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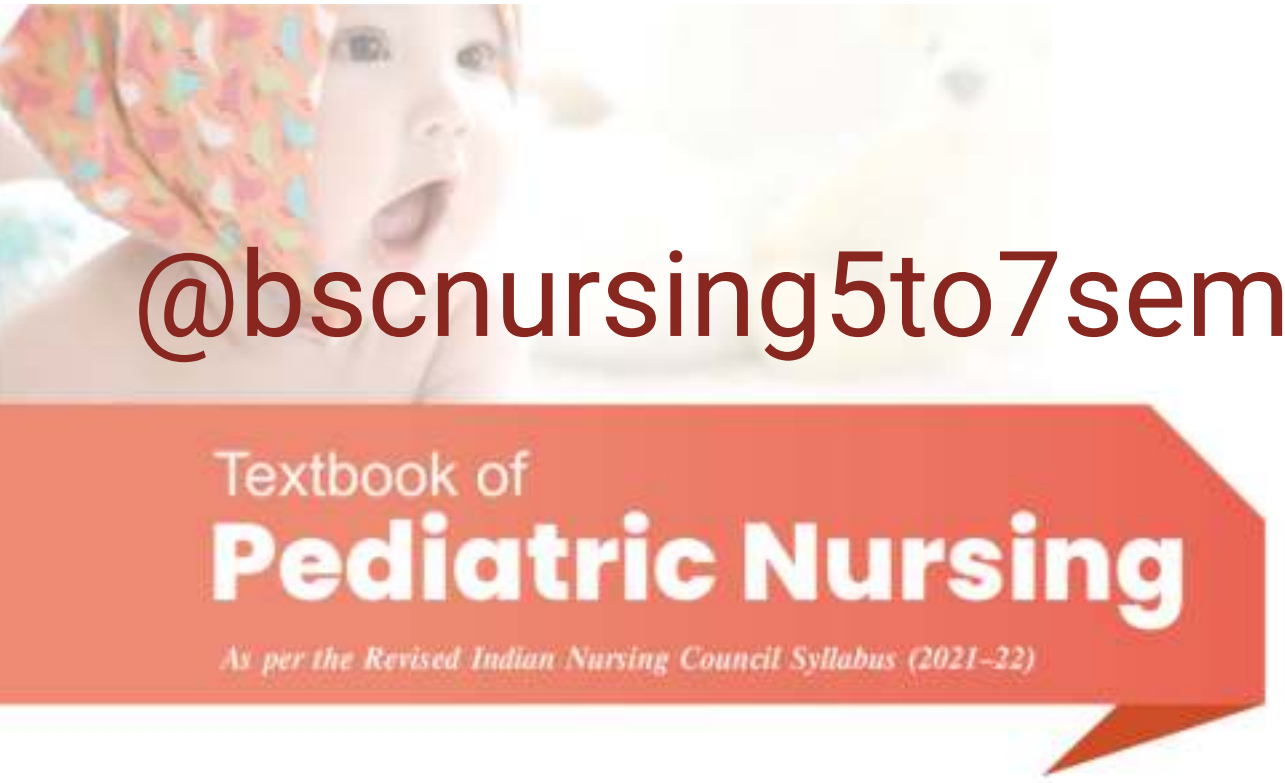


Textbook of Pediatric Nursing

As per the Revised Indian Nursing Council Syllabus (2021–22)

Unit	Time (Hrs)	Learning Outcomes	Content	Teaching/ Learning Activities	Assessment Methods
II	12 (T)	Describe the normal growth and development of children at different ages	**The Healthy Child** • Definition and principles of growth and development • Factors affecting growth and development	• Lecture discussion • Demonstration • Developmental study of infant and children	• Short answer • Objective type • Assessment of field visits and developmental study reports
		• Identify the needs of children at different ages and provide parental guidance • Identify the nutritional needs of children at different ages and ways of meeting needs	• Growth and development from birth to adolescence • Growth and developmental theories (Freud, Erickson, Jean Piaget, Kohlberg) • The needs of normal children through the stages of developmental and parental guidance	• Observation study of normal and sick child • Field visit to Anganwadi, child guidance clinic • Videos on breastfeeding	• Short answer • Objective type • Assessment of field visits and developmental study reports
		Identify the role of play for normal and sick children	• Nutritional needs of children and infants ▪ Breastfeeding ▪ Exclusive breastfeeding ▪ Supplementary/artificial feeding and weaning • Baby friendly hospital concept • Types and value of play and selection of play material	• Clinical practice/ field	
III	15 (T) 20 (L)	• Provide care to normal and high-risk neonates • Perform neonatal resuscitation • Recognize and manage common neonatal problems	**Nursing Care of Neonate** • Appraisal of newborn • Nursing care of a normal newborn/essential newborn care • Neonatal resuscitation • Nursing management of low birth weight baby • Kangaroo mother care • Nursing management of common neonatal disorder ▪ Hyperbilirubinemia ▪ Hypothermia ▪ Hyperthermia ▪ Metabolic disorder ▪ Neonatal infections ▪ Neonatal seizures ▪ Respiratory distress syndrome ▪ Retinopathy of prematurity • Organization of neonatal care unit • Neonatal equipment	• Modular-based teaching: **ENBC and FBNC module (oral drills, videos, self-evaluation exercises)** • Workshop on neonatal resuscitation: NRP module • Demonstration • Practice session • Clinical practice • Lecture discussion	• OSCE • Short answer • Objective type
IV	10 (T) 5 (L)	Apply principles and strategies of IMNCI	**Integrated Management of Neonatal and Childhood Illnesses**	*Modular based teaching:* **IMNCI module** • Clinical practice/ field	• OSCE
V	8 (T)	Describe the etiology, pathophysiology, clinical manifestation and nursing management of children with disorders of respiratory, and endocrine system	**Nursing Management in Common Childhood Diseases** **Respiratory system** • Identification and nursing management of congenital malformations • Congenital disorders: Tracheoesophageal fistula, diaphragmatic hernia	• Lecture discussion • Demonstration • Practice session • Clinical practice	• Short answer • Objective type • Assessment of skills with checklist

Contd...

Unit III

Nursing Care of Neonate

Learning Objectives

At the end of this unit, the students will be able to:

- Perform neonatal resuscitation.
- Provide care to normal and high-risk neonates.
- Recognize and manage common neonatal problems.

Unit Outline

Chapter 7

Normal Newborn

Chapter Outline

- Introduction
- Neonatal Resuscitation
- Birth Injuries
- Essential Newborn Care
- Facility-Based Newborn Care
- Family-Based Integrated Management of Neonatal and Childhood Illness

INTRODUCTION

During birth of a baby, certain physiological processes take place. It is important that each delivery is attended by at least one person skilled in neonatal resuscitation.

About 10% of neonates require some respiratory assistance at birth. Less than 1% need extensive resuscitation.

NEONATAL RESUSCITATION

About 10% of all neonates require assistance at birth to breathe; and about 25% of all neonatal deaths are contributed to by birth asphyxia. The presence of risk factors can help identify those who may need resuscitation. Every birth should be attended by someone who had been trained in initiating neonatal resuscitation. Resuscitation procedures and proportions of newborns who need them are shown in Figure 7.1.

Risk factors associated with the need for resuscitation at birth are shown in Table 7.1.

The articles needed for resuscitation are shown in Table 7.2.

Figure 7.2 describes the steps of resuscitation according to NRP India. These include:

Initial assessment: At the time of birth, as you receive the baby in dry, warm linen, ASK if the baby is breathing/crying? If the answer is "Yes", then the baby should stay with the mother. If the answer is "No", then cut the cord and continue to the initial steps of resuscitation.

Section A (airway): These are the initial steps taken to establish an airway and begin resuscitating a newborn.

- Place the baby under a radiant warmer.
- Dry the baby, position the head to open the airway; clear the airway as necessary (it may involve suctioning the trachea to remove meconium).
- Stimulate the baby to breathe, and reposition the head to maintain an open airway.

Evaluation of the effect of Section A: Evaluate the newborn simultaneously during these first interventions, and this should not take more than 30 seconds to complete. Simultaneously evaluate respiration and heart rate. If the baby is not breathing (is gasping or has apnea) or has a heart rate below 100 beats/min (bpm), you should immediately proceed to Block B (left side). If the baby's respiration appears labored or is persistently cyanotic, proceed to Block B (right side).

Section B (breathing): If the baby has apnea or is gasping or has a heart rate below 100 bpm, assist the baby's breathing by providing positive pressure ventilation (PPV). PPV is given by ambu bag and mask, rate is 40–60 breaths/min.

