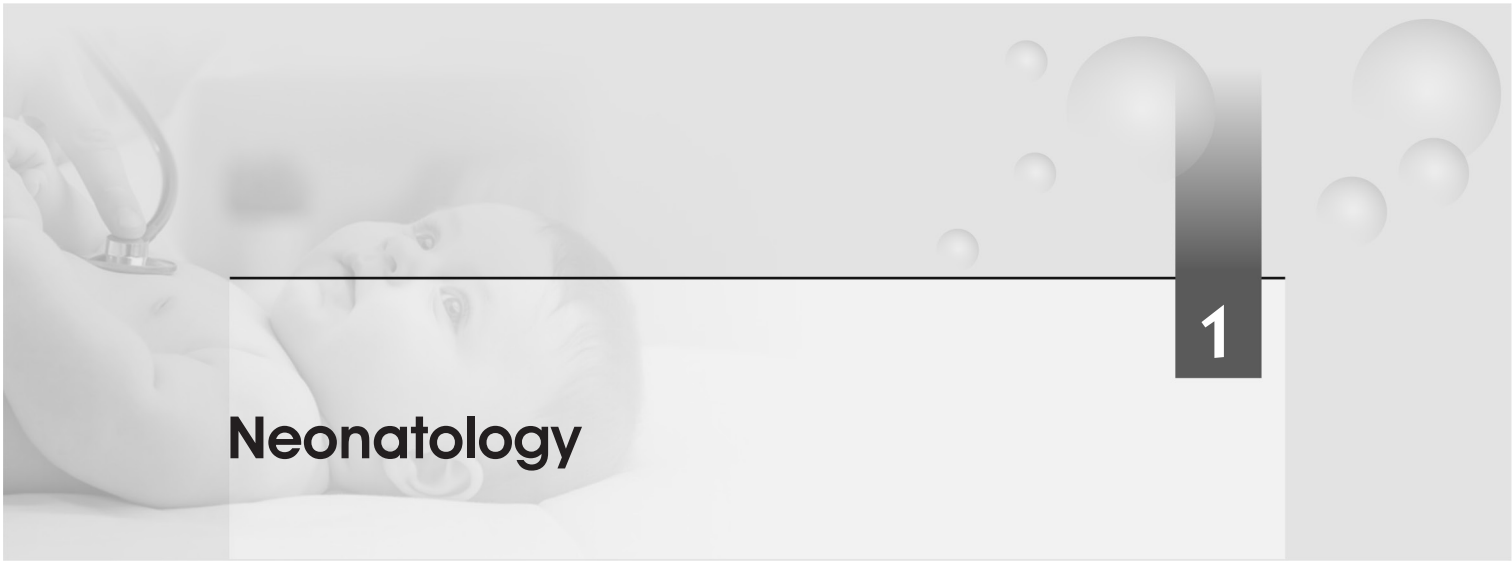


1 Neonatology

NEONATAL RESUSCITATION

Introduction

Neonatal resuscitation means to revive or restore life to a baby from a state of asphyxia. 90% of newly born babies make the transition from intrauterine to extrauterine life without difficulty. They begin spontaneous and regular respiration with little or no assistance. Approximately, 10% of newborns require some assistance to begin breathing at birth. About 1% of newborns may need extensive resuscitation for their survival. Adequate ventilation is more important than additional oxygen; quick action with a bag and mask is more important than intubation. This period of resuscitation is very important for the survival of a newborn baby (golden five minutes).

Steps for Successful Resuscitation

I. Preparation for Birth

i. A warm room with temperature >25°C, draught-free.
ii. A clean, dry and warm delivery surface.
iii. A radiant warmer/overhead lamp with 100 watts bulb, if available.
iv. Two clean, warm clothes for a baby towel to be used.
v. A folded piece of cloth.
vi. A newborn-size self-inflating baby bag and infant masks in two sizes, size 'l' for normal weight babies and '0' for lower weight babies (Figs 1.1 and 1.2).
vii. A suction device, machine, mucous suction.
viii. Oxygen source, e.g. cylinder or any other device (if available).
ix. A clock (with hour, minutes and second hands).

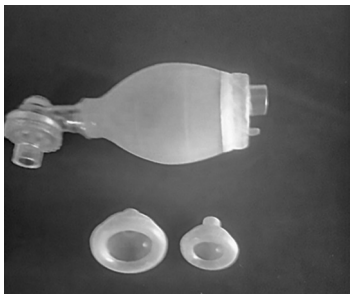


Fig. 1.1: Bag and mask

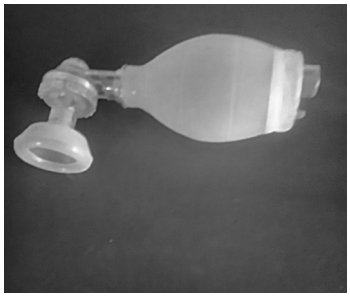


Fig. 1.2: Bag and mask (fit)

x. All equipments must be cleaned and checked, to the appropriate size. The volume of the bag should not be more than 500 ml and generate a pressure of at least 35 cm of water.
xi. Mucous extractor: The trap should be enough (20 ml) to prevent aspirated fluid from going into the resuscitator's mouth. Suction should not exceed a negative pressure of 100 mm Hg or 130 cm of water (Fig. 1.3).

