CHAPTER 7

AN INTRODUCTION TO NEONATAL RESUSCITATION

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Introduction

Worldwide, an estimated 140 million neonates are delivered yearly. Most of these births are in developing countries where deliveries occur mostly outside the hospital. In Nigeria, with only about 58% of pregnant women attending antenatal clinic and much less (35%) delivering in orthodox medical facilities, majority of births occur at home or at traditional birth places without skilled assistants. These situations result in the high neonatal mortality from perinatal asphyxia as usually seen in developing countries[1].

Apnoea and breathing problems in the neonate are common and can result from a variety of causes. Acquisition of resuscitation skills is therefore essential not only for perinatal care providers at delivery but for all health care workers caring for infants in the neonatal period. This is because asphyxia in the newborn contributes about 28% of neonatal mortality[2] and survivors sometimes have serious sequelae such as cerebral palsy and mental retardation[3]. Neonatal resuscitation aims at preventing these avoidable mishaps.

Physiological Changes during Transition from Intrauterine To Extrauterine Life

Effective resuscitation of the neonate follows the same sequence of resuscitation as for an older child or adult: as A—Airways, B—Breathing, C – Circulation and D – Drug.

However, some simple interventions at every one of these stages make significant impact for survival of the newborn. In order to appreciate these differences and effectively perform neonatal resuscitation, the anatomical differences and substantial physiologic changes which occur in the transition from fetal to extra-uterine life have to be understood.

These include:

- switching from dependence on the placenta to dependence on the lungs for gas exchange.
- change from fluid-filled to air-filled lungs.
- dramatic increase in the blood flow to the lungs.
- reversal and closure of intra and extra cardiac shunts with increase in systemic circulation.

Before delivery, the lungs of the fetus are expanded in utero not with air but with fluid. The pulmonary and alveolar vessels are markedly constricted, partly due to the low partial pressure of oxygen (paO_2) in the fetus. Most of the blood coming from the heart to the lungs, through the pulmonary artery is shunted via the ductus arteriosus to the aorta because of the increased resistance to flow in the constricted blood vessels of the fetal lungs.

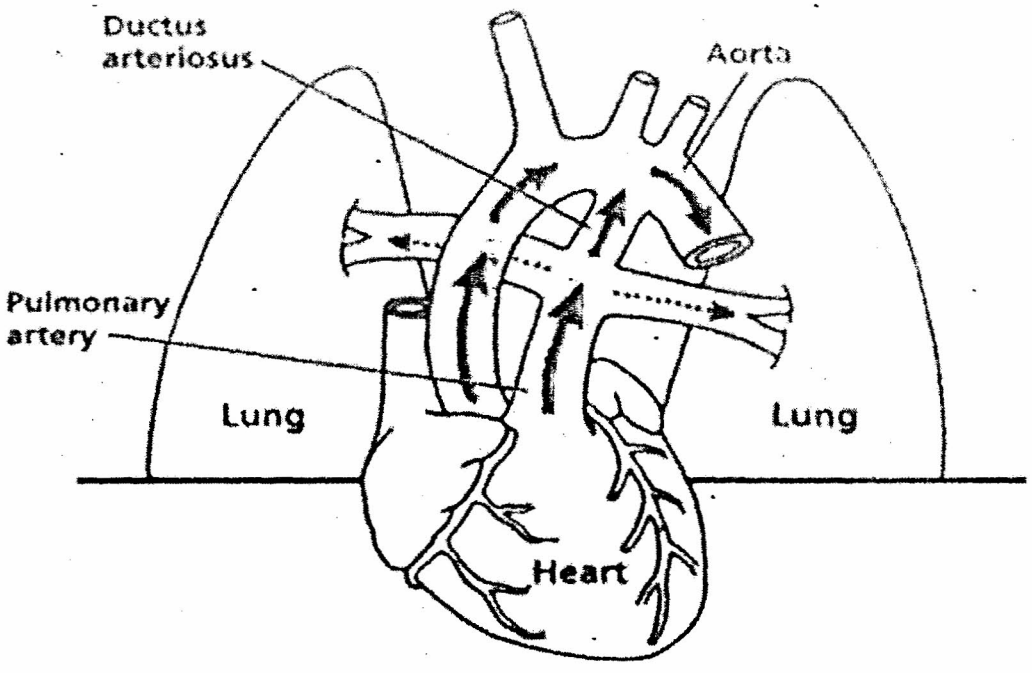


Figure 7.1. Fetal Circulation

Thus, in the fetus, gas exchange does not take place in the lungs but in the placenta.

After a normal birth, the connection to the placenta is severed; and at the first **few breaths, the fluid in the alveoli is** absorbed into the lung lymphatics and replaced by air. The oxygen content causes increase in p_aO_2 which results in the dilatation of the pulmonary arterioles and decreased resistance to blood flow. With increased blood flow, oxygen is absorbed into the blood and taken in the circulation throughout the body of the newborn.

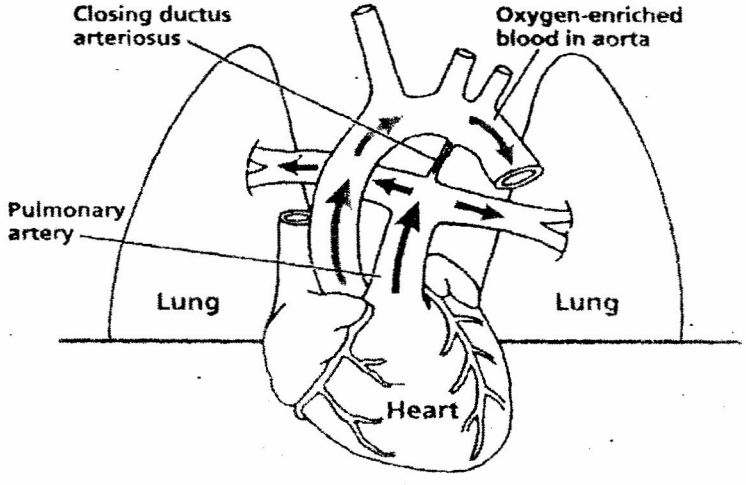


Figure 7.2: Closure of ductus arteriosus and preferential flow of blood to the lungs

Clamping of the umbilical cord closes the umbilical arteries and vein causing increased systemic blood pressure. This, together with decreased resistance to blood flow in the lungs, results in a dramatic increase in pulmonary blood flow and reduced flow through the ductus arteriosus. Subsequent termination of the right to left shunts of the fetal circulation completes the transition to extra-uterine circulation.

Abnormal Physiological Events at Birth

The asphyxiated newborn infant undergoes an abnormal transition. This could result from:

- inadequate ventilation e.g. meconium could block air passage
- systemic hypotension from haemorrhage in the mother or hypoxia in the neonate leading to poor cardiac contractility or bradycardia and low blood pressure.
- persistent pulmonary hypertension of the newborn (PPHN) if the pulmonary arterioles remain constricted because of complete or partial failure of gaseous distension of the lungs.