If the baby is breathing, but has persistent respiratory distress (labored breathing), attach a pulse oximeter to

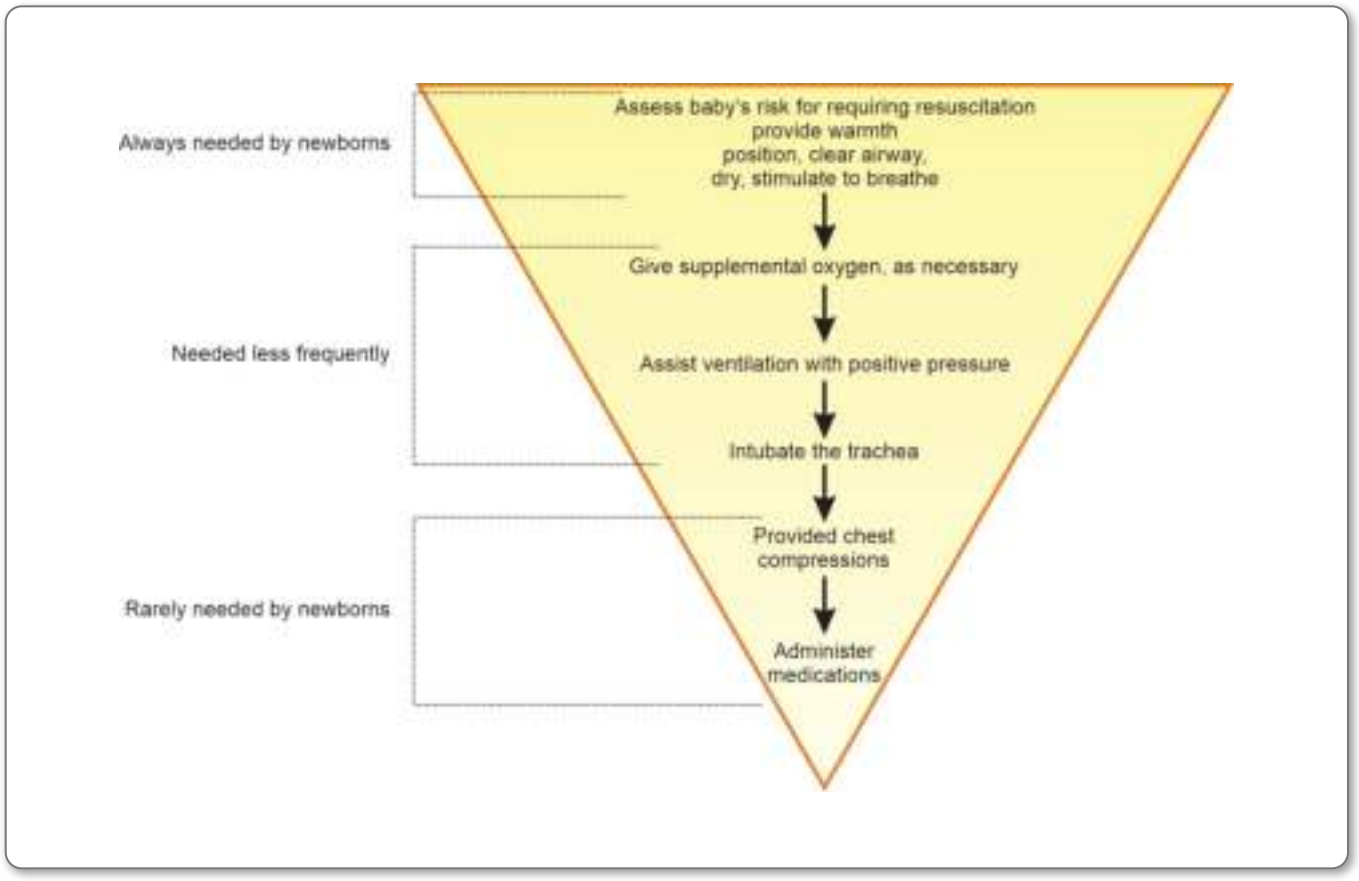


Figure 7.1: Resuscitation procedures and proportions of newborns who need them

Table 7.1: Resuscitation at birth: Risk factors

Antepartum risk factors	
• Maternal Hypertension • Diabetes in mother • Antepartum bleed (2nd or 3rd, trimester) • Maternal infections • Maternal medical problems (cardiac, pulmonary renal, thyroid, etc). • Polyhydramnios • Oligohydramnios	• Multiple gestation • Premature rupture of membranes • Post-term gestation • Intrauterine growth restriction • Malformations in fetus • Mothers <18 years or older than 35 years • Inadequate antenatal care • Previous fetal or neonatal deaths
Intrapartum risk factors	
• Abnormal fetal heart rate patterns (late and variable decelerations) • Meconium stained amniotic fluid • Significant intrapartum hemorrhage (Abruptio placentae, placenta previa) • No-vertex presentation • Forcep/vacuum deliveries	• Emergency cesarean section • General anesthesia to mother • Premature labor • Chorioamnionitis • Prolonged labor (>24 hours) • Cord prolapse • Macrosomic (large) fetus

Table 7.2: Equipment checklist

Purpose	Equipment
Warm	Preheated warmer, towels
Clear airway	Bulb syringe, meconium aspirator, 10°–12°F suction catheter attached to wall suction set at 80–100 mm Hg, shoulder roll
Heart rate assessment	3 lead ECG, Stethoscope
Oxygenate	Free flow oxygen with flowmeter-5–10 L/min, tubings, blender Pulse oximeter probe, pulse oximeter
Ventilate	PPV device with masks, face mask of size 0 (for preterm) and 1 (for term), self-inflating bag with pop off valve, flow inflating bag, reservoir 8 French feeding tube, 20 mL syringe, CPAP
Intubate	Laryngoscope, blade size 0 and 1, ET tubes size- 2.5, 3, 3.5, 4, laryngeal mask airway
Medicines	1:10,000 Epinephrine, Normal saline, 1 mL syringe

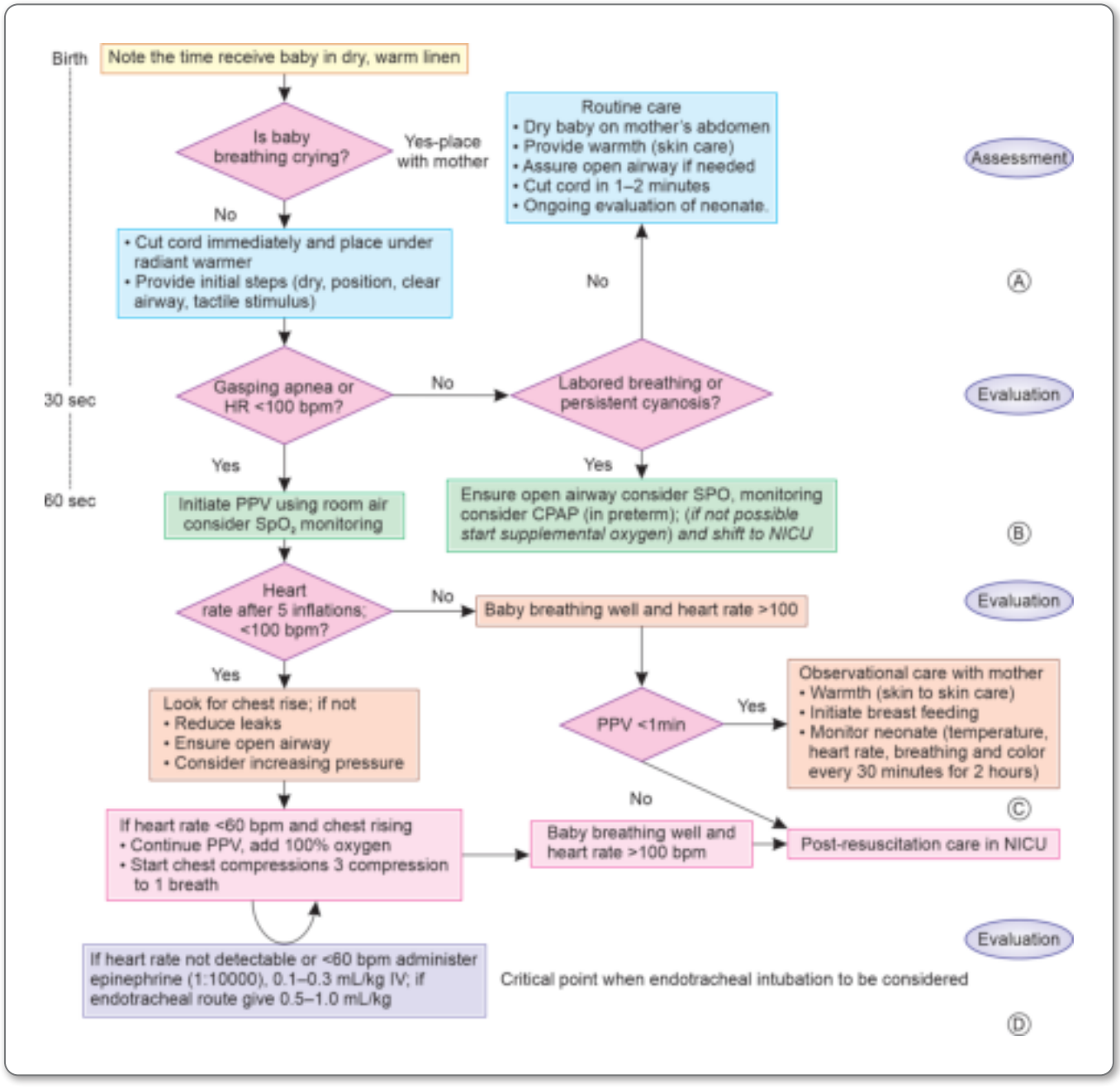


Figure 7.2: Neonatal resuscitation program (NRP India)

consider need for supplemental oxygen. If the baby is preterm, 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 NICU.

Evaluation of the effect of Section B: After 30 seconds of 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 Block C.

Section C (circulation): Support Circulation by starting chest compressions while continuing PPV. Chest compression is given by 'two-finger' technique or 'thumb-encircling' technique (Fig. 7.3). The ratio of compressions to ventilations is 3:1, with 90 compressions and 30 breaths to achieve approximately 120 events per minute to maximize ventilation is recommended. At this stage, it is strongly recommended that endotracheal intubation is done, if already not done earlier. ET tube sizes for various weight and gestation age is shown in Table 7.3. This is for more effective coordination of chest compressions and PPV.

Figure 7.3: Two finger and thumb encircling technique

Table 7.3: ET tube sizes for babies of different weights/gestations

Weight (g)	Gestational age (wks)	Tube size (mm) (inside dilameter)
Below 1000	Below 28	2.5
1000–2000	28–34	3.0
2000–3000	34–28	3.5
Above 3000	Above	38 3.5–4.0

Evaluation of the effect of Section C: After 45–60 seconds of chest compressions and PPV, evaluate the newborn again. If the heart rate is still below 60 bpm, proceed to Block D.