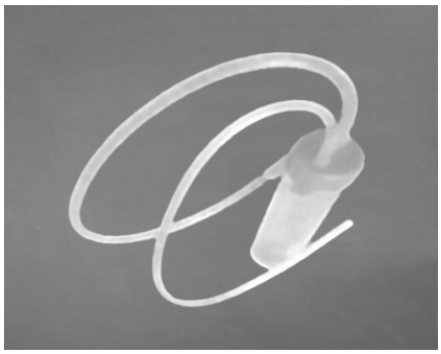


Fig. 1.3: Mucous extractor

Test the function of the bag and mask for ventilation.

- Fit the mask onto the bag.
- Form a seal between the mask and the palm. Squeeze the bag enough for the pop-off (pressure release) valve to open and make a sound as the air escapes (Fig. 1.4).
- Ensure that the bag re-inflates when released after squeezing the bag.

Fig. 1.4: Test for function of bag and mask

Assessment at Birth

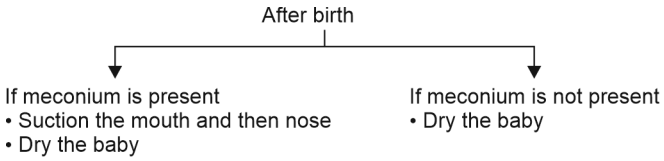
Baby should be delivered on the mother's abdomen just after birth or make sure there is a pre-warm, clean towel or clothes on the bed to place the baby on. Note the time of birth and keeping the baby warm as a first priority. The baby has to be dried with a pre-warm and clean towel (better to use cotton towel). The wet towels or clothes should

be replaced after drying the baby and baby should be wrapped in a clean, dry and pre-warm towel or cloth. After the birth baby remains wet with the amniotic fluid which if not dried can lead to heat loss and the temperature of the body falls rapidly. Breathing and warming must go together and breathing should be assessed whilst drying the baby. Drying also provides sufficient stimulation for breathing to start. Examine the newborn baby. Look for meconium on the body of the baby.

In case if meconium is present: Meconium is the faeces passed by the foetus *in utero*; it is greenish to brownish in colour. When meconium is present on the baby's surface and the baby is not crying you should immediately start the suction. First do suction from mouth by inserting the tube of suction devices, not more than 5 cm beyond the lip. Apply suction while withdrawing the tube. Suck from your mouth when a mucous extractor is used. Stop suctioning when secretions are clear.

Suction Procedure

- Do suction first from mouth then from nose on both sides.
- Do not do suction vigorously or deeply (do not insert the suction tube more than 5 cm in the mouth and more than 2 cm in the nose) as it can produce a vagal response, causing the heart rate to slow down or breathing to stop. Keep applying the suction while withdrawing the tube from the mouth or nostrils.
- Do suction from both nostrils placing the tube about 2 cm inside each nostril.



Assess the Baby's Breathing

i. The chest moves equally on both sides with no difficulty (30–60 times in a minute)
ii. If the baby is crying or the chest rising regularly between 30–60 times in a minute, there is no need of resuscitation.

If the Baby is Gasping or Not Breathing, Start Resuscitation

Transfer the baby to a pre-warm, clean and dry surface and do the following:

A. Provide a warm environment

a. Shut down all windows and switch off the fan of the room before the birth.
b. Place the newborn under an overhead lamp of 200 watts bulb placed 50–60 cm above the surface, or
c. Place the newborn under a radiant warmer.

B. Open the baby's airway: Position the head

Place the baby on his back. Put a folded piece of cloth under the baby's shoulder (shoulder pad) to maintain the head in a slightly extended position. It will open the airway. Hyperextension and hyperflexion cause close the airway. The suction of the mouth and the nose, suction first the mouth and then the nose.

C. Stimulation: Both drying and suctioning stimulate the newborn.

If the baby does not cry at birth, stimulate for breathing such as

- Slapping or flickering the soles of the feet.
- Rubbing the newborn's back or limbs gently.

If the Baby is Still Not Breathing

If the baby is not breathing well after 30 seconds after the above steps, start the ventilation with a bag and mask.

1. Position the baby to maintain an open airway with the help of a shoulder roll. Position yourself at the side or back of the head of the baby for better resuscitation.
2. Position of bag and mask on the face. The mask should be placed on the face so that it covers the nose and mouth. The appropriate size of the mask is chosen. The mask is properly held on the face with the thumb and index and or middle fingers encircling the rim of the mask by the left hand. Hold the bag in the right hand (right-handed person) or *vice versa* (Fig. 1.5).