When an infant is compromised in any of these ways, there is an initial rapid attempt to breathe followed by primary apnoea. At this stage, spontaneous breathing can be induced by appropriate sensory stimuli such as rubbing the back or tapping the feet. If there is no intervention and the insult persists, there begins a period of deep gasping and irregular breathing, followed by a period of secondary apnoea during which spontaneous respiration cannot be induced by sensory stimuli, and can only be reversed by vigorous adequate ventilatory support within minutes otherwise death ensures.

As one can never be certain if a compromised infant is in primary or secondary apnoea, all apnoeic newborn should be resuscitated to ensure that the lungs are adequately ventilated. If Pha infant deteriorates to the stage of secondary apnoea, the blood pressure begins to drop as well, and resuscitation becomes more challenging.

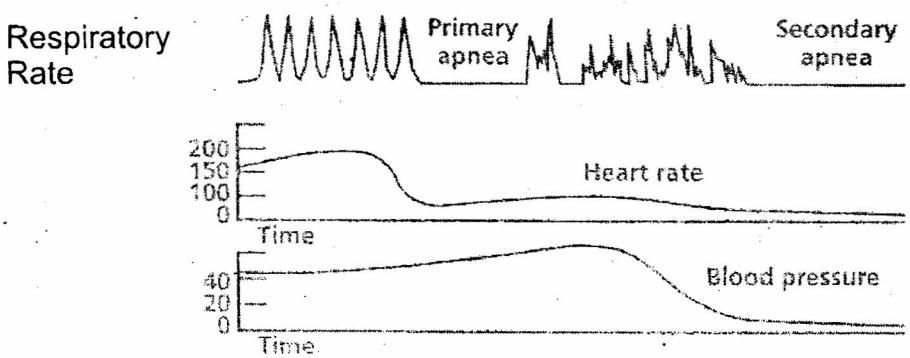


Figure 7.3: Heart rate and blood pressure changes during apnea

In most centers, because there are no monitors it is not possible to measure blood pressure of the neonate during resuscitation. The rational thing to do is ventilate the lungs to reverse the situation and not waste time determining if the baby is in primary or secondary apnoea. Once a baby does not respond to tactile stimulation, resuscitative measures should proceed promptly with positive pressure ventilation using the ambu bag. The longer a baby stays asphyxiated, the longer she will take to respond to resuscitation. An asphyxiated baby will have slow respiration, cyanosis, bradycardia and would be limp because of hypoxia.

Preparation for Newborn Resuscitation

In developing countries or resource poor settings, hospital equipment are often grossly inadequate for advanced or complete resuscitation of the newborn. It is therefore pertinent that all facilities taking deliveries should have both remote (or long term plans) and immediate preparations for deliveries. The use of protocols should also be instituted. These preparations include:

*Personnel**

Regular training and retraining of staff caring for the newborn infant.

At every birth, there should essentially be at least one skilled personnel able to perform positive pressure ventilation, and assist with chest compression, should such intervention be needed. If complete resuscitation with endotracheal intubation and medication are required, two or more persons are needed. Response to a call for help should be pre-planned and close by. While working as a team, each person has an assigned role and the most senior person coordinates the resuscitative process and one person must keep a timed record of the whole procedure from the moment of birth, including the administration of drugs and the response of the baby. There is need for effective and good communication among team members while maintaining professional behavior for success of the resuscitation process.

Environment

Ensure a warm and draft-free delivery room with a separate space available within the room for ventilation of the baby. If a resuscitaire or infant warmer is not available, then provide

- A firm surface to resuscitate the infant.
- Light and heat source with overhead lamps or fluorescent bulbs and clean linen or towels.
- Suction machine – electrical or mechanical and oxygen source dedicated to the baby

***Training of trainers on neonatal resuscitation NRT based on the NRP Course in Neonatal Resuscitation Textbook, American Academy of Pediatrics and American Heart Association[4,5]. It is taught annually as a pre-conference workshop by the Paediatric Association of Nigeria, (PAN) supported by The Latter Day Saints Charities of Salt Lake City USA.**

Some tertiary institutions also give provider trainings on a regular basis.

Communication

Communication is essential for successful resuscitation

Maternal clinical history should be reviewed with the Anaesthetist and obstetric staff to determine possible risk factors, the fetal condition, and therapies given. High risk deliveries (*appendix I*) should be attended by a paediatrician with training and experience in neonatal resuscitation. Consultations should be prompt. If time permits, a meeting with the family is desirable.

Arrangement for transfer of high risk pregnancy is best before onset of labour, Otherwise, contact should be established with a tertiary Paediatric Hospital if prevalent conditions and time do not allow pre natal transfer. The baby should then be transferred with on going respiratory assistance.

Equipment

Resuscitation equipment should be checked daily and after each usage.

When use is anticipated, recheck oxygen supply and equipment such as: suction machine, positive pressure devices, resuscitation equipment, largyngoscope, and endotracheal tubes. If an infant is expected to be in poor condition, medications should be made readily available and easily accessible. When the baby arrives and needs resuscitation, is not the right time to begin checking supplies and equipment.

Steps in Resuscitating A Newborn Infant.*

As soon as the baby is born, check the time when baby is completely expelled from the mother (birth time). In the first 30 seconds, evaluation and intervention should simultaneously proceed.

The need for resuscitation is assessed by asking 4 basic questions.

- Is the baby a term baby?
- Is amniotic fluid clear?
- Is baby crying or breathing?
- Is muscle tone good?

If the answer to each of these four questions is YES, routine care should be given. If however, the answer is NO to any one of the questions, the **A stage** of the initial steps of resuscitation must commence and be completed within 30seconds **(Figure 7.3).**

Routine Care

This is for the term and vigorous newborn infant and consists of providing

- warmth – skin to skin care with the mother,
- clearing the mouth and nose,
- drying of the skin and
- evaluation of respiration, heart rate (HR) and colour

There is no need for suctioning if baby is crying or breathing spontaneously; and there is no evidence of meconium in the mouth.

Apgar Score

Apgar score consists of the total points assigned to 5 objective signs evaluated

and given a score of 0, 1, or 2 in the newborn. This system of evaluation describes quantitatively, the newborn's overall status and response to resuscitative efforts and is assigned at the end of 1 and 5 minutes. If the score is less than 7 at 5 minutes, another score is assigned at 10 minutes and occasionally at 20 minutes after birth. (*see Appendix 3*). Apgar score should be followed by a description of the events that took place during the resuscitation and interventions performed.

Assessment during resuscitation

The quickest and most accurate evaluation for continuing resuscitation, is using the "HR", "respiration" and "colour". The signs of evaluation and intervention are often simultaneously done and repeated frequently throughout resuscitation. It directs decision on which action or step to take next. A rising heart rate is the most important indicator of successful resuscitative efforts.

Initial Steps AIRWAY

- provide warmth (place on a resuscitaire or warmer).
- position and clear the mouth and nose.
- dry the skin and stimulate the baby,
- Re-position and evaluate respiration, heart rate and colour.

Although these steps are referred to as initial steps, they are maintained throughout the resuscitation process.