Section D (drug): Administer epinephrine as you continue PPV and chest compressions. Intravenous administration of epinephrine may be considered at a dose of 0.01 to 0.03 mg/kg of 1:10,000 epinephrine. If endotracheal administration is attempted while IV access is being established, higher dosing at 0.05 to 0.1 mg/kg may be reasonable.

Evaluation of the effect of Section D: If the HR remains below 60 bpm, the actions of Section C and D are continued and repeated (lower curved arrow).

When the heart rate improves and rises above 60 bpm, chest compressions are stopped. PPV is continued until the HR is above 100 bpm and the baby is breathing well. Evaluation occurs after initiation of each action and is based on the following two signs:

1. Respiration
2. Heart rate

Also, oxygenation can be assessed when oximetry facilities are available. This process of evaluation, decision and action is repeated frequently throughout resuscitation.

Types of Care after Resuscitation

Routine care: Almost 90% of newborns are vigorous term babies with no risk factors. They do not need to be separated from their mothers at birth. Thermal control can be provided by putting the baby directly on the mother's abdomen without cutting the cord and covering with dry linen. Clearing the upper airway can be provided as necessary by wiping the baby's mouth and nose. After 1–3 minutes, the cord can be cut and the baby is placed on the mother's chest and breast feeding initiated. Ongoing breathing and activity can be observed with the baby on the mother's chest.

Observational care: Babies who have received PPV for <1 minute to help them initiate breathing can also be cared for with their mothers. Besides, the thermal control and breast feeding (as in routine care), breathing, activity and color of these babies should be monitored at least once every 30 minutes during the first 2 hours after birth.

Post-resuscitation care: Babies who have received PPV for more than 1 minute or more extensive resuscitation, are at high risk of further deterioration. These babies should be managed in a neonatal intensive care unit (NICU) or special newborn care unit (SNCU) monitoring. Neonates with respiratory distress after birth initiated the delivery room also need to be shifted to SNCU.

Discontinuing Resuscitative Efforts

An APGAR score of 0 at 10 minutes is a strong predictor of mortality and morbidity in late preterm and term infants. Assisted ventilation may be stopped if the APGAR score is 0 after 10 minutes of resuscitation and HR is undetectable.

BIRTH INJURIES

A birth injury is a trauma to the baby that occurs during the birth process. The injury generally occurs due to tremendous pressure put upon the baby while passing through the birth canal.

Causes of Birth Injury

A difficult birth or injury to the baby can occur because of the baby's size or the position of the baby during labor and delivery. Conditions that may be associated with a difficult birth include:

- **Large babies:** Birth weight over 4,000 g.
- **Prematurity:** Babies born before 37 weeks (premature babies have more fragile bodies and may be more easily injured)
- **Cephalopelvic disproportion:** The size and shape of the mother's pelvis is not adequate for the baby to be born vaginally
- **Dystocia:** Difficult labor or childbirth
- Prolonged labor
- **Abnormal birthing presentation:** Such as breech delivery

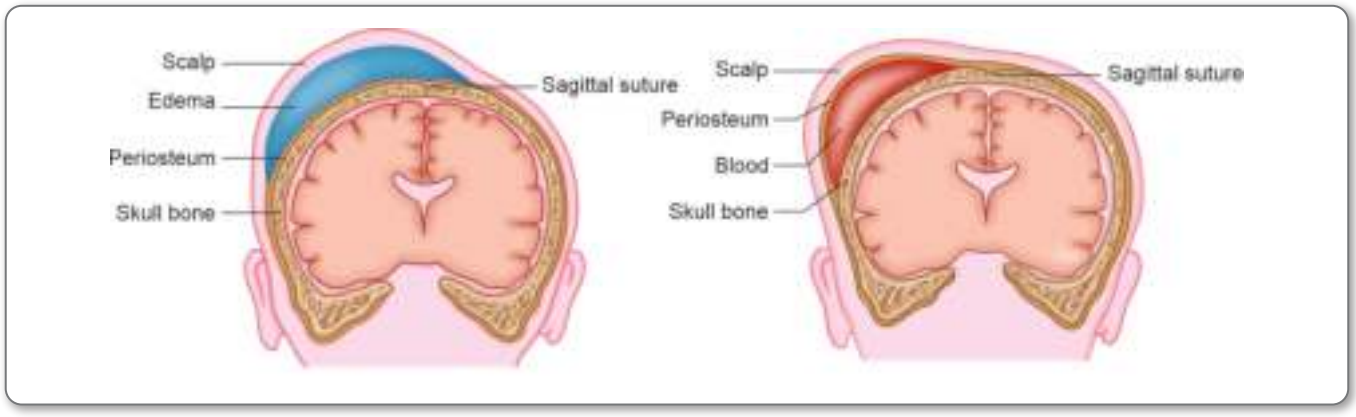


Figure 7.4: Caput succedaneum and cephalohematoma

Types of Injuries

The following are the common birth injuries:

Caput succedaneum (Fig. 7.4): It is a severe swelling of the soft tissues of the baby's scalp that develops as the baby travels through the birth canal. Swelling crosses suture lines. Some babies have bruising on the area. The swelling usually disappears in a few days without problems. Babies delivered by vacuum extraction are more likely to have this condition.

Cephalohematoma: Cephalohematoma is an area of bleeding between the bone and its fibrous covering. It often appears several hours after birth as a raised lump on the baby's head. Swelling does not cross the suture line. The body resorbs the blood. Depending on the size, most cephalohematomas take two weeks to three months to disappear completely. If the area of bleeding is large, some babies may develop jaundice as the red blood cells break down.

Bruising/forceps marks: Forceps used with delivery can leave temporary marks or bruises on the baby's face and head while delivery. Babies delivered by vacuum extraction may have some scalp bruising or a scalp laceration (cut).

Subconjunctival hemorrhage: It is the breakage of small blood vessels in the eyes of a baby. One or both of the eyes may have a bright red band around the iris. This is common and not harmful. The redness is usually absorbed in a week to 10 days.

Facial paralysis: This may occur due to the facial nerve injury as a result of pressure on a baby's face during delivery. This may also occur with the use of forceps for delivery. The injury is often seen when the baby cries. There is no movement on the side of the face with the injury and the eye cannot be closed. If the nerve was only bruised, the paralysis usually improves in a few weeks.

Brachial palsy (also known as Erb's Palsy): Brachial palsy (Fig. 7.5) occurs when the brachial plexus (the group of nerves that supplies the arms and hands) is injured. It is most common when there is difficulty delivering the baby's shoulder (shoulder dystocia). The baby loses the ability to flex and rotate the arm. Many cases of brachial palsy get resolved spontaneously in 24 hours or less. Splints or therapy may not be necessary in these cases. If the injury caused bruising and swelling around the nerves, movement should return within a few months. Tearing of the nerve may result in permanent nerve damage. Special exercises are used to help maintain the range of motion of the arm while healing occurs.

Figure 7.5: Erb's palsy

Fractures: Fracture of the clavicle is the most common fracture during labor and delivery. The clavicle may break when there is difficulty delivering the baby's shoulder or during a breech delivery. The baby with a fractured clavicle will rarely move the arm on the side of the break. However, healing occurs quickly. As new bone forms, a firm lump on the clavicle often develops in the first 10 days. If the fracture is painful, limiting movement of the arm and shoulder with a soft bandage or splint may be helpful. Parents are advised not to lie the infant on the affected side until the fracture has healed.

Many birth injuries, such as bruising, swelling, forceps scars and even the rare fracture (usually during a breech birth), are

not serious and heal within a few weeks. Temporary loss of nerve or muscular function caused by bruising, pressure or swelling around the nerves can similarly resolve itself within weeks or months. However, if the nerves are torn, the resulting damage may be permanent.

Prevention of Birth Injuries

- Adequate knowledge must be shared with the parents about the risks, and the possible courses of action.
- Performing a caesarean section when the risk factors for shoulder dystocia are present.
- Avoiding the use of forceps or a vacuum extractor when there is evidence of a large baby, and
- Avoiding excessive force at delivery.

ESSENTIAL NEWBORN CARE

The events during first few minutes and hours of life have an immense bearing on the immediate and long-term outcome of the infant. The basic principles of care at birth are the same whether the baby is managed by a doctor or any other health professional and whether the baby is delivered at home or in the hospital.

Aims of neonatal care at birth include the following:

- **Maintain a patent airway:** Infant must be positioned side lying after feeding to prevent aspiration. Place infant in supine positions during sleep to prevent sudden infant death syndrome (SIDS). Keep bulb syringe at the bedside in case suctioning is needed.
- **Prevention of hypothermia:** After having ensured that the baby has established effective breathing, it is essential that all efforts are made to prevent the occurrence of hypothermia. The baby should be resuscitated under a radiant warmer or any heat source and should be adequately covered thereafter. Normothermia can be maintained by appropriately clothing the baby according to season and providing kangaroo mother care.
- **Establishment of breastfeeding:** Breast feeding has to be initiated within half an hour of birth, exclusive breastfeeding has to be given till six months of age. Babies who are adequately fed, are contented, playful, have good sleep and are satisfied for at least 2–3 hours after a feed. An adequately fed baby passes urine at least 5–6 times in a day, while babies pass urine (even stools) after each feed during the first 3 months of life.
- **Prevention of infection:**
  - **Eye care:** The eyes should be cleaned with sterile normal saline. Use one swab for each eye. For prophylaxis against gonococcal ophthalmia 1.0% silver nitrate drops or 0.5% tetracycline or erythromycin ophthalmic ointment can be used.
  - **Cord care:** The umbilical cord should be tied using a disposable clamp. The clamp should be applied at least 2–3 cm beyond the base of the cord to avoid inadvertent incision of gut contained in minor exomphalos. Do not apply anything on the cord. A sterile disposable delivery kit should be used for each baby to prevent cross infection.
  - **Vitamin K** 1.0 mg is administered intramuscularly to all babies weighing more than 1000 g, and 0.5 mg to babies weighing less than 1,000 g at birth.
  - **Immunization**: Administer BCG, hepatitis B and OPV at birth.
- **Identification of at risk neonates:** Quick and thorough clinical examination should be done to identify any life-threatening congenital anomalies and birth injuries.
  - Babies with birthweight <1800 g, babies with gestation <34 weeks
  - Examine cord for two umbilical arteries and one umbilical vein. The presence of a single umbilical artery is associated with IUGR, renal and cardiac anomalies.
  - Single palmar crease (Simian crease) is associated with Down syndrome.
  - The face and head should be closely observed for any asymmetry and dysmorphic features.
  - The anomalies concentrated over the mid-line areas in the front and back include spina bifida, ambiguous genitalia, hypospadias, exomphalos, cleft lip and cleft palate, etc.
  - The abdomen should be palpated for any masses.
  - Examine heart for its position and any murmurs. Displacement of the heart toward the right side in association with respiratory difficulty and resuscitation problems is suggestive of either diaphragmatic hernia or pneumothorax on the left side.
  - Babies with asphyxia needing post resuscitation care
  - Babies with breathing difficulty

Weight Change Pattern in Term Baby

Majority of term newborns lose 5–10% of their weight during first 2–3 days of life and regain their initial weight by end of first week.