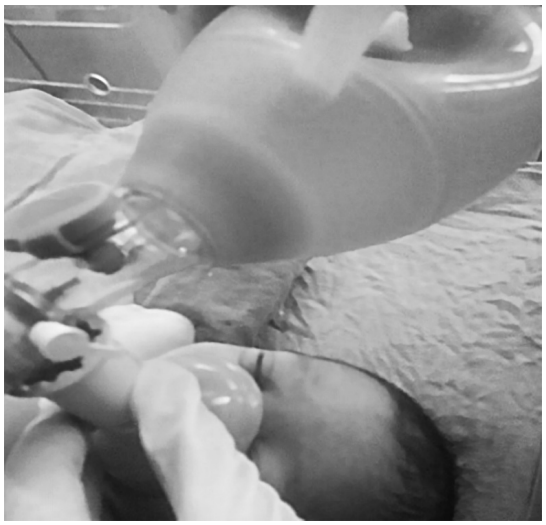


Fig. 1.5: Ventilation with bag and mask

Initiation of Ventilation

Start ventilation by squeezing the bag to deliver breath. Adequate pressure is required to squeeze the bag just sufficient to produce a gentle chest rise. Avoid over inflation (Fig. 1.6).

How often should you squeeze the bag

During the initial phase breaths should be delivered at the rate of 40–60 breaths per minute. It can be maintained by saying yourself.

Breathe and two, three breathe and two, three

- Squeeze the bag while you say breathe and release the bag while you say "Two, Three".

Say	Do
Breathe	Squeeze the bag
and Two, Three	Release the bag

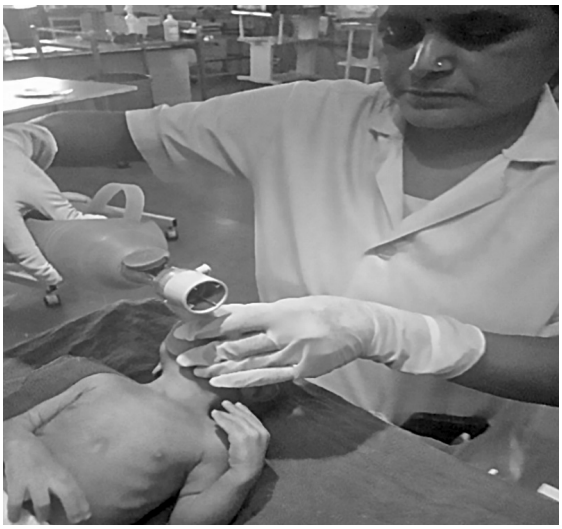


Fig. 1.6: Procedure of bag and mask ventilation

- Ensure chest rise. Ensure chest movement when you squeeze the bag. If not adequate, check the seal of the bag and mask is inadequate, the airway is blocked, and proper pressure is not given. Correct it.
- Improvement is indicated by spontaneous breathing which is after 30 seconds of adequate ventilation with a bag and mask. But some babes require prolonged ventilation. If the baby is crying or breathing regularly with no grunting at the rate of 30–60/min, stop the ventilation.
- Evaluate heart rate by feeling the umbilical cord pulse or listening to the heartbeat with a stethoscope. Count the beats for 6 seconds and multiply by 10. It gives a heart rate in a minute. Heart rate above 100/min is normal.
- If the heart rate is normal but the baby is still not breathing well, continue the ventilation process. Reassess after 30 seconds until the baby is breathing well. If not, continue ventilation and refer to advance care. Provide oxygen if available. If no improvement such baby may require chest compressions, endotracheal intubation and medications.

Resuscitation with Positive Pressure Ventilation and Chest Compressions

Babies who have heart rates below 60/min despite stimulation and 30 seconds of positive pressure ventilation, probably have very low oxygen levels and significant acidosis. As a result, the myocardium is depressed and unable to contract strongly enough to pump blood to the lungs to pick up oxygen. Therefore, you will need to mechanically pump the heart while you simultaneously ventilate the lung until the myocardium is sufficiently oxygenated to recover adequate spontaneous function. This process also helps to restore oxygen delivery to the brain.

Chest compression: Sometimes referred to as external cardiac massage consisting of rhythmic compressions of the sternum that compress the heart against the spine, increase intrathoracic pressure and circulate blood to the vital organs of the baby.

Compressing the sternum compresses the heart and increases the pressure in the chest, causing that to be pumped up to arteries, when pressure on the sternum is released, blood enters the heart from the veins.

Persons required for chest compression: Two people are required to administer effective chest compressions. One to compress the chest and to continue ventilation. A second person may be the same person who came to monitor heart rate and breath sounds during positive pressure ventilation.

Techniques of Chest Compression

Two techniques are used to perform chest compressions.

Thumbs Technique

Method: This technique is done by encircling the torso with both hands and placing the thumb on the sternum and the fingers under the baby's back supporting the spine. The thumbs can be placed side by side or, on a small baby one over the other. The thumbs will be used to compress the sternum, while your fingers provide the support needed for the back. The thumbs should be flexed at the first front and pressure applied vertically to compress the heart between the sternum and the spine.

Two Fingers Technique

The tips of the middle finger and either the index finger or ring finger of one hand are used to compress the sternum, while the other hand is used to support the baby's back.