Providing warmth:

Positioning is important – slightly extend the neck to bring the posterior pharynx, larynx and trachea in line and allow unrestricted flow of air into the lungs. It is also called the "sniffing" position. Avoid over extension or flexion of the neck. This is particularly important because of the short neck of babies, it may not be immediately obvious and care must be taken to correctly position it

This position may be difficult to keep in a baby with a large occiput from excessive moulding or cephal haematoma. A shoulder roll is used to elevate the ***shoulder*** slightly to enhance the correct position. The shoulder roll is not a pillow and should not be placed under the occiput. It should only be used when indicated.

Clear the Airway

Clear the airway only if necessary. A vigorously crying baby may not require suctioning. If however, secretions are present, suctioning is indicated. Secretions are removed by wiping of the nose and mouth with a towel, or by suctioning with a bulb syringe, mucus extractor or suction catheter. The mouth

should be suctioned first, before the nose to clear fluid that could be aspirated should the baby take a gasp on suctioning of the nose.

Deep continuous and aggressive suctioning especially using a catheter can stimulate the posterior pharynx and produce a vagal response leading to severe bradycardia or apnoea

However, the intervention at this stage is different if meconium is present. Intervention also depends on the infant's level of activity (vigorous or non-vigorous). This has to be determined immediately after birth when the need for resuscitation is assessed using the four basic questions.

Presence of Meconium in a Vigorous Infant

In a Nigerian study[6],the incidence of meconium staining of the amniotic fluid was 20.4% and of these, 15% had meconium aspiration syndrome. An infant delivered with meconium stained liquor, but vigorous at birth has:

- good tone,
- strong respiration effort and
- HR more than 100bpm.

The mouth and nose are cleared of secretions before the baby is dried, and the rest of the initial steps of resuscitation are initiated.

Presence of Meconium in a Non-Vigorous Infant

Aspiration of meconium does not occur with normal fetal breathing movements. It occurs mostly because of accompanying asphyxia, reaching the stage of gasping respirations prior to delivery.

Characteristics of the non-vigorous infant with meconium are:

- Apnoea or poor respiratory effort
- Heart rate less than 100bpm.
-Limp or poor muscle tone

Action

- Avoid stimulating the baby and take it immediately to the resuscitation table.
- Insert a laryngoscope and with a 10F or 12F suction tube clear the mouth and pharynx to visualize the glottis if necessary.
- Intubate within 30 seconds inserting an endotracheal tube connected to a meconium aspirator or a T-piece connector.

Cautionary Note

1. * It must be emphasized that the skill of Neonatal Resuscitation cannot be acquired by just reading up the procedure. Training and practice are required to acquire this lifesaving skill and anyone who is likely to perform this procedure should take advantage of a hands-on practical training.
2. # The current 6th edition of Neonatal Resuscitation Textbook (AHA/AAP)4 , "Is amniotic fluid clear" is not in the initial assessment questions, though it was in previous editions. In Nigeria, meconium stained fluid and meconium aspiration are common causes of morbidity and mortality in infants at birth, thus should remain an early evaluation question[5].

-Apply suction by occluding with a finger or thumb, the meconium aspirator as the endotracheal tube is slowly withdrawn in 3 seconds

Figure 7. 4. Meconium Aspirator

This process can be repeated if necessary, while attention is paid to the respiratory need of the infant and ventilation given in between the endotracheal suctioning. Direct suctioning of the trachea using a suctioning tube without an endotracheal tube or saline lavage is NOT advised.

A recent re-emphasized multicenter trial[7] has shown that intrapartum suctioning of the pharynx (suctioning during delivery while head is in the perineum) has no advantage in reduction of the risk of meconium aspiration syndrome. This procedure is no longer recommended.

Stimulation

Clearing the airway and drying the baby's skin provide enough stimulation most times for baby to initiate breathing. If however there is no response, stimulate by gently slapping or flicking the side of the feet and reposition infant in the sniffing position. The back could also be rubbed.

Hazardous stimulation includes:

- Shaking baby
- Turning baby upside down and slapping baby with body swinging like a pendulum.
- Rubbing skin with methylated spirit or hot water.

Avoid continuous tactile stimulation. If the baby is in secondary apneoa, no amount of stimulation will initiate breathing. Positive Pressure Ventilation is indicated.

On completing each stage of resuscitation, the infant should be reevaluated. This evaluation is done by assessing

- Respiration
- Heart rate
- Oxygenation (colour)

Assessment of Respiration
Look for chest rise. It should be easy, calm and regular.

Assessment of Heart rate
Check for pulsation as the base of the umbilical stump or ausculate the left side of the chest. Count for 6 seconds and multiply by 10 for the heart beat per minute. Or ask an attendant to attach a pulse oximeter probe or cardiac monitor if available.

Assessment of Oxygenation
In assessing oxygenation, colour is often used. This remains for now, the best method of assessing oxygenation in most hospitals in developing countries where pulse oximeters are not available in delivery rooms.
This assessment is done by looking at the central part of the body, the lips and tongue. Acrocyanosis (blue hands and feet only) does not indicate low blood oxygen level. It is most often due to cold and does not require supplemental oxygen administration.

Studies however have shown that the use of skin colour could be subjective and varies with skin pigmentation. It has also been noted that the normal transition from intrauterine state (with a blood oxygen saturation of 60%) to the extra/uterine state (with blood oxygen saturation of >90%) in room air, takes a few minutes in a normal healthy newborn. **(Table 7.1)** It is therefore helpful to use a pulse oximeter for accurate assessment and judicious use of oxygen therapy. This is attached to the right hand for pre-ductal values.