Preterm babies experience 10–15% of weight loss and is regained by 10–14 days.

Babies who are adequately fed, are contented, playful, have good sleep and are satisfied for at least two to three hours after a feed. An adequately-fed baby passes urine at least 5–6 times in a day, babies may also pass urine (even stools) after each feed during the first 3 months of life.

The average daily weight gain in term babies is around 20–30 g/day.

Early Identification of Disease (Danger Signs)

Before discharge, the danger signs must be explained to the mother and advised to bring the baby to the facility if any of the following danger sign is observed.

Danger Signs

- Bleeding from any site
- Appearance of jaundice within 24 hours of age or yellow staining of palms or soles
- Failure to pass meconium within 24 hours or urine within 48 hours
- Persistent vomiting or diarrhea
- Poor feeding
- Undue lethargy or excessive crying
- Drooling of saliva or choking during feeding
- Respiratory difficulty, apneic attacks or cyanosis
- Sudden rise or fall in body temperature
- Seizures
- Evidences of superficial infections such as conjunctivitis, pustules, umbilical sepsis or oral thrush, etc.

Practices to be Discouraged

- Applying kajal, surma in eyes
- Putting oil or boric acid in nostrils
- Applying cow dung on cord

Follow-up

Each baby should be followed up in the well-baby clinic for assessment of growth and development, early diagnosis and management of illnesses and health education of parents. Immunizations can also be done during follow up visits.

FACILITY-BASED NEWBORN CARE

India accounts for 30% of the neonatal deaths globally. In India, the neonatal mortality rate is 37/1,000 live births. Most of these deaths occur within the first days of life, 46.2% occurring in the first two days of life and 73.3% taking place within the first week of life. Neonatal mortality is one of the major contributors (2/3) to the Infant Mortality.

Facility-based Newborn Care (FBNC) program is one of the key initiatives launched by the Government of India under the National Rural Health Mission and RMNCH+A Strategic program to improve the status of newborn health in the country.

Under the program, efforts are being made to provide different level of newborn care at the health facilities (Table 7.4).

Table 7.4: Newborn Care facilities at different levels

Health facility	All newborns at birth	Sick newborns
Primary health centre (PHC)/Sub-centre (SC) identified as MCH Level I	Newborn care corner in labor rooms	Prompt referral
Community health centre (CHC)/First referral unit (FRU) identified as MCH Level II	Newborn care corner in labor rooms and in operation theatre (OT)	Newborn stabilization unit
District hospital identified as MCH Level III	Newborn care corner in labor room and in operation theater	Special newborn care unit (SNCU)

- Newborn care corners (NBCCs) established at all delivery points to provide essential newborn care, within the delivery room. This area is mandatory for all health facilities where deliveries take place. It provides an acceptable environment for all infants at birth. Services provided in the newborn care corner include:
- Essential care at birth
- Resuscitation
- Provision of warmth
- Early initiation of breastfeeding
- Weighing the neonate
  - Newborn Stabilization Units (NBSUs) established at Community Health Centers/First Referral Units for management of selected newborn conditions and to stabilize serious and sick newborns for short periods before referral to higher centers. It is located within or in close proximity to the maternity ward.
  - Special Newborn Care Units (SNCUs) set up at district hospital level. SNCUs are established in the vicinity of the labor room to provide special care for sick newborn except assisted ventilations and major surgeries. The SNCU is expected to provide the following services:
    - Care at birth
    - Resuscitation of asphyxiated newborns
    - Managing sick newborns (except those requiring mechanical ventilation and major surgical interventions)
    - Kangaroo mother care
    - Postnatal care
    - Follow-up of high risk newborns
    - Referral services
    - Immunization services

The FBNC guidelines provide directions for specifications and processes related to establishment of new facilities and provide technical guidelines/key clinical protocols to service providers working in newborn care facilities for managing sick newborns. Services provided by these facilities are depicted in Table 7.5.

Set Up of Newborn Care Facilities

Newborn Care Corner (NCC)

An area of about 20–30 sq ft in size is earmarked within the labor rooms of all health facilities for establishing a newborn care comer. The corner is equipped with radiant warmer and resuscitation kits.

Table 7.5: Services provided at various newborn care facilities

Newborn care corner	Stabilization unit	Special newborn care unit
Care at birth	**Care at birth**	**Care at birth**
• Prevention of infection	• Prevention of infection	• Prevention of infection
• Provision of warmth	• Provision of warmth	• Provision of warmth
• Resuscitation	• Resuscitation	• Resuscitation
• Early initiation of breastfeeding	• Early initiation of breastfeeding	• Early initiation of breastfeeding
• Weighing the newborn	• Weighing the newborn	• Weighing the newborn
Care of normal newborn	**Care of normal newborn**	**Care of normal newborn**
• Breastfeeding support	• Breastfeeding support	• Breastfeeding support
• Care of sick newborn	• Care of sick newborn	• Care of sick newborn
• Identification and prompt referral of 'at risk' and 'sick' newborn	• Management of low birth weight infants ≥800 g with no other complications • Phototherapy for newborns with hyperbilirubinemia • Management of newborn sepsis • Stabilization and referral of sick newborns and those with very low birth weight (rooming in) • Referral services	• Managing of low birth weight infants <1800 g • Managing all sick newborns (except those requiring mechanical ventilation and major surgical interventions) • Follow-up of all babies discharged from the unit and high-risk newborns • Immunization services • Referral services
Immunization services	Immunization services	Immunization services

Newborn Stabilization Unit (NBSU)

- For setting up a 4-bedded stabilization unit, at least 200 sq ft of floor space is required. The unit should be located within or in close proximity to the maternity ward.
- In addition, two beds in the postnatal ward should be dedicated for rooming-in.
- **Power and water supply:** The unit should have 24 hours uninterrupted stabilized power and water supply.
- **Lighting:** The unit should be well lit, preferably with compact fluorescent light (CFI) panels.
- **Floor surfaces and walls:** The floor surfaces and walls should be easily cleanable thus minimizing the growth of microorganisms.
- **Equipment:** The equipment for maintaining temperature and conducting resuscitation are required.

Criteria for Admission to NBSU

- Newborns presenting to FRU/NBSU with emergency signs
- Newborns not having emergency signs, weight above 1800 g and any of the following signs of sickness:
  - Feeding problem
  - Breathing Rate 60–70/min
  - Hyperthermia (axillary temperature >37.5°C)
  - Hypothermia (35.5°–36.4°C)
  - Jaundice requiring only phototherapy of Newborns with suspected sepsis 3. Weight 1500–1800 g, with no sign of sickness
- Newborns who cannot be transferred to SNCU or referral facility due to any reason
- Newborns back-referred (from SNCU) to NBSU for completion of treatment

Special Newborn Care Unit (SNCU)

- **Beds:** The minimum recommended number of beds for an SNCU at the district hospital is 12. However, if the district hospital conducts more than 3,000 deliveries per year, 4 beds should be added for each 1,000 additional deliveries.
- **Space:** An average floor area of 50 sq ft per bed should be available for a patient care area with an additional 50 sq ft to be utilized as ancillary area. Therefore, on an average, a total area of 100 sq per patient is required. For example, for a 12-bedded SNCU, 1,200 sq ft area is required.

  Additional space will be required for the step-down area which will have beds for babies rooming-in with the mothers after the acute phase of illness is over. The number of beds (adult beds would be required for rooming in babies with mother) is 30% of the SNCU beds. For example, a 12-bedded unit will require 4 additional adult beds for the step down.

- **Areas:** The unit should be so designed as to have the following area:
  - **Patient care area:** For a unit of 12 beds, the patient care area would be 600 sq ft (50 sq ft per bed). The patient care area is designed to have two interconnected rooms separated by transparent observation windows from the nurses' working place in between. While one room can be used for intramural newborn (those born within the health facility, another room can be used for extramural newborns those born outside the health facility).
  - **Ancillary area:** 600 sq ft ancillary area should include separate areas for hand washing and gowning area at the entrance, nurses work station, clean area for mixing intravenous fluids and medications, doctors duty rooms, computer terminal, mother's area for expression of breast milk and learning mother crafts, unit store and side lab. It is desirable to have areas for portable X-ray, boiling and autoclaving and laundry room.
  - **Step-down area:** In addition to the patient care area and ancillary space, the SNCU design should include the step-down unit. The step-down could be within the premises or in close proximity.
- **Civil requirements:**
  - **Power supply:** The unit requires 24 hours uninterrupted stabilized power supply, sufficient to take the load of equipment.
  - **Floor surfaces:** The floor surfaces should be easily cleanable and minimize the growth of micro-organisms
  - **Walls:** As with floors, the case of cleaning, durability, and acoustical properties of wall surfaces must be considered.
  - **Water supply:** The unit should have 24 h uninterrupted running water supply.
  - **Lighting:** Light sources should be as free as possible of glare or veiling reflections. No direct view of the electric light source or sun should be permitted in the newborn space.
  - **Temperature:** The unit should be designed to provide an air temperature of 78.8°–82.4°F (28° ± 2°C)
  - **Equipment:** SNCU equipment include equipment for resuscitation, phototherapy and thermoregulation such as radiant warmers and phototherapy units.