Method

- In this method, the tips of your middle finger and either the index or the ring finger of one hand are used for compressions (use right hand in right-handed and left hand in left-handed person).
- Position the two fingers perpendicular to the chest and press with your fingertips.
- Your other hand should be used to support the newborn's back so that the heart is more effectively compressed between the sternum and spine. With the use of a second-hand supporting the back, you can more easily judge the pressure and the depth of compression.

How much pressure to use: Use pressure to depress to a depth of about one-third of the anteroposterior diameter of the chest, and then release the pressure to allow the heart to refill. So, one stroke delivered a downward stroke and release. The thumb and finger should remain in contact during both compression and release. Chest compressions may cause trauma to the baby.

Coordination of Compressions with Ventilation

- Chest compressions must always be accompanied by positive pressure ventilation. These two must be coordinated in such a way that on ventilation is interposed after every third compression. For 90 compressions–30 breaths per minute. The person doing the compression should take the counting out loud from the person who is doing ventilation.
- The compressor should count breathe and two three, breathe and two three
- While the person ventilating squeezes during breathe and releases during two-three.

- Stop compression after 30 seconds of ventilation and compression, feel the pulse at the base of the cord.
- Examine the chest with a stethoscope if the heart rate is more than 60 beats per minute stop chest compression but continue positive pressure.
- If the heart rate rises above 100 beats per minute and baby begins to breathe spontaneously, withdraw positive pressure ventilation.
- If the heart rate remains below 60 per minute, then insert an umbilical catheter and give epinephrine.

Endotracheal Intubation

Indication

- If there is meconium and the baby has depressed respiration, muscle tone, or heart rate.
- If positive pressure ventilation is not resulting in adequate clinical improvement.
- If chest compression is necessary, intubation may facilitate the coordination of chest compression and maximize the efficacy.
- If epinephrine is required to stimulate the heart.

MEDICATIONS DURING RESUSCITATION

Epinephrine

If the heart rate remains below 60 bpm despite administration of ventilation and chest compressions (at about 3 min age) place an umbilical venous catheter and a dose of 0.6 ml of epinephrine is given into the catheter followed by a normal saline flush. If there is no improvement in heart rate repeat the dose every 3–5 min. Give blood volume expander. Recheck the effectiveness of ventilation, chest compression, endotracheal intubation and epinephrine delivery, if no improvement then consider that the baby is in shock and if there is evidence of blood loss. Treat the hypovolaemia with an isotonic crystalloid solution such as

- 0.9% normal saline
- Ringer lactate
- O Rh-negative packed red cells if severe foetal anaemia is expected.
- ***Dose:*** Initial dose 10 ml /kg given over 5 to 10 mins. If minimal improvement in the initial first dose, give another 10 ml/kg through the intravenous route (e.g. umbilical vein).
- If no improvement after the above measures, consider congenital airway malformation, pneumothorax, diaphragmatic hernia or congenital heart disease.
- If the heart rate is absent despite all the above techniques for a minimum of 10 minutes, discontinue resuscitation.

Post Resuscitation Care

It includes:

1. Warmth
2. Chest breathing, temperature, colour, craniosacral facial therapy
3. Observation
4. Monitor blood sugar

5. Watch for any complications
6. Initiate breastfeeding if the baby is well

HYPOGLYCAEMIA

Hypoglycaemia is defined as blood sugar lowering less than 45 mg/dl.

Management: Hypoglycaemia in newborns is managed as follows:

- Give an initial dose of 2 ml 10% dextrose /kg/min
- Maintenance 6 mg/kg/min 10% dextrose for 30 min

If not normal: Increase the dose 8 mg/kg/ min for 30 min

If not normal: Increase 10 mg/kg/min for 30 min

If not normal: Increase 12 ml/kg/min for 30 min maximum

Don't give more than 12 mg/kg/min via peripheral vein. If needed give through a central line.

If not improved

Hydrocortisone 2–6 mg /kg in 2–3 divided doses IV for 2 days

Example: Baby weight 2.5 kg

Then, 2.5 × 6 × 30 (minutes) = 450 mg in 30 min

= 4.5 ml of 10% dextrose in 30 min (10% dextrose contains 100 mg of dextrose/ml)

= 4.5 × 2 = 9 ml/hr.

So, the dose for a 2.5 kg baby is 9 ml/hr

Guideline

1. *Symptomatic baby:* Blood sugar <50 mg/dL in first 48 hours or blood sugar <60 mg after first 48 hours then give IV dextrose
2. *Mild jitteriness, and convulsions:* Give breastfeeding and oral glucose
3. *Asymptomatic*: If BS is even less than 25 mg/dl for 4 hours, do not give IV glucose, give oral dextrose and breastfeeding

RESPIRATORY DISTRESS IN NEWBORN

Respiratory distress is one of the common and critical symptoms and signs in newborns.