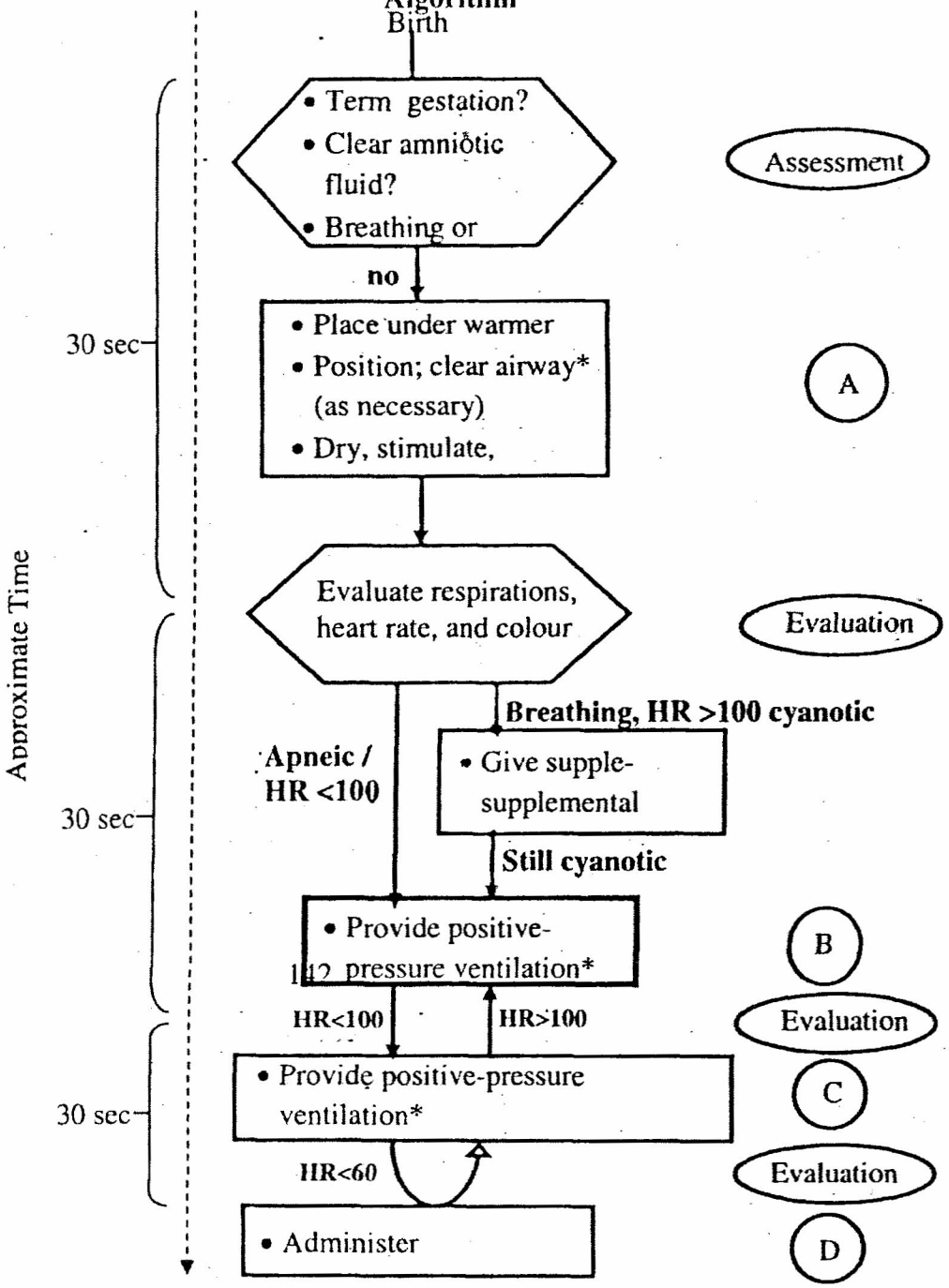
Table 7.1

Saturations in the first 10 minutes of life in a healthy newborn baby

Time from birth	Target saturations during resuscitation
2 minutes	65 - 85%
3 minutes	70 - 90%
4 minutes	75 - 90%
5 minutes	80 - 90%
10 minutes	85 - 90%

Pulse oximetry makes assessment easy and accurate. However, oximeters are not readily found in hospitals in the third world. Besides, an assistant's help is required and it takes about one or two minutes to attach. The sole responsibility of the primary resuscitator should be focused on the process of resuscitating the infant.

Figure 7.5. NEONATAL RESUSCITATION CHART (Modified AHA/AAP NRP Algorithm[5])



* Endotracheal intubation may be considered

BREATHING

Ventilation of the lungs is the most important and the most effective step in neonatal resuscitation.

If the **Airway stage** of resuscitation in the first 30 seconds, does not achieve adequate inflation then **P**ositive **P**ressure **V**entilation is required. **PPV** is undertaken in the next 30 seconds, using the ambu bag and mask. It is provided at the rate of 40-60 inflations per minute. To maintain this rate, the phrase "Breathe – Two – Three" is repeated and the bag squeezed on "Breathe" and released while saying "Two, Three". Each circle should take just less than a second in order to accomplish 40-60 in a minute.

Initially, positive pressure ventilation should be commenced with air (21% oxygen) and supplemental oxygen administration guided by pulse oximetry. Recent studies have revealed that resuscitation of newborn infants with 21% (i.e. room air) is as successful as that with 100% oxygen[8,9].

Regardless of gestation, oxygen saturations that resemble those of healthy term babies should be aimed at. (See Table 7.1) Excessive oxygenation even for brief periods can be harmful to the newborn during and after resuscitation[2].

In order to deliver the exact concentration of oxygen desired on initiating resuscitation, the ambu-bag has to be connected to compressed gas mixture of air and oxygen from a blender through a flow - meter. This can be regulated to supply the required percentage of oxygen at a desired flow rate in keeping with oximetry readings. Oxygen blenders are not readily available in most third world delivery rooms. The pulse oximeter records the saturation of ***haemoglobin with oxygen (SpO_2)*** which differs from the ***partial pressure of oxygen, (paO_2)*** dissolved in plasma, measured by a blood gas analyser.

Without blenders and pulse oximeters, resuscitation can begin cautiously using a self-inflating bag and mask to deliver roughly graded concentration of oxygen needed for resuscitation. When not connected to an oxygen source it can deliver 21% oxygen (i.e. room air) which is enough to start off resuscitation of most of the 10% of babies requiring assistance to breathe at birth. Within seconds if not improving, the bag should be connected to oxygen source but without the reservoir attached. This delivers about 40% oxygen. Subsequently, if required, oxygen reservoir may be connected to deliver about 90-100% oxygen all within the second 30 seconds of the initial steps of resuscitation ending in approximately 60 seconds.

Since with adequate ventilating the baby's heart rate rapidly improves, and colour change follows. The effect of resuscitation efforts can be assessed while evaluating

the heart rate and colour even in the absence of these monitors. Supplemental oxygen is tailed off gradually once the saturations reach 90%. At this point, the normal newborn should be pink all over, have good tone and have a calm regular breathing.
Effective ventilation is confirmed by observing three signs:

- ***Increase in the heart rate to about 100/min***
- ***A slight rise in the chest and upper abdomen with each positive pressure inflation***
- ***Oxygenation improves and colour changes to pink.***