FACILITY-BASED INTEGRATED MANAGEMENT OF NEONATAL AND CHILDHOOD ILLNESS

Facility-based Integrated Management of Neonatal and Childhood Illness (F-IMNCI) is the integration of the Facility-based Care package with the IMNCI package, to empower the health personnel with the skills to manage newborn and childhood illness at the community level as well as the facility. It helps to build capacities to handle referrals taking place from the community.

Majority of the health facilities (24 × 7 PHCs, FRUs, CHCs and District hospitals) do not have trained pediatricians to provide specialized care to the referred sick newborns and children, the F-IMNCI training helps in skill building of the medical officers and staff nurses posted in these health facilities to provide this care.

The F-IMNCI package has been developed by a committee of experts constituted by the Ministry of Health and Family welfare, Government of India.

This package includes the following:

IMNCI package (explained in Unit 4)	Facility-based care
• Module 1: Introduction • Module 2: Assess and Classify the sick young infant age up to 2 months • Module 3: Identify treatment for the sick young infant • Module 4: Treat the young infant and Counsel the mother • Module 5: Assess and Classify the sick child age 2 months up to 5 years • Module 6: Identify treatment for the sick child • Module 7: Treat the child • Module 8: Counsel the mother • Module 9: Follow-up	Module 1: Emergency triage assessment and treatment (ETAT) • Triage • Maintain temperature • Check and treat hypoglycemia • Airway and breathing • Give oxygen • Circulation • Coma and convulsions • Dehydration Module 2: Facility-based care of sick young infant • Care at birth including neonatal resuscitation • Care of newborn in postnatal ward • Management of sick newborn • Management of low birth weight babies • Neonatal transport Module 3: Facility-based care of sick child • Case management of children presenting with cough or difficult breathing • Case management of children presenting with diarrhea • Case management of children presenting with fever • Management of children with severe anemia • Case management of children with severe malnutrition

Summary

The neonatal period, i.e., the first 28 days of life carries the highest risk of mortality per day than any other period during the childhood. The risk of mortality in the first 4 weeks of life is much higher than the post-neonatal period. Three-fourths of total neonatal deaths occur in the first week of life. The first 24-hour account for more than one-third of the deaths that occur in the entire neonatal period. Thus providing essential neonatal care is vital.

Assess Yourself

1. Explain the components of essential newborn care.
2. Differentiate between cephalohematoma and caput succedaneum.
3. BMV (PPV) must be initiated when HR is below……. (100) and chest compressions are started when the HR is below……. (60)
4. Two methods of chest compressions are …….. and …….. (thumb encircling and two finger technique)
5. Ratio of chest compressions to ventilations is ……. (3:1)
6. List the newborn care facilities at different levels.

Chapter 8

Low Birth Weight Baby

Chapter Outline

INTRODUCTION

In India, over 30% infants born are low birth weight (LBW). Nearly 75% neonatal deaths and 50% infant deaths occur among the low birth weight neonates. Even after recovering from neonatal complications, some LBW babies may remain more prone to malnutrition, recurrent infections, and neurodevelopmental handicaps. Low birth weight, therefore, is a key risk factor of adverse outcome in early life.

LOW BIRTH WEIGHT (LBW) BABY

The normal birth weight of newborns in our country is around 2800–3000 g. LBW baby denotes birth weight of less than 2500 g. Low birth weight neonates are further classified as:

- Very low birth weight (VLBW <1500 g)
- Extremely low birth weight (ELBW <1000 g) infants

Types of LBW

The newborn baby can be LBW because either it is preterm or IUGR. A preterm baby has not yet completed 37 weeks of gestation. Since fetal size and weight are directly linked to gestation, and the delivery takes place prematurely, the baby is likely to have less weight.

The second situation that leads to low birth weight is intrauterine growth retardation or IUGR. This condition is similar to malnutrition. Here, gestation may be full term or preterm, but the baby is undernourished, undersized and therefore, low birth weight. Such a baby is also called a small-for-date or SFD neonate. Two-thirds of LBW neonates fall in this category. At times, a LBW neonate may be both preterm as well as small-for-date.

Etiology of LBW

The causes of preterm labor include teenage mothers, low maternal weight, cervical incompetence, antepartum hemorrhage, previous fetal loss and previous preterm delivery. Sometimes, preterm labor is medically induced for the sake of the baby as in the case of Rh iso-immunization or maternal diabetes mellitus. Poor nutritional status of the mother and frequent pregnancies are the major causes of intrauterine growth retardation. Mothers with a weight of less than 40 kg and a height of less than 145 cm often give birth to small for date babies. Insufficient nutritional intake during pregnancy also has an adverse effect on fetal weight. Maternal hypertension, pre-eclampsia, postmaturity, frequent pregnancies, multiple pregnancy, anemia, malaria and tobacco use are other causes of intrauterine growth retardation. Chronic maternal diseases of heart, kidneys, lungs or liver may also lead to intrauterine growth retardation.

Table 8.1: Types of LBW Baby

Preterm baby	Small-for-date baby
Preterm baby is diagnosed on the basis of period of gestation calculated from the last menstrual cycle of the mother. If it is less than 37 completed weeks, the baby is preterm. Features of Preterm babies: • Skin-skin of preterm babies is thin, transparent and gelatinous. • Sole creases- Deep skin creases on soles are present only on the anterior one third. • Ear cartilage- External ear or the pinna is soft and devoid of cartilage. Hence, it does not recoil back promptly on being folded. • External genitalia- In males, the scrotum does not have rugae and testes are not descended into the scrotum. • In females, the labia are widely separated, not covering the labia minora, resulting in the prominent appearance of the clitoris. • Hair- The back of the preterm babies has abundant growth of fine hair called lanugo. • Breast nodule — measures less than 5 mm.	• Small-for-dates neonates have an emaciated look and loose folds of skin because of lack of subcutaneous tissue. These are particularly prominent over the buttocks and the thighs. They look alert and often plethoric. • Normally, the head is bigger than the chest by about 2 cm. In small- for-date babies, the head circumference exceeds the chest circumference by more than 3 cm. • The small-for-date babies are often full term or borderline term in gestation. When their birth weight is plotted on the intrauterine growth chart, it falls below the 10th centile.

Signs and Symptoms of Preterm and SFD Infants

The clinical distinction between the two types of LBW babies should be made. The two types of LBW baby are preterm baby and small for date baby (Table 8.1):

Any baby at birth may be classified based on gestation into preterm, term or post-term and on the birth weight into small-for-date (SFD) appropriate-for-date (AFD), and large-for-date (LFD) as shown in Figure 8.1. If a baby is preterm as well as small-for-date, he/she would have a combination of the above mentioned features.

Problems of Preterm Neonates

The LBW babies are predisposed to a number of neonatal problems. The problems of preterm and the small-for-date infants are different. The basic underlying feature of the preterm LBW infant is immaturity of their organ systems.

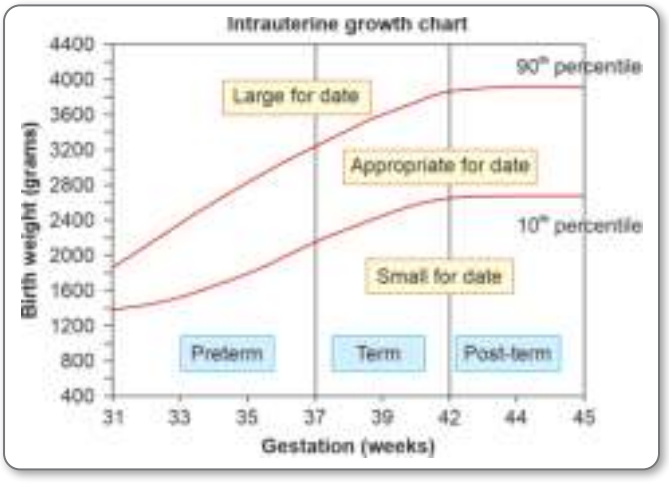


Figure 8.1: Classification of babies

- **Asphyxia:** They may not establish respiration satisfactorily at birth and develop asphyxia necessitating expert resuscitation.
- **Hypothermia:** Newborn babies keep themselves warm by active metabolism in the brown fat stores. The preterm babies lack brown fat and therefore become hypothermic at the usual ambient temperature unless specific measures are taken to keep them warm.
- **Feeding problem:** Preterm neonates less than 34 weeks of gestation cannot coordinate sucking and swallowing. Therefore, they are unable to feed from the breast.
- Preterm LBW infants, especially those less than 30 weeks of gestation may not tolerate any enteral feeds initially because of gut immaturity.
- **Respiratory distress syndrome (RDS):** Preterm babies, especially less than 34 weeks, have immature lungs which do not expand well after birth and thus are unable to perform the function of gas exchange. They develop RDS characterized by rapid and labored respiration, chest indrawing, grunting, and cyanosis. Because of the immature respiratory control mechanisms these babies also have a tendency for apneic spells. In an apneic spell the baby stops breathing, develops slow heart rate and turns blue.
- Preterm infants also have immature vascular bed around the brain ventricles. These delicate vessels may rupture and cause intraventricular hemorrhage.
- Immature metabolic pathways of preterm infants predispose them to develop hypoglycemia, metabolic acidosis and hyperbilirubinemia.