Cardinal Signs of Respiratory Distress

1. Tachypnea RR >50/min
2. Chest retraction
3. Grunting
4. Flaring of alae nasi
5. Cyanosis.

Common Causes

1. ***Cardiac:*** Congestive cardiac failure (CCF) and congestive heart failure (CHD)
2. ***Metabolic:*** Hypothermia, hypoglycaemia
3. ***Central nervous system:*** Asphyxia, cerebral oedema
4. ***Chest wall:*** Thoracic distress

Age of Onset of Pulmonary Causes

i. First 6 hours of life

- Respiratory distress syndrome
- Transient tachypnoea of newborn
- Meconium aspiration syndrome

ii. At any age

- Pneumonia
- Transient pulmonary hypertension
- Pneumothorax
- Tracheoesophageal fistula
- Lobar emphysema

Causes as per Preterm and Term Baby

i. Preterm baby: Respiratory distress syndrome, congenital pneumonia, pulmonary bleed, hypothermia, hypoglycaemia.

ii. Term baby

- Transient tachypnea of the newborn, meconium aspiration syndrome, pneumonia, birth asphyxia, persistent pulmonary hypertension of the newborn (PPHN), patent ductus arteriosus (PDA), congenital pneumonia, pneumothorax, congenital malformations, aspiration pneumonia, sepsis, CHD, anaemia, secondary PPHN, acidosis.
- *Surgical causes:* Diaphragmatic hernia, tracheoesophageal fistula, choanal atresia.
- *Other causes*
  - *Cardiac:* Congenital heart disease
  - *Metabolic:* Acidosis, inborn error of metabolism

TRANSIENT TACHYPNOEA OF NEWBORN (TTN)

Predisposing factor: Delivered by lower segment caesarean section

Clinical Features

- Tachypnoea and increased work on breathing which persists for 24–48 hours.
- X-ray chest—excess diffuse parenchymal infiltrate due to fluids in interstitium, fluid in interlobar fissure, occasional pleural effusion.

Management

- Supportive therapy—transient tachypnoea resolves within 1–5 days after minimal therapeutic intervention.
- Oxygen therapy—sometimes continuous positive airway pressure, mechanical ventilation.

RESPIRATORY DISTRESS SYNDROME (RDS)

Hyaline Membrane Disease (HMD)

Clinical features are severe respiratory retraction, tachypnoea, chest indrawing, flaring of alae nasi, sternal retraction, crepts and rhonchi.

Investigations

- Micro ESR, CRP, hemogram, blood culture, blood urea, creatinine, sodium, potassium, calcium.
- X-ray chest–ground glass appearance of the field.
- Bilateral air bronchograms.
- Six hourly blood sugar monitoring.
- If ventilated, then 6 hourly arterial blood gas analysis.

Treatment

- Oxygen-bubble–CPAP.
- If no improvement or worsening on bubble CPAP, then administer surfactant using intubation surfactant-extubation (INSURE) technique.
- If INSURE fails then ventilate.
- If the ventilator setting shows no improvement or increase then repeat the dose of surfactant.
- Nutrition and calcium.
- Antibiotic–because pneumonia is present.
- First-line therapy IV ciprofloxacin and amikacin.
- If apnea of prematurity is present, then give IV caffeine.
- Once stable, start expressed mother milk by nasogastric tube.

Course

- RDS is self-limiting at the age of 3–4 days as infants begin to produce endogenous surfactants.
- Use of ventilator should proceed with caution to avoid ventilator-induced injury.
- If patient does not improve with surfactant consider the presence of patent ductus arteriosus or other congenital heart disease.
- If improves with surfactant initially then deteriorate, consider nosocomial pneumonia.

RESPIRATORY DISTRESS DUE TO PATENT DUCTUS ARTERIOSUS (PDA)

Distress due to PDA appear after 24 hours of birth generally. Suspect PDA if baby improves after giving little oxygen.

Management

1. Lasix
2. Oxygen with CPAP
3. Paracetamol
4. Distress appears after 24 hours of age in PDA, pulmonary stenosis. Confirm by echocardiography.
5. Acidosis
6. HCO_3 level high

PERSISTENT PULMONARY HYPERTENSION (PPHN)

If oxygen saturation is not improving after high oxygen introduction, then PPHN/CHD is suspected.

MECONIUM ASPIRATION SYNDROME

Intrapartum Care

Routine oropharyngeal suction and endotracheal suctioning are to be avoided in neonates born through meconium-stained liquor. If depressed respiration or poor muscle tone, proceed with initial steps—positive pressure ventilation should be provided if the heart rate is <100/min.

Postnatal Management

1. If no distress, keep in observation and feed
2. If respiratory distress is present, judicious use of oxygen (Fig. 1.7), CPAP or mechanical ventilation if
   - Significant hypoxia (PaO_2 <50 mm Hg)
   - Hypercarbia ($PaCO_2$ >60 mm Hg)
   - Acidosis (pH <7.25)
3. In severe cases with hypoxaemic respiratory failure—extracorporeal membrane therapy
4. Fluids
5. If seizures are present, treat the seizures
6. If shock is present, inotropes (first-line dobutamine)
7. Antibiotics, if sepsis is suspected
8. Once stable—start expressed breast milk by nasogastric tube