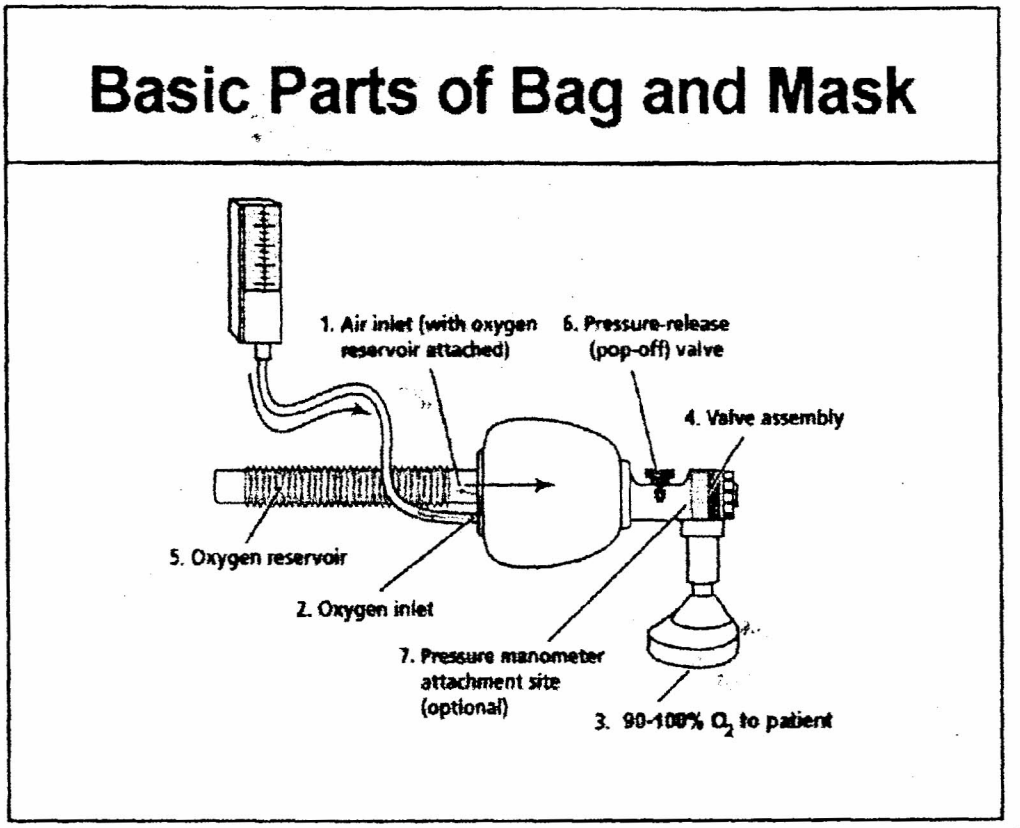
It is pertinent to mention that the skill of ventilating a newborn adequately can only be learnt through training and practice against a sound background knowledge. Critical areas of study include:

- the different types of resuscitation devises available to ventilate newborns.
- the advantages and disadvantages of each assisted ventilation device and their important characteristics and safety features.

All these are fully dealt with in the AAP/AHA Neonatal Resuscitation Textbook[4] which is used in the Paediatric Association of Nigeria, Neonatal Resuscitation Training (PAN,NRT). However, some salient facts will be mentioned here. The most commonly used device is the ***self-inflating bag***. Others are ***flow-inflating*** and the ***T-piece resuscitator.***

T-piece resuscitator
The T-piece resuscitator is very similar to the flow-inflating bag but has an added advantage of being mechanically controlled providing a more consistent pressure with each breath. It delivers the breath by simply occluding and opening a cap above the mask with a finger or instead of squeezing, a thumb.

Figure 7.6 Self inflating Bag and Mask[10]



- Readily available at delivery room
- Completely re-inflates when squeezed.
- Does not require compressed gas to function
- Requires a good seal between mask and face.
- Cannot be used to deliver free-flow oxygen (supplementary oxygen) as bag must be squeezed for oxygen delivery.
- Will require to have an oxygen reservoir attached in order to deliver 100% oxygen.

-A self inflating bag should have a safety pressure pop-off valve or attachment for a manometer which measures the pressure being delivered.

Flow-inflating bag

- Also known as the anesthetic bag.
- Bag will not inflate without a firm seal on the patient face.

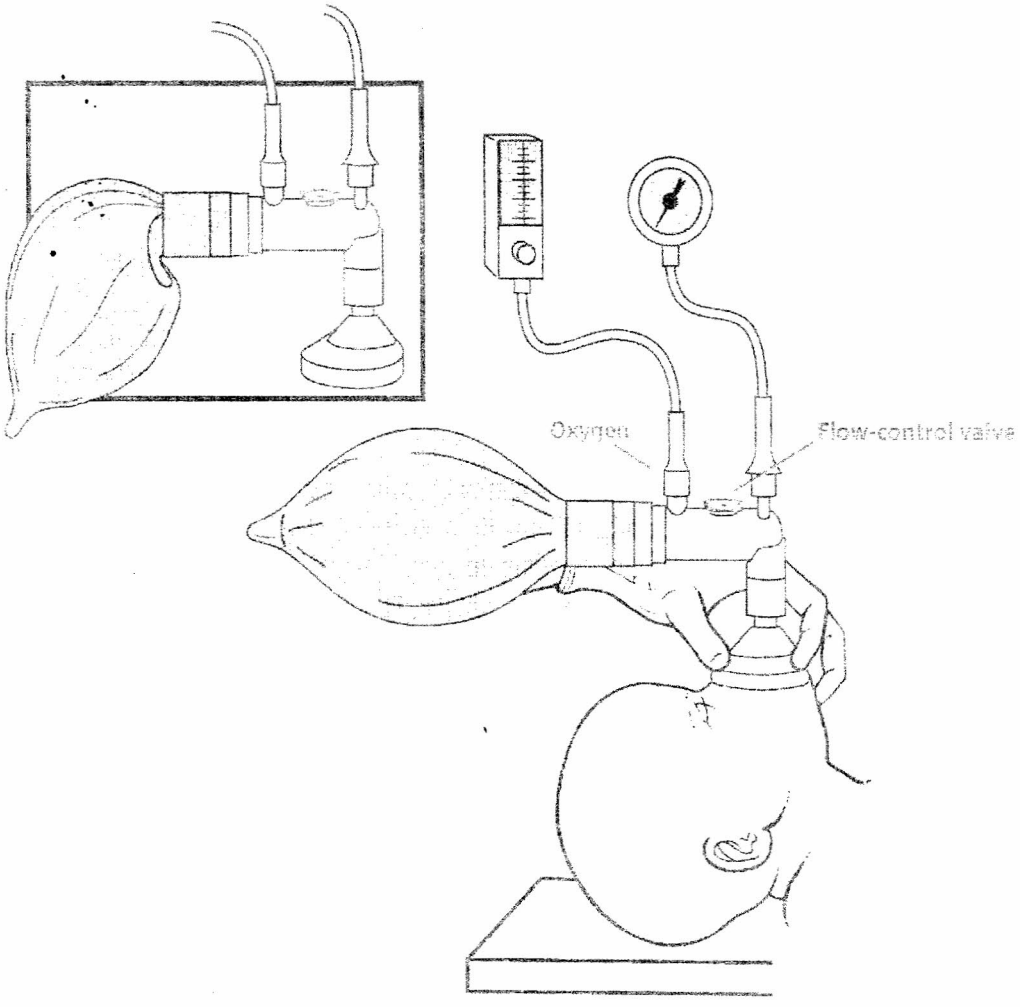


Figure 7.7. Flow-inflating bag and mask or Anaesthetic Bag[4]

-Can deliver free-flow oxygen at 100% concentration.

-It requires compressed gas source to inflate.