- **Infection:** Preterm babies do not have efficient humoral, cellular and mucosal immune mechanisms to protect themselves against bacteria. Interventions such as needle pricks and intravenous lines, especially in the setting of a contaminated environment, predispose them to potentially fatal bacterial infections.
- **Retinopathy of prematurity (ROP):** Preterm infants may develop blindness if given excess oxygen, because of damage to the immature retina, a condition called Retinopathy of Prematurity.

Problems of SFD Neonates

The basic underlying problem of SFD neonates is in-utero undernutrition and hypoxia. They have small placentae. The stress of labor may lead to fetal distress, meconium passage in utero and birth asphyxia. Since, they are chronically undernourished in utero, they also lack adequate brown fat stores. This predisposes them to hypothermia. They also develop hypoglycemia because of insufficient energy stores. They too are candidates for neonatal sepsis because of the ill effects of chronic intrauterine stress on the immune system. Small-for-dates infants are more likely to have malformations than their normal counterparts. They also face feeding difficulties, though to a lesser extent than the preterm babies.

MANAGEMENT OF LBW BABIES

Delivery of Low Birth Weight Babies

Ideally, the delivery of an anticipated LBW baby should be conducted in a hospital. Premature labor as well as intrauterine growth retardation are indications for referral of the pregnant mother to a well-equipped facility. In-utero transfer of a low weight fetus is more desirable, convenient and safe than the transport of a low weight baby after birth. Delivery should be conducted by trained health professionals, of whom, at least one should be well-versed with the art of neonatal resuscitation. The standard procedure of resuscitation should be followed efficiently. Resuscitation equipment like suction catheters, bag and mask, oxygen cylinder, laryngoscope, etc. should be kept ready beforehand. Baby must be provided warmth from a heat source, like a radiant warmer or heater or a lamp with 200 W bulb to prevent hypothermia.

Deciding the Place where a LBW Baby Should be Managed

A healthy LBW newborn with a birth weight of 1800 g or above and gestation of 34 weeks or more can be managed at home by the mother and the family under the supervision of a health worker. The indications for hospitalization of a neonate are:

- Birth weight less than 1800 g
- Gestation less than 34 weeks
- Neonate who is not able to take feeds from the breast or by katori spoon (irrespective of birth weight and gestation)
- A sick neonate (irrespective of the birth weight or gestation)

Keeping LBW Babies Warm

Provision of warmth to prevent hypothermia is one of the important principles of newborn care. A baby under cold stress wastes energy and oxygen while trying to maintain temperature. Hypothermia can lead to hypoglycemia, bleeding diathesis, pulmonary hemorrhage, acidosis, apnea, respiratory failure, shock and even death. These conditions can be prevented by the following measures:

At Home

The mother herself is a source of warmth for the baby. It is of immense help to nurse the baby next to the mother, day and night. The room where a low birth weight baby is nursed should be kept warm (temperature between 28°C and 30°C in all seasons). This temperature is slightly uncomfortable for adults, but this discomfort has to be accepted for the sake of the baby. While in summer months no extra effort is required to maintain this temperature, in winter months a room heater may have to be used. The baby should be clothed well. Two or three layers of clothes are generally required. If the room is not warm enough, woolen sweater should also be put on. Feet should be covered with socks, hands with mittens and head with a cap. A blanket can also be used to cover the baby.

If a child is maintaining normal body temperature, the trunk feels warm to touch while the soles and the palms are pink and warm. In early stages of hypothermia, the trunk is warm but the soles and palms are cold to touch. This condition, cold stress, is not normal and baby requires additional warmth immediately.

In the Hospital

Overhead radiant warmer or incubator may be used to keep the baby warm. Regular monitoring of axillary temperature should be carried out in all hospitalized babies.

Nutrition and Fluids

Mode of Providing Fluids and Feeds

Birth weight, gestation, presence or absence of sickness and individual feeding effort of the baby determine the decision as to how a low birth weight neonate should be provided fluids and nutrition (Table 8.2). Ultimate goal is to meet both these needs from direct and exclusive breast feeding.

- Neonates weighing less than 1200 g or of a gestation of less than 30 weeks, or those having sickness should receive intravenous fluids initially. Enteral feeds should be introduced gradually by gavage as the baby's acute problems begin to settle. In due course, the baby is shifted to katori-spoon feeds and then to direct breast feeds.

Table 8.2: Guidelines for the modes of providing fluids and feeding

Age	Categories of neonates		
Birth weight (g)	<1200	1200–1800	>1800
Gestation (weeks)	<30	30–34	>34
Condition			
Initial	Intravenous fluids Try gavage feeds, if not sick	Gavage	Breastfeeding. If unsatisfactory, give katori-spoon feeds
After 1–3 days	Gavage	Katori-spoon	Breast
Later (1–3 weeks)	Katori-spoon	Breast	Breast
After some more time	Breast	Breast	Breast
(4–6 weeks)			

- Infants weighing 1200–1800 g (or 30–34 weeks gestation) and not having significant illness should be put on gavage feeds initially. In few days, it should be possible to shift the baby to katori-spoon feeds, and then gradually to breast feeds. In order to promote lactation and enable the baby to learn sucking, all babies on gavage or katori-spoon feeds should be put on the breasts before each feed for 5–10 minutes. With improvement in their overall condition, the infants would start meeting part and later, all of their nutritional needs from direct breastfeeding. Breast milk is the best milk for the LBW baby.

Must Know

- For gavage and katori-spoon feeds, use expressed breast milk only. Start with small volume and gradually build up.
- When the baby is on gavage or katori-spoon feeds, it is important that he is put to the breast before every feed. Although the baby may not obtain much milk, it will help promote lactation and enable the baby to learn how to suck.
- When shifting a baby from one mode of feeding to another, be very careful. Introduce the new mode for only some of the feeds to begin with.
- The feeding of every baby should be individualized. The above recommendations should only serve as broad guidelines.

Most LBW babies weighing more than 1800 g or over 34 weeks of gestation are able to feed directly from the breast. However, some of them may not be able to suck satisfactorily during the first few days of life. During this period, the feeds may be provided by katori-spoon.

Enteral Feeds

Breast milk is the ideal feed for the low birth weight babies. Those unable to feed directly on the breast, can be given fresh expressed breast milk (EBM) by gavage or katori-spoon.

It is well to remember that the breast milk of the mother of the LBW baby contains appropriately higher protein and calories and is uniquely suited to provide optimum nutrition to her LBW baby. The milk is thus not only species specific, it is also baby specific. If lactation is inadequate in spite of the best efforts, the baby should be carefully evaluated for supplementary feeding with top milk. This decision however should be taken after careful thought. Feeding with milk other than breast milk should be reserved essentially for the hospitalized babies and resorted to for the minimum necessary period until breast milk feeding can be ensured. Any formula providing (per dL) about 2 g protein (preferably whey-dominant), 4.0 g fat (containing polyunsaturated fatty acids and medium chain triglycerides), 10–12 g of carbohydrate (as lactose and maltodextrins) and 70–80 Kcal calories is quite suitable. If it is not possible to afford a formula milk, any milk obtained for household use may be fed without dilution.

It is emphasized again that a decision to feed a milk other than breast milk is a major decision and must not be taken lightly. Only when all avenues for obtaining breast milk are exhausted, should one resort to this as an interim unavoidable choice.

Amount and Scheduling of Enteral Feeds

For infants on gavage or katori-spoon feeds, total daily requirements can be estimated from the table on the fluid requirements. In a stable, growing LBW baby daily intake of feeds should be gradually built up to 180–200 mL/kg. LBW babies should be fed every 2 hours starting at 2 hours of age. Two- hourly feeds are also applicable to LBW receiving direct breast feeding. LBW babies may take longer on the breast as compared to their normal weight counterparts.

Technique or Methods of Feeding

- Gavage feeds
- Katori-spoon feeds
- Breast feeding

Intravenous Fluids

The fluid requirements of LBW neonates are summarized in Table 8.3.

Table 8.3: Fluid requirements of neonates (mL/kg body weight)

Day of life	Birth weight	
	>1500 g	1000–1500 g
1	60	80
2	75	95
3	90	110
4	105	125
5	120	140
6	135	155
7 onward	150	170

Must Know

- On the first day, the fluid requirements range from 60–80 mL/kg, the difference between the two categories being 20 mL
- The daily increment in all groups is around 15 mL/kg till day 7.
- Extra 20–30 mL/kg fluid should be added for infants nursed naked under a radiant warmer.
  For those receiving phototherapy add extra 15 mL/kg fluid.
- These are general guidelines; fluid therapy of each baby should be individualized.

For the initial 2 days, intravenous fluids should consist of 10% dextrose only. After that, sodium (2–4 mEq/kg) and potassium (2–3 mEq/kg) is also added to dextrose. These requirements are generally met by preparing one-fifth isotonic saline (N/5 saline is one fifth saline and it is prepared by adding four parts of Dextrose to one part of normal saline). If intravenous fluids are mixed in the nursery, full aseptic precautions must be taken.

For administering intravenous fluids to the neonate, a small volume infusion set should be used. The flow of fluids should be carefully monitored. Too rapid an infusion may result in congestive heart failure and even death in a small baby. Parenteral fluid therapy needs to be monitored carefully, especially among babies weighing <1500 g. Adequacy of fluid therapy is indicated by weight pattern in the expected range (vide infra).

Judging Adequacy of Nutrition

The key measure of optimal feeding is the weight pattern of the baby. A preterm LBW baby loses up to 1–2% weight every day amounting to 10% cumulative weight loss during the first week of life. Birth weight is regained between 10th and 14th day. Babies start gaining weight by the second week of life at a rate of about 15–20 g/day. SFD-LBW babies who are otherwise healthy should not have any appreciable weight loss at all and they should start gaining weight early. It is desirable to weigh all LBW babies at 2 weeks (to check regaining of the birth weight), 4 weeks (to ascertain a weight gain of at least 200–300 g) and then every month. Hospitalized LBW babies should be weighed every day on the same weighing machine. Excessive weight loss, or inadequate weight gain indicates inadequate feeding, cold stress, excessive insensible water loss or systemic illness (like anemia, sepsis, late metabolic acidosis, etc.).