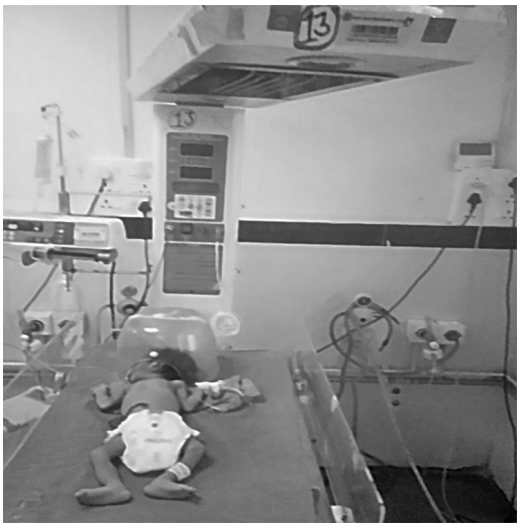


Fig. 1.7: Radiant heat warmer and oxygen administration via hood

Investigations

1. Micro-ESR, CRP, hemogram, blood urea, creatinine, sodium potassium creatinine
2. X-ray chest
3. Daily weight and urine output charting
4. If ventilated, then 6 hourly blood gas analysis

PNEUMONIA

Treatment

1. Supportive care. Appropriate oxygen support
2. Antibiotic therapy for sepsis
   Penicillin + Aminoglycoside or Vancomycin
3. If there is shock—vasopressors such as dopamine or dobutamine

PNEUMOTHORAX

Investigations

Transillumination of the chest, X-ray chest.

Treatment

Needle aspiration or chest tube drainage.

APNEA

Apnea is defined as cessation of breathing for longer than 20 sec or a short duration in the presence of bradycardia or change in skin colour (pallor or cyanosis). Significant bradycardia is defined as heart rate <80 beats/min and significant desaturation is defined as oxygen saturation less than 80–85%. About 30–40% of preterm neonates exhibit periodic breathing patterns characterized by three or more respiratory pauses of greater than 3 seconds duration. Periodic breathing is a normal event in preterm infants and does not require any treatment. In contrast, apnea is a pathological cessation of breathing that results in hemodynamic disturbances and merits treatment.

APNOEA OF PREMATURITY (AOP)

It presents after 1–2 days of life and within 7 days. Apnoea occurring in the first 24 hours and beyond 7 days of life is more likely to have a secondary cause than being AOP.

Secondary Causes

a. Temperature instability: Hypothermia or hyperthermia
b. Metabolic: Acidosis, hypoglycemia, hypocalcaemia, hyponatraemia, hypernatraemia.
c. Haematological: Anaemia, polycythaemia.
d. Neurological: Intracranial infections, intracranial haemorrhage, seizures, perinatal asphyxia, placental transfer of drugs such as narcotics, magnesium sulphate, or general anaesthetics.
e. Pulmonary: RDS, pneumonia, pneumothorax, hypoxaemia, hypercarbia, airway obstruction due to neck flexion.
f . Cardiac: CHD, hypo/hypertension, CCF, patent ductus arteriosus.
g. Gastrointestinal: Gastroesophageal reflex abdominal distension, necrotizing enterocolitis.
h. Infections: Sepsis, pneumonia, meningitis, enterocolitis.

Investigations

To exclude secondary causes, blood glucose, calcium, electrolyte, haematocrit, sepsis screening, ultrasound head, X-ray chest, and echocardiography.

Management

1. The neonate should be checked for bradycardia, cyanosis and airway obstruction.
2. The neck should be kept slightly extended.
3. The airways should be suctioned if secretions are present.
4. Most apneic spells respond to tactile stimulation.
5. Oxygen by nasal cannula or hood is provided if infant is hypoxic.
6. If the neonate does not respond to tactile stimulation positive pressure ventilation (PPV) should be initiated.
7. Maintain temperature, airway breathing and circulation (TABC).
8. Oral feeding can be continued if apnea is occasional and not severe. Avoid oral feeds in case of repeated episodes requiring positive pressure ventilation. Decreasing the volume of feeding may be considered by feeding in small volumes more frequently, e.g. every 1 hour instead of every 2 hours.
9. Transfuse packed cells if required.

Specific Measures

Methylxanthines

Mx therapy in which two drugs are used, caffeine and aminophylline. The efficacy of both the drugs is same. Caffeine has fewer side effects and better dosage, and convenience as it requires once daily administration compared to three daily doses of aminophylline.

Caffeine Citrate

- *Loading dose:* 20 mg/kg of caffeine citrate (10 mg/kg of caffeine alkaloid).
- *Maintenance dose:* 5–10 mg of caffeine citrate (2.5–5 mg/kg of caffeine alkaloid).

Theophylline

- *Loading dose:* 5–10 mg/kg
- *Maintenance dose:* 1.5–3 mg/kg q 8–12 hours

Indication: When unresponsive to tactile stimulation or frequent episodes of apnoea.