How to perform Positive Pressure Ventilation

1. Assemble all the equipment needed in sequence of their use after checking that each is functioning well.
2. Call for help
3. Select the appropriate size mask. Size 0 (preterm) and Size 1(full term)
4. Apply the appropriate mask to the appropriate sized bag. 200-750ml average 500ml (neonate)
5. Clear the airway by suctioning.
6. Position the baby's head in "sniffing position"
7. The attending staff positions self at the head of the baby or right side so the chest rise can be visually monitored.
8. Initiate PPV with inspiration pressure of about 20cm water and at the rate of 40 – 60 breaths per minute repeating the phrase 'breathe' 'two, three'.
9. An assistant connects pulse oximeter to baby's right wrist or hand (hypothenar).
10. While this is happening continue ventilation with room-air for term infant (or for a preterm initiate with a higher oxygen concentration (40%). By connecting to oxygen without the oxygen reservoir attached).
11. If no visual signs of improvement, (colour and chest rise) within the first 5 to 10 breath, check heart rate. Initiate steps to correct ventilation failure (see table 2) and continue ventilation for a total of 30 seconds then evaluate this **Breathing stage** If no improvement despite 30 seconds of effective PPV, initiate chest compressions and give 100% oxygen.
12. If baby is still deteriorating, decompress the stomach by passing an oro-gastic tube using an 8F feeding tube and a 20ml syringe to deflate it. Leave tube in place open ended to allow degassing the stomach with continuing ventilation. Assess infant

Table 7.2. Possible Reasons for failure of ventilation.

Problem	Solution
Poor seal between mask and face	- Reapply the mask and lift jaw a little or more pressure on the rim of the mask.
Blocked airway	- Reposition the baby's head in sniffing position - Suction the mouth and nose if necessary - Ventilate with baby's mouth slightly opened
Inadequate pressure is exerted.	- Increase to 30cm water gradually - The pop-off value will release air just below 40cm.
Still poor	- Alternative airway Example endotracheal intubation or laryngeal mask.

The majority of infants can be managed with positive pressure ventilation via a face mask. With improvement in the infant's condition, the inflation pressures and breath rate can be progressively reduced. If no improvement, endotracheal intubation is indicated.

Endotracheal Intubation

This is performed by the highly skilled and should be quickly carried out by someone with the competence and experience. This prevents unnecessary prolongation which could predispose to asphyxia.

Indications

- When a baby has meconium aspiration, and is limp, not vigorous apneic or with laboured respiration and HR is less than 100bpm (not vigorous), immediate intubation to clear airway is required.
- To augment the effect of positive pressure ventilation (PPV) if not adequate
- When chest compressions are indicated, intubation could enhance ventilation..
- To alleviate upper airway obstruction
- Endotracheal intubation is required for administration of drugs such as surfactant or adrenaline.
- Diaphragmatic hernia.

The various points at which endotracheal intubation can be done are asterisked on the Resuscitation Chart. (See figure 7.5, page 117)

Equipment and Supply needed[4]

Preparation is important for the success of endotracheal intubation. All equipment and supplies for endotracheal intubation should be ready for use and easily be accessible in the delivery room, theatre and labour and laid out on the resucitatation tray when preparing for intubation. (Appendix 7.4, page 134)

Preparing the Equipment Needed for Endotracheal Intubation

1. Laryngoscope

- Choose appropriate size blade Size 0 – Preterm babies Size 1 – Term babies
-Ensure that batteries and bulb are functional and it lights up.Use a straight not curved blade.

2. Endotraheal tube (ETT)

Select the appropriate-sized tube

The infant's weight determines the size of ETT to be selected using the following guide in Table 7.3, which correlates the weight with the inside diameter of the tube and the lip to tip length usually 6cm plus estimated weight of baby in kilograms.

Table 7.3 Endotracheal tube size and lip to tip length according to estimated birth weight and gestational age of infant.

Weight (g)	Gestational Age (wks)	Tube Size (mm) (inside diameter)	Depth of insertion (cm from upper lip)
Below 1,000	Below 28	2.5	7
1,000 - 2,000	28 - 34	3.0	8
2,000 - 3,000	34 - 38	3.5	9
Above 3,000	Above 38	3.5 - 4.0	10

- The endotracheal tube should have uniform diameter throughout its entire length. The ET tube with tapered ends should be avoided.
- ETT with the black line near the tip should be used as this black line guides the depth of insertion and would be left at the level of the vocal cord. In this position, the tip of the ETT lies above the bifurcation of the trachea.

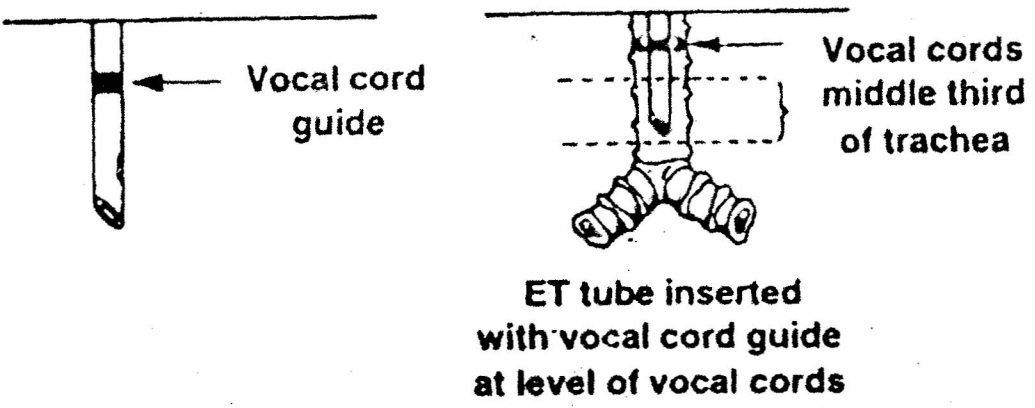


Figure 7.8: Vocal Cord position using the Vocal Cord Guide

Shorten length of ETT to 13cm by cutting it a little diagonally to firmly hold the connector which has to be repositioned to the new 13cm position.

Figure 7.9: Shortening of the Length of the Endotracheal Tube

3. Suction Machine
- Ensure suction machine is functional and connected.
4. Ambu-Bag
- Resuscitator check ambu-bag and ensure it is functioning well.
5. Oxygen Source
- Ensure oxygen supply
6. Strappings
- Cut tape ready for stabilizing
7. Timer and stop clock

How to intubate

The recognition of the anatomic landmarks of the airway is a prerequisite for a successful intubation. This should be reviewed in a standard anatomy book or the text book of Neonatal Resuscitation[6]

Step 1.POSITIONING
Take a position at the head of the baby laid on a flat firm surface. Stabilize the head in a sniffing position for optimal viewing of the glottis. Hold laryngoscope on the left hand while holding the baby's head with the right hand. An Assistant can hold the head in the correct position.

Step 2. INTRODUCING THE LARYNGOSCOPE BLADE.
Open baby's mouth with index finger of the right hand and insert the laryngoscope blade. Slide the laryngoscope blade over the tongue starting from the right side of the tongue towards the middle while the tongue is pushed slightly to the left.
The blade is advanced to the base of the tongue into the pouch between the tongue and the epiglottis (vallecular).

Step 3. *VISUALISING THE GLOTTIS.*
Lift the tongue to expose the pharynx by pulling gently the blade of the laryngoscope away from self in a straight line in the direction of the handle in the left hand.
Avoid moving the handle up and down in a rocking motion. The correct motion is felt on the shoulder and not on the wrist with the pull.