Vitamin Supplements

- **Vitamin K:** All LBW babies <1000 g should receive 0.5 mg IM vitamin K at birth and others 1.0 mg IM at birth.
- Vitamins A and D are required in doses of 1000 IU and 400 IU respectively every day from 2 weeks of age. Several of the available multivitamin preparations provide these doses in 0.3 mL (5 drops) volume.
- **Iron:** At 6–8 weeks of age, iron supplements should be started in a dose of 2–3 mg/kg/day to prevent anemia of prematurity.
- **Calcium and phosphorous:** Very low birth baby (<1500 g, <32 weeks gestation) needs vitamin E, calcium and phosphorus supplementation till 37 weeks.

Prevention of Infection

The LBW babies are predisposed to serious bacterial infections. Even when treated aggressively, the mortality due to sepsis is high. The following measures will help prevent infections:

- Hand washing by the health professional attending delivery and by the mother and family before handling the baby.
- Ensuring early and exclusive breast milk feeding and avoiding all the pre-lacteal feeds. Careful attention to the hygiene of katori-spoon feeds. Dropper/bottle/nipple/cotton wick should never be used for feeding the baby.
- Care of the umbilical stump.
- Avoiding unnecessary interventions such as intravenous lines and needle prick.

Early Detection of Sickness and Management of Complications

Clinical monitoring is the most important and practical method for early detection of complications. It involves periodic evaluation for signs of illness. These include lethargy, refusal to feed, hypothermia, respiratory distress, grunt, apnea, abnormal weight gain pattern, jaundice over soles and palms, abdominal distension, feed intolerance, cyanosis, pallor, sclerema, seizures and bleeding. A baby who shows anyone or more of the above signs/symptoms should be immediately referred to for hospitalization and prompt management of the specific complications by a neonatologist.

Transporting a Sick LBW Baby

Every infant should be stabilized before transport as far as possible. A doctor or nurse should accompany the baby, if possible. The referring doctor should ensure sending a written note covering the antenatal, intra-natal and neonatal details along with the baby.

Vaccinations in LBW Babies

If the LBW baby is not sick, the vaccination schedule is the same as for the normal babies. Hence BCG and OPV should be given at the earliest. A sick LBW baby however, should receive these vaccines only on recovery.

Prognosis

Mortality of LBW babies is inversely related to gestation and birth weight and directly to the severity of complications.

Because of organ system immaturity, the preterm babies fare more poorly in the immediate neonatal period than the corresponding weight SFD babies. Adequacy of management at birth also makes a major difference. A low birth weight baby who experiences significant birth asphyxia or develops hypothermia soon after birth is seriously compromised no matter what heroic measures are instituted later on.

Long-term outcome of LBW infant likewise depends on gestation, birth weight and the nature and severity of complications. In general, over 90% LBW babies who survive the newborn period have no neurodevelopmental handicaps. Therefore, it is heartening to note that essential care of the LBW neonates is a highly rewarding experience.

KANGAROO MOTHER CARE

Introduction

Kangaroo mother care (KMC) is a method of caring for newborn infants. In this method the infant in placed between mother's breasts in direct skin-to-skin contact. It is particularly useful in caring for low birth weight infants below 2000 g. Nurses have a major role to play to initiate and motivate mothers to practice KMC as they conduct deliveries in various health settings and function in neonatal ICUs.

Components of Kangaroo Mother Care

Skin to skin contact: This component involves direct skin-to-skin contact of the newborn with the mother. It should be early and continued for prolonged periods of time.

Exclusive breastfeeding: Most of the babies below 2000 g would gain weight adequately on exclusive breastmilk feeding.

Physical, emotional and educational support: This should be provided by the nursing and medical staff to the mother and the family.

Early discharge and follow-up: KMC should be initiated in the hospital under supervision. KMC would facilitate early discharge from the hospital and this practice should be continued at home. These babies should be followed up regularly to ensure a normal outcome.

Benefits of KMC

KMC has been shown to have benefits on:

Breastfeeding: Studies have shown that KMC results in increased breastfeeding rate as well as increased duration of breastfeeding.

Thermal control and metabolism: Studies carried out in low-income countries showed that prolonged skin-to-skin contact between the mother and her preterm/LBW infant provides effective thermal control and are associated with a reduced risk of hypothermia. KMC results in normal temperature during the procedure without any risk of hypothermia.

KMC satisfies all five senses of the baby. The baby feels warmth of mother through skin-to-skin contact (touch), she listens to mother's voice and heart beat (hearing), sucks on breast (taste) has eye contact with mother (vision) and smells mother's odor (olfaction).

Growth: Infants cared for by KMC have a slightly better daily weight gain during hospital stay as evident from several studies conducted in different parts of world.

Other effects: KMC helps both infants and parents. Mothers report being significantly less stressed during kangaroo care than when the baby is receiving incubator care. Mothers prefer skin-to-skin contact to conventional care and report increased confidence, self-esteem and feeling of fulfillment. They describe a sense of empowerment, confidence and a satisfaction that they can do something positive for their preterm infants. Fathers felt more relaxed, comfortable and better bonded while providing kangaroo care.

KMC does not require additional staff compared to incubator care.

Eligibility Criteria for KMC

Baby: All babies are eligible for KMC. However very sick babies needing special care may preferably be cared under radiant warmer, and KMC can be started after the baby has become stable. Some guidelines for practicing KMC include:

- **Birth weight ≥1800 g:** If stable, can be started on KMC soon after birth.
- **Birth weight (1200–1799 g):** In such case the delivery should take place in an equipped facility, which can provide neonatal care. Should delivery occur elsewhere, the baby should be transferred to such facility soon after birth, preferably with the mother. One of the best ways of transporting small babies is keeping them in continuous skin-to-skin contact with the mother. It may take a couple of days for a sick baby to become stable before KMC can be initiated.
- **Birth weight (<1200 g):** These babies benefit most from transfer before birth to a hospital with neonatal intensive care facilities. It may take days to weeks before baby's condition allows initiation of KMC. KMC can be initiated in a baby who is otherwise stable but still on intravenous fluids or some oxygen administration.

Mother: All mothers can provide KMC, irrespective of age, parity, education, culture and religion. The following aspects must be taken into consideration when counseling for KMC:

- **Willingness:** The mother must be willing to provide KMC. Nurses should counsel her adequately regarding different aspects of KMC. Once mother knows about KMC, she will be willing to provide KMC to her baby.
- **General health:** If the mother has suffered from complications during pregnancy or delivery or is otherwise ill, she should recover reasonably well before she can initiate KMC.

- **Supportive family:** She needs support to deal with other responsibilities at home. The other family members, e.g., father or grandmother should also be encouraged to provide kangaroo care to the LBW baby.
- **Supportive community:** This is particularly important when there are social, economic or family constraints.

Initiation of KMC

Counseling: When baby is ready for KMC, arrange a time with the mother that is convenient for her and her baby. The first session is important and requires time and undivided attention. Ask her to wear light, loose clothing. KMC can be provided using any front open garment. Provide a warm place for her. Respect her requirement of privacy while providing KMC. Encourage her to bring other key family members. Unless they are convinced, it will not be possible for the mother to do KMC at home.

Baby clothing: Baby should be naked except cap, socks and nappy.

Kangaroo positioning (Fig. 8.2): The baby should be placed between the mother's breasts in an upright position. The head should be turned to one side and in slightly extended position. This slightly extended head position keeps the airway open and allows eye-to-eye contact between the mother and the baby. Avoid both forward flexion and hyperextension of the head. The hips should be flexed and abducted in a "frog" position; the elbows should also be flexed. Baby's abdomen should be somewhere at the level of the mother's epigastrium.

This way baby has enough room for abdominal breathing. Mother's breathing stimulates the baby, thus reducing the occurrence of apnea. Mother can provide KMC sitting or reclining in a bed or a chair. She can keep herself in slightly backward reclining position and support baby's body and neck using her own hand.

Feeding: The mother should be explained that she should breastfeed in the kangaroo position and that KMC actually makes breastfeeding easier. Furthermore, holding the baby near the breast stimulates milk production.

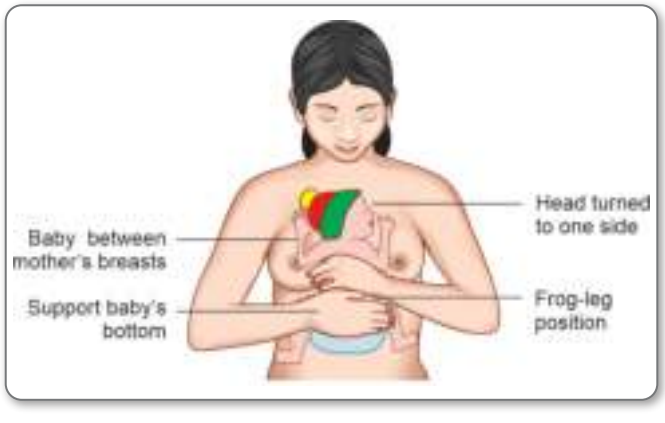


Figure 8.2: Kangaroo positioning

Psychological support: The mother should be encouraged to ask for help if she is worried. The nurse should be prepared to respond to her questions and anxieties.

KMC during sleep and resting: The mother can sleep with the baby in kangaroo position in a reclined or semi-recumbent position, about 15° from horizontal. This can be achieved with an adjustable bed, if available, or with several pillows on an ordinary bed. It has been observed that this position may decrease the risk of apnea for the baby. A comfortable chair with adjustable back may be useful for resting during the day.