- Mx therapy is initiated as IV therapy. Oral formulation of both drugs can be used in place of intravenous formulation once the infant is stable and tolerates oral feeds.
- Mx therapy should be continued until 34 weeks of post-menstrual age and stopped thereafter if no episode of apnea has occurred in the last 7 days.
- Caffeine or aminophylline initiated to facilitate extubation may be stopped after 5–7 days of therapy.
- Continuous positive airway pressure (CPAP)–indicated if apneic episodes persist despite optimal Mx therapy.
- Nasal intermittent positive pressure ventilation (NIPPV)–if no response to CPAP.
- Persistent apneic episodes may persist beyond 37–40 weeks in some infants born before 28 weeks of gestation. Mx therapy should be continued in such infants if apnoeic episodes continue to occur beyond 34 weeks of post-menstrual age.

PERINATAL ASPHYXIA (BIRTH ASPHYXIA)

Birth asphyxia or perinatal asphyxia is an injury to the fetus or newborn occurring due to a lack of oxygen (hypoxia) or a lack of blood perfusion (ischaemia) to various organs. Complications during childbirth is most common cause. As per the Neonatology Forum of India Apgar score of <3 severe birth asphyxia and 4–7 at 1 minute-moderate birth asphyxia.

Risk factors for hypoxic-ischaemic encephalopathy (HIE) contribute to hypoxia or ischemia. HIE is the CNS dysfunction associated with birth asphyxia.

1. ***Treat seizures:*** Seizures are commonly subtle, focal or multifocal. First rule out metabolic causes of seizure such as hyoglycaemia, hypocalcaemia and hyponatraemia. Treat seizures with antiepileptic drugs (AEDs) such as phenobarbitone and phenytoin. Subtle seizures do not require any treatment. When the neonate is seizure-free for 3-4 days, AEDs are stopped.
2. ***Fluids:*** Maintain normal requirements as per situation.
3. Calcium
4. If respiratory distress (hypoxia), oxygen is given to maintain saturation between 90 and 95%.
5. If shock is present, give inotropes first line medication—dopamine.
6. Antibiotics—if sepsis is suspected.
7. Once stable, start expressed breastmilk by nasogastric tube.

Monitoring

1. Six hourly blood sugar monitoring
2. Blood urea, creatinine, sodium, potassium, calcium, creatinine phosphokinase–MB.
3. Sepsis screen, blood culture if sepsis is suspected
4. Daily weight and urine output charting.
5. If ventilated, then 6 hourly arterial blood gas analysis.

NEONATAL SEPSIS

When pathogenic organism enters to the bloodstream it can result in neonatal sepsis which may be generalized or localized to the lungs, brain and bones.

Diagnosis

1. Diagnosis of neonatal sepsis on clinical manifestations only.
2. Blood culture
3. Sepsis screen
   - Total leukocyte count (TLC)—below 5000/mm^3
   - Absolute neutrophil count (ANC)—less than 1800 per mm^3
   - Immature band cell + metamyelocyte + metamyelocyte to total neutrophil ratio (ITR more than 20%)
   - C-reactive protein (CRP)—value of more than 10 mg/dl is taken as positive.
   - Micro-ESR—elevated >15 mm
   - Lumbar puncture—cerebrospinal fluid (CSF) should be examined within 30 minutes of drawing the CSF because white blood cells (WBC) and glucose fall rapidly with time.

Treatment

1. Supportive therapy
2. Antibiotic therapy

Supportive Therapy

1. Provide warmth, ensure temperature between 36.5 and 37.5°C.
2. Maintain TABC (temperature, airway, breathing, circulation).
3. Start oxygen, maintain (SpO_2 90–95%).
4. Assess peripheral circulation—peripheral pulse, capillary refill time (normal 2–3 sec), and skin colour. Serial measurement of urine output.

If circulation is poor: IV normal saline or Ringer lactate 10 ml/kg over 5–10 min.

If no improvement: Repeat 1–2 times over the next 30–45 min.

If perfusion is still poor: Dopamine or dobutamine may be required.

- Hypoglycaemia should be treated with dextrose 10% 2 ml/kg stat. Do not use glucose bolus routinely.
- Potassium should be supplemented if normal urine flow is established.
- Consider exchanging blood transfusion in sclerema.
- Blood transfusion—transfuse packed cells if the baby has low haematocrit (35-40%)
- Avoid enteral feeds, if haemodynamically unstable. Give IV fluids. Once the baby is stable give orogastric feeds. Feed mother's milk.

Antibiotic Therapy

Antibiotic therapy is an essential part of sepsis, a blood sample for culture and sensitivity is taken but do not wait for results and start antimicrobial therapy which covers common causative bacteria. Choice of antibiotic:

Low resistance to common antibiotics: Ampicillin (50 mg/kg/dose 12 hourly or 8 hourly)/Cloxacillin (50 mg/kg/dose 12 hourly/8 hourly) + Gentamicin (5 mg/kg/dose 8 hourly IV) 7–10 days. Ampicillin + Gentamicin, if meningitis.

High resistance/ meningitis

- Ciprofloxacin/piperacillin + Amikacin (first-line medication)
- Meropenem/vancomycin (second-line medication)

Change of Antibiotic

If no improvement occurs after 48 hours of antibiotic treatment of first-line medication then change to second-line medication. Stop antibiotics, when neonates become asymptomatic, blood culture is sterile.