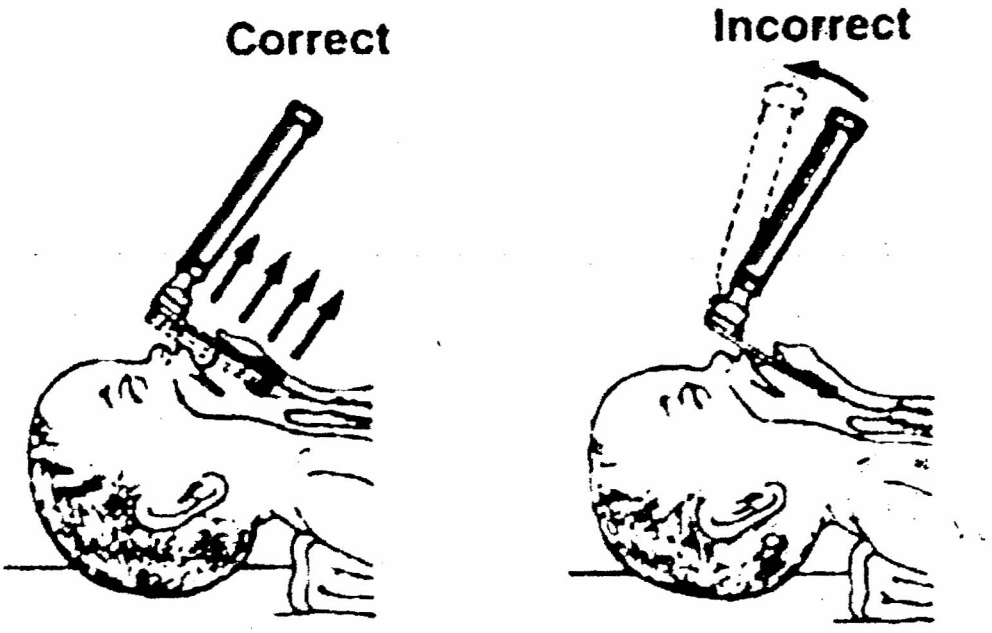


Figure 7.10: Correct and Incorrect Motion of the Laryngoscope Handle
Identify the landmarks before inserting ETT. If properly placed, from top or chin side, the glottis should be seen below the blade, if not visible the blade is pulled out slightly or slide inside a little further. This action should reveal the following anatomy

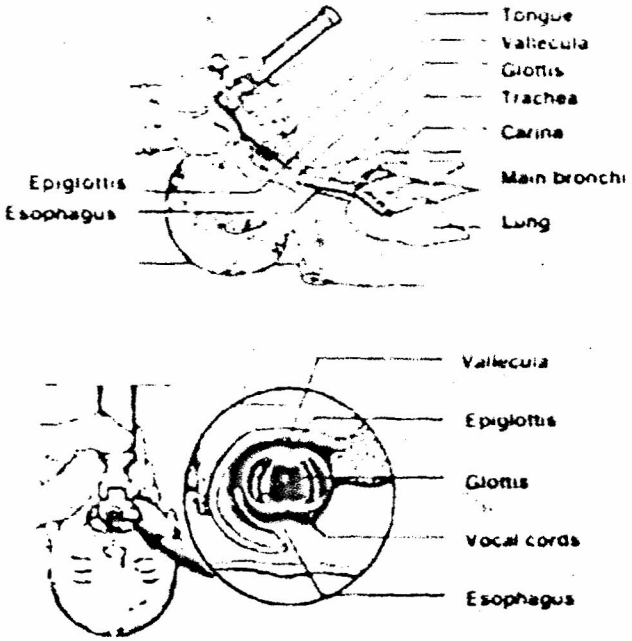


Figure 7.11 and 7.12 Landmarks to be identified prior to endotracheal tube placement
The vocal cord appears as an inverted V with vertical stripes on each side of the glottis.

Step 4. *PLACEMENT OF THE ENDOTRACHEAL TUBE*
The tube is inserted using the right hand to introduce it from the right side of the baby's mouth. If the visualized cords are closed, the tube should not be forced through but a few seconds should be allowed for them to open up before the tube is inserted. The depth of ET tube insertion should be guided by the vocal cord guide taking note of the black line marking on the tube at the level of the tip (see Figure 7.8)

Step 5. *STABILISING THE ENDOTRACHEAL TUBE*
The tube is stabilized by pressing it on the hard palate, firmly but not too tight to occlude airflow while carefully removing the laryngoscope. An Assistant secures the tube as it is attached to either the connector for the Ambu bag to ventilate the baby or to the meconium aspirator, as the condition of the baby dictates. Thus ventilation can continue simultaneously with securing of the tube and yet another assistant if present, evaluates the baby's respiration.

Meconiun aspiration, is achieved by placing a finger over the open end of the meconium aspirator attached to both the ET tube and the suction machine, to generate the suction pressure for the extraction of the meconium while the tube is gradually being withdrawn from the trachea in about three to five seconds only. The whole procedure of intubation and aspiration of meconium occurs so quickly, it should last not more than 30seconds. If no meconium is aspirated, intubation can be repeated

provided baby's condition permits. Otherwise, ventilation should resume before the second attempt.

Signs of Correct Placement of Endotracheal tube.

Bilateral equal breath sounds heard over the chest. Care must however be taken to differentiate breath sounds from the transmitted sounds of the abdomen heard over the infants thin chest wall.

- Rise of the chest with each ventilation.
- Change in colour from cyanosed to pink body.
- Absence of gastric distension.
- Mist in the ET tube.

Possible Complications of Intubation to be avoided

Hypoxia,
Bradycardia
Apnoea
Pneumothorax
Soft tissue injury,
Infection

CIRCULATION

In the majority of infants, establishment of adequate ventilation will restore circulation Failure to initiate spontaneous breathing or heart rate less than 60bpm or presence of persistent cyanosis suggests that myocardial function is depressed and the contractility of the heart too weak to maintain adequate cardiac output. External cardiac massage or cardiac compression is thus indicated.

Chest Compression

This is a rhythmic, sustained compression and relaxation movement of the chest using the thumbs or fingers. It is delivered on the lower third of the sternum to a depth of approximately one third the anterior-posterior diameter of the chest while simultaneously continuing to ventilate the lungs.

Indication:

Heart rate of less than 60bpm despite adequate ventilation with supplementary oxygen for 30 seconds

Effective ventilation must always precede cardiac compressions.

Two persons are needed for the two activities. One ventilation is performed after every third compression of the chest. Count aloud, 'one – and – two – and three – and – breathe' compressing the chest with each count and releasing on every 'and'. Fingers or thumb must be in contact with the chest at all times during both compression and release.

The person ventilating squeezes the bag during "Breathe-and" and releases on "one-and"

One cycle of 3 compressions plus 1ventilation should last 2 seconds. In one minute, approximately 30 breathes is given with 90 compressions.

