained in an infant during resuscitation. What is the Heart Rate per minute?

H.R.in 6 seconds	H.R. per minute 6
6	_____
9	_____
12	_____
14	_____

23. Indicate the correct ET tube size for infants with the following weights.

Weight	Tube size
800 gm	_____
3400gm	_____
1200gm	_____
2500gm	_____

24. If the baby is pale, there is evidence of blood loss and resuscitation is not resulting in improvement, you should consider giving _____ml/kg of _____ by_____route.

25. After one minute of well-coordinated chest compressions and ventilation, the baby's heart rate is less than 60 beats per minute. You should now give_____ by the most quickly accessible route while continuing chest compressions and _____.

26. During endotracheal intubation what is the maximum permissible time for successfully carrying out endotracheal intubation?_____ .

27. If you have not completed endotracheal intubation in the prescribed time limit, what should you do?
_____.

28. The blade of a laryngoscope for preterm newborn should be No. _____ . The blade for term newborns should be _____.

29. During Positive Pressure Ventilation with chest compressions, the rate of 'events per Minute' should be _____events per minute.

30. What concentration of pinephrine is recommended for neonatal resuscitation?
_____.

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