FLUID THERAPY IN NEWBORNS

Fluids are indicated as per the body weight of the baby.

- *Birth weight more than 1800 g:* Breastfeeding
- *Birth weight 1200–1800 g:* Enteral feeding with breastfeeding

Indications for intravenous (IV) fluid therapy

- Baby weight less than 1200 g
- Gestation <30 weeks
- Sick baby
- Shock
- Severe perinatal asphyxia

Choice of Fluid

- First 48 hours of life: Electrolyte-free fluid such as 10% of dextrose. Sodium administration is not required unless intravascular expansion is necessary as in shock.
- After 48 hours of life: Isolyte–P if baby is passing urine 5–6 times a day.

Administration of IV Fluids

- Micro drip infusion set (pedia drip set) 1 ml = 60 micro-drops
- Syringe pump
- Calculate fluid requirement for 8 hours and fill in a burette of micro-drip set. Give it, and then refill again and administer 8 hourly. Volume of IV fluid to be given (Table 1.1)

Table 1.1: Daily fluid requirement (ml/kg/day)

Birth wt.	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
<1500 g	80	95	110	120	130	140	150
>1500 g	60	75	90	105	120	135	150

If birth weight is less than 1500 g

- Day 1: 10% dextrose only with no electrolyte as a initial fluid. Infusion rate 4–6 mg/kg/min.
- Sodium and potassium should be added to IV fluids after 48 hours.
  Fluids should be stopped when oral feeds constitute two third of the daily requirement.

Example: 4 days old neonate with birth weight of 1.2 kg.

Total fluid = Requirement on day 4 of life as per table = 125 ml/kg/day
= 125 × 1.2 = 150 ml/day = 150 ml/24 hours = 6.2 ml/hour

Fluid order – give IV fluid isolyte-P 150 ml in 24 hours @ 6.2 ml/hour with syringe pump or 6 micro-drops/min with micro-drip set.

Monitoring

1. Measure blood glucose level 8 hourly.
2. Daily weight recording.
3. Urine output: Oliguria when urine output is less than 1 ml/kg/hour.

Signs of overhydration: Puffiness of eyelids, excessive weight gain and respiratory distress. If there is no weight loss or there is weight gain in initial 3 days of life do not give daily increment. Keep the fluid rate as same the previous day. However, if there is excessive weight gain (3–5%) decrease the fluid intake by 15–20 ml/kg/day.

- If there is oliguria and weight loss, increase fluid intake by 10–20 ml/kg

- If there is oliguria with weight gain, decrease the daily volume by 10 ml/kg and evaluate the renal failure.
- Acute kidney injury: Replace insensible losses 25 ml/kg in term babies and 50 ml/kg/day in preterm babies as electrolyte free 10% dextrose solution and replace urine put as half normal saline (0.45%). During fluid restriction, glucose infusion should not be below 4 mg/kg/min.
- Fluids for dehydration: Serial recording of weight is the most reliable way to assess the severity of dehydration. Physical signs of dehydration are less reliable in neonates.
- Dehydration is corrected slowly over 24 hours in newborns. The fluid used for deficit correction is ½ normal saline. Half is corrected over 8 hours and remaining half over 16 hours. This is in addition to maintenance needs plus ongoing losses.
- Potassium 2 mEq/kg/day is added to IV fluids after urine flow is established. 1 ml of KCl solution = 2 mEq of potassium.

Note: Severe dehydration refer, Chapter 6: Diseases of Gastrointestinal System and Liver.

NEONATAL JAUNDICE

Neonatal jaundice is visible in skin and eyes when total serum bilirubin (TSB) concentration is 5–7 mg/dl, in contrast to adults have jaundice visible in eyes when TSB concentration exceeds 2 mg/dl. High serum bilirubin levels can cause bilirubin induced neurological dysfunction in some babies. In most of other cases jaundice is benign and does not require any treatment.

Physiological Jaundice

Physiological jaundice of newborn usually appears on third day or 72 hours of age, maximum intensity is seen on fourth or fifth day and disappears by seventh day. The bilirubin level usually does not exceed 10 mg/dl. This does not need any therapy but is watched for severity. Adequate fluids and feeds are given to the baby. Reassurance is given about the benign nature of the condition. Associated conditions may exaggerate this and should be treated accordingly.

Pathological Jaundice

Any of the following alert signs in neonatal jaundice when present it is assumed as pathological jaundice.

1. Visible jaundice in the first 24 hours.
2. Total serum bilirubin (TSB) increased by >5 mg/dl/day or 0.5 mg/dl/hr.
3. TSB >15 mg/dl.
4. Conjugated serum bilirubin >2 mg/dl.
5. Clinical jaundice presenting >2 weeks age in term and 3 weeks in preterm.
6. Signs of acute bilirubin encephalopathy or kernicterus.

Investigations

- Total serum bilirubin (TSB)
- Glucose -6-phosphate dehydrogenase (G6PD) deficiency
- Thyroid screen
- ABO of infant and mother