Competence and mastery is achieved on practicing both the activities of a compressor and a ventilator. Studies have shown that it may take a minute for spontaneous circulation to be achieved following cardiac compression [4]

Any interruption for monitoring of HR could also prolong the time for recovery. It is therefore recommended that a well coordinated chest compression and ventilation be allowed to proceed for 45 to 60 seconds before assessing HR preferably counting from the umbilical stump or reading the HR from the oximeter to avoid interrupting the cardio-pulmonary resuscitation[6]

Chest compression can stop when HR is more than 60 bpm.

Aim for a ratio of approximately 90 chest compressions to 30 breaths per minute (3:1), resulting in a total of 120 events per minute)

Ventilations should be well coordinated with chest compressions. Supplemental oxygen should be increased to 100% when compressions are commenced. Excessive chest movement is a sign of over-inflation which can cause pneumothorax.

The thumb technique is preferred to the two-finger technique. As both thumbs meet over the sternum with the rest of the fingers around the chest wall, the infant is also better supported and the depth of compression is better and consistent

MEDICATIONS[11]

Medications are rarely indicated in Newborn Resuscitation. With effective ventilation and a well coordinated PPV and cardiac compression, the heart rate of the newly born infant should improve. However if despite this it remains low or less than 60bpm, then drugs are indicated.

Adrenaline

Dosage: 0.1 - 0.3 ml/kg of 1 in 10,000 dilution as a quick IV push repeated at 3-5 minute intervals. It should be followed by a small saline flush. The ET dose is 0.5 - 1.0ml/kg 1in 10,000 if no IV access can be secured.

Volume Expansion

In blood loss or shock (pale skin, poor perfusion, weak pulse) Isotonic crystalloid is used. 10 ml/kg of normal saline given over 5 to 10 minutes via the umbilical vein. It may be repeated if necessary. Low birth weight infants should be given more slowly to avoid pulmonary oedema. There may be need to follow

with transfusion using O negative red blood cells if massive blood loss has occured, particularly in babies not responding to resuscitation interventions.

Bicarbonate
This drug is not indicated for routine use in resuscitation.

Naloxone
Post resuscitation use in respiratory depression
Dose 0.1 mg/kg

Route of Delivery

- Umbilical venous catheter is the preferred route. The vein seen in the cross sectional view of the cut umbilical stump as a single slit shaped opening unlike the double well rounded arteries.
- Endotracheal tube is for adrenaline only
- peripheral intravenous line could be difficult to achieve in the collapsed infant
- intraosseous needle for failed or unsuccessful umbilical venous catheterization
- umbilical arterial catheter **should not** be used for drug administration during resuscitation.

Ongoing Care
Post resuscitation, baby would require careful observation and management in a special or intensive care nursery. Close monitoring of the of temperature, cardio-respiratory status, blood glucose and infection risk assessment should form part of the management.

Stopping Resuscitation

If all steps in resuscitation has been taken and still no response, it is reasonable to consider discontinuing after 10minutes of absent heart rate. It is helpful to be able to review events during resuscitation and this is made easier when events are recorded during resuscitation.

Gentleness and consideration of the cultural and religious expectation of the parents are helpful when informing parents. This should not be unnecessarily delayed, and a request for autopsy should be discussed with the parent at the same time in the hope that the institution and the health profession may learn appropriate lessons from the experience.

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APPENDIX 7.1

Equipment check

Oxygen cylinder full Stop clock

Standard Equipment Setup[12]

Radiant warmer, Stethoscope

Oxygen source with warmer and humidifier

Suction source, suction catheter, and meconium "aspirators"

Nasogastric tubes

Apparatus for bag-and-mask ventilation

Ventilation masks

Laryngoscope (handles, No. 00, 0, and 1 blades; batteries)

Endotracheal tubes (2.5, 3.0, 3.5, and 4.0mm)

Drugs

Epinephrine (1:10,000 solution)

Volume expanders (normal saline, Ringer's lactate, 5% albumin, 0-negative whole blood [cross-matched against the mother's blood])

Stop Clock

Syringes, hypodermic needles, and tubes for collection of blood samples

Equipment for umbilical vessel catheterization

Warm blankets

Additional Equipment Setup

All of the above plus the following:

Pressure manometer for use during ventilation

Oxygen blender

Heart rate and blood gas monitoring equipment (neonatal monitors)

Micro-blood gas analysis catheter

Umbilical vessel catcher setup (ready to insert)

Transcutaneous oxygen tension or saturation monitor (or pulse oximeters)

Blood gas laboratory immediately available

Humified gas

APPENDIX 7.2

Risk factors associated with the need for neonatal resuscitation[4]

Antepartum Factors	
Maternal diabetes	Post-term gestation
	Multiple gestation
Gestational hypertension or preeclampsia	Size-dates discrepancy
Chronic hypertension	Drug, therapy, such as magnesium
	Adrenergic agonists
Fetal anemia or isoimmunization	Maternal substance abuse
	Fetal malformation or anomalies
Previous fetal or neonatal death	Diminished fetal activity
Bleeding in second or third trimester	No prenatal care
Maternal infection	Mother older than 35 years
Maternal cardiac, renal, pulmonary, thyroid, or neurologic disease	
Polyhydramnios	
Oligohydramnios	
Premature rupture of membranes	
Fetal hydrops	
Intrapartum Factors	
Emergency cesarean section	Category 2 or 3 fetal heart rate patterns
Forceps or vacuum-assisted delivery	Use of general anesthesia
Breech or other abnormal presentation	Uterine tachysystone with fetal heart rate changes
Premature labour	Narcotics administered to mother within 4 hours of delivery
Precipitous labour	Meconium-stained amniotic fluid
Chorioamnionitis	Prolapsed cord
Prolonged rupture of membranes (>18 hours before delivery)	Abruptio placenta
Prolonged labour (>24 hours)	Placenta previa
Macrosomia	Significant intrapartum bleeding

Appendix 7.3

Apgar Score

Sign	0	1	2
Colour	Blue or Pale	Acrocyanotic	Completely Pink
Heart rate	Absent	<100 minute>	>100 minute
Reflex irritability	No response	Grimace	Cry or Active Withdrawal
Muscle Tone	Limp	Some Flexion	Active Motion
Respiration	Absent	Weak Cry; Hypoventilation	Good, crying

Appendix 7.4

Equipment List for Endo-tracheal Intubation

1. Laryngoscope with an extra set of batteries and extra bulbs.
2. Blades: No. 1 (term newborn), No. 0 (preterm newborn), No. 00 (optional for extremely preterm newborn). Straight rather than curved *blades are preferred.*
3. Endotracheal tubes with inside diameters of 2.5, 3.0, 3.5, and 4.0 mm.
4. Stylet (optional) that fits into the endotracheal tubes.
5. Suction setup with catheters of size 10F (for suctioning the pharynx), size 8F, and either size 5F or 6F (for suctioning endotracheal tubes of various sizes).
6. Roll of waterproof adhesive tape or plaster(1/2 or ¾ inch) device.
7. Scissors.
8. Oral airway.
9. Meconium aspirator
10. Stethoscope (with neonatal head).
11. Self-inflating bag with oxygen reservoir or flow-inflating bag.
12. Pulse oximeter and neonatal probe
13. Time piece and a stop clock.