Time of Initiation

The KMC can be started as soon as the baby is stable. Babies with severe illness or requiring special treatment should wait until they are reasonably stable before KMC can be initiated. Short KMC sessions can be initiated during recovery with ongoing medical treatment (IV fluids, low concentration of oxygen). KMC can be provided while the baby is being fed via orogastric tube. Once the baby begins to recover, nurses should motivate the family members to practice KMC.

Duration of KMC

Skin-to-skin contact should start gradually, with a smooth transition from conventional care to continuous KMC. Sessions that last less than one hour should, however, be avoided because frequent handling may be too stressful for the baby. The length of skin-to-skin contacts should gradually be increased to become as prolonged as possible, interrupted only for changing diapers. When the mother needs to be away from her baby, other family members, e.g., father, can also help by caring for the baby in skin-to-skin kangaroo position. Encourage the mother to increase the duration of KMC each time. The aim should be to provide KMC as long as possible.

Discharge criteria for baby mother dyad practicing KMC: The baby can be discharged from the hospital when the following criteria are met:

- The baby's general health is good and there is no concurrent disease such as apnea or infection.
- Baby is feeding well, and is receiving exclusively or predominantly breast milk.
- Baby is gaining weight (at least 15 g/kg/day for at least three consecutive days) and has regained birth weight.
- Baby's temperature is stable in the KMC position (within the normal range for at least three consecutive days).
- The mother is confident of taking care of her baby at home and would be able to come regularly for follow-up visits.

These criteria are usually met by the time baby weighs around 1500 g.

Discontinuation of KMC: KMC should be continued for some time at home, it can be weaned off, once the baby starts becoming intolerant to the procedure or at 40 weeks of post-conceptional age.

Thus KMC is a skin-to-skin contact between a mother and her newborn, frequent and exclusive or nearly exclusive breastfeeding, and early discharge from hospital, has been proposed as an alternative to conventional neonatal care for LBW infants.

ORGANIZATION OF NEONATAL UNIT

The Neonatal Intensive Care Unit (NICU) is a primary care unit designed to care for those infants who are born prematurely, born to high-risk mothers, or born with a problem that is not conducive to normal growth and development, which requires complex medical and/or surgical intensive care.

Location: NICU must be located near to labor room and post-natal unit so that baby can be easily transferred after delivery and mother can visit the baby.

Staff: NICU is typically directed by one or more neonatologists and staffed by nurses, nurse practitioners, pharmacists, physician assistants, resident physicians, and respiratory therapists.

Equipment: Equipment in NICU include incubators, radiant warmers, pulse oximeter, vital sign monitors , bilirubinometer, resuscitation devices, CPAP machine and ventilators.

Communication mechanisms: It should be available in NICU like telephones to communicate with parents/caregivers and members of health team.

Continuing education/staff development: Each nursing staff member is expected to participate in continuing education programs in conjunction with clinical advancement requirements for professional development. The sister in-charge is responsible for the coordination of staff development with input from staffs and nursing superintendent.

Common cases seen in NICU: Anemia, Apnea, Bradycardia, Bronchopulmonary dysplasia (BPD), Hydrocephalus, Intraventricular hemorrhage, Jaundice, Necrotizing enterocolitis (NEC), Patent ductus arteriosus (PDA), Periventricular leukomalacia, Infant respiratory distress syndrome (RDS), Retinopathy of prematurity (ROP), Sepsis, Transient tachypnea of the newborn (TTN).

Levels of Care

The concept of designations for hospital facilities that care for newborn infants according to the level of complexity of care provided was first proposed in the United States in 1976. Levels in the United States are designated by the guidelines published by the American Academy of Pediatrics.

Level 1 Neonatal Care (Basic)

Well-newborn nursery: It has the capabilities to provide neonatal resuscitation at every delivery, evaluate and provide postnatal care to healthy newborn infants, stabilize and provide care for infants born at 35 to 37 weeks' gestation who remain physiologically stable, stabilize newborn infants who are ill and those born at 35 weeks' gestation until transfer to a facility that can provide the appropriate level of neonatal care.

Level 2 Neonatal Care (Specialty)

Special Care Nursery: Level II units are subdivided into two categories on the basis of their ability to provide assisted ventilation including continuous positive airway pressure.

Level 2A: Level 2A has the capabilities to resuscitate and stabilize preterm and/or ill infants before transfer to a facility at which newborn intensive care is provided provide care for infants born at 32 weeks' gestation and weighing 1500 g who have physiologic immaturity such as apnea of prematurity, inability to maintain body temperature, or inability to take oral feedings or who are moderately ill with problems that are anticipated to resolve rapidly, and are not anticipated to need subspecialty services on an urgent basis. They also provide care for infants who are convalescing after intensive care.

Level 2B: Level 2B has the capabilities of a level 2A nursery and the additional capability to provide mechanical ventilation for brief durations (24 hours) or continuous positive airway pressure.

Level 3 Neonatal Care (Advanced Specialty)

Level 3A: Level 3A has the capabilities to provide comprehensive care for infants born at 28 weeks' gestation and weighing 1000g provide sustained life support limited to conventional mechanical ventilation, perform minor surgical procedures such as placement of central venous catheter or inguinal hernia repair.

Level 3B: Level 3B has the capabilities to provide comprehensive care for extremely low birth weight infants (less than 1000 g and 28 weeks' gestation) advanced respiratory support such as high-frequency ventilation and inhaled nitric oxide for as long as required. Prompt and on-site access to a full range of pediatric medical subspecialists. Advanced imaging, with interpretation on an urgent basis, including computed tomography, magnetic resonance imaging, and echocardiography. Pediatric surgical specialists and pediatric anesthesiologists on site or at a closely related institution to perform major surgery such as ligation of patent ductus arteriosus and repair of abdominal wall defects, necrotizing enterocolitis with bowel perforation, tracheoesophageal fistula and/or esophageal atresia, and myelomeningocele.

Level 3C: Level 3C has the capabilities of a level 3B NICU and also is located within an institution that has the capability to provide ECMO and surgical repair of complex congenital cardiac malformations that require cardiopulmonary bypass.

NEONATAL TRANSPORT

Introduction

Transporting sick neonates is not an easy task. Indeed, in cases of at-risk pregnancy, it is safer to transport the mother prior to delivery than to transfer the sick baby after birth (in-utero transport). In developing countries, the problem of transporting small and sick neonates is compounded by several practical constraints like:

- Facilities are scarce and not easily available
- Families have poor resources
- Organized transport services are not available. At times the baby may have to be transported on foot or on bullock cart
- No health provider is available to accompany the baby
- Facilities are not fully geared up to receive sick neonates
- Communication systems are non-existent or inefficient

Thus, transporting neonates in developing countries is a formidable challenge. In spite of the best planning, babies will develop serious problems during transport to a higher level of care. Care providers should, therefore, be ready and confident to handle this responsibility.

Transport to Health Facility

Ideally transport of a newborn should be in an orderly manner, i.e., a neonate who is found to be sick by a health worker at home visit should be referred to a PHC. If the facilities or expertise at the PHC are not adequate enough to manage this sick neonate, he should be referred to the FRU and thereafter to the Medical College. Sickest of the neonates require referral to an apex institution or a tertiary care center. However, most sick babies are directly referred to Medical Colleges or even the apex institutions, thus bypassing the PHCs & FRUs. This creates an imbalance, as a result the higher institutions are overburdened and there is poor utilization of resources as well as the manpower at FRUs and district hospitals. It is thus important to promote and practice regionalization of care.

Prepare Well Before Transport

- **Assess and stabilize:** Make careful assessment of the baby. Make sure that there is a genuine indication for referral.
  It is important that a neonate is stabilized before the transport is begun, as an unstable neonate will deteriorate on the way and may reach the referral facility in a moribund state. The neonate should be assessed for temperature maintenance, airway patency, breathing efforts, state of circulation, fluid and hydration status, medications to be administered and feeding that is to be provided. If, on assessment, any of the above parameters is found to be compromised, remedial action should be quickly taken.
  - **Temperature:** Assess temperature by touch or by using a thermometer. If the baby is found to be in cold stress or hypothermia, the baby should be warmed either under a warmer or by providing KMC.
  - **Airway:** Assess the airway for patency by noting the position of the neck, any secretions in mouth/nose and whether chest movements is adequate. If the neonate has secretions or his position is not appropriate, he needs to be suctioned and placed in appropriate position with a shoulder roll.
  - **Breathing:** Assess the baby for breathing efforts; if not breathing adequately, provide tactile stimulation or if need be, provide ventilation using a bag and mask with 100% oxygen. If the neonate has respiratory distress, he may require oxygen supplementation using an oxygen hood.
  - **Circulation:** Assess the status of circulation by pulse volume and capillary refilling time. If the circulation is compromised, i.e., CRT >3 secs and/or peripheral pulses are poor with normal temperature, then a fluid bolus of 10 mL/kg normal saline or Ringer lactate should be provided over 20–30 minutes. The status should be reassessed for need of further boluses.
  - **Fluids:** If the neonate to be transported is sick and cannot be fed, then the maintenance fluid based on birth weight, the day of life and presence or absence of abnormal losses needs to be calculated and started. Any neonate on IV therapy must be transported with a health care provider.
  - **Medications:** Assess the need for antibiotics, anticonvulsants vitamin K, theophylline, etc. and administer them in appropriate dosage and by the recommended route. Also remember to document the drugs administered to the baby on the referral note to avoid inadvertent repeat dosing and toxicity.
  - **Feeding:** Assess if the baby can be fed using paladai or gavage or directly at the breast. If the neonate can be fed, he should be fed enterally.
- **Correct hypothermia:** If baby is in hypothermia (temperature <36°C), normalize the temperature of the baby, as far as possible, before commencing the transportation. Continuing hypothermia during the period of travel will compromise many body systems.
- **Write a note:** Write a precise note for the providers at the referral facility providing details of the baby's condition, need for referral and treatment given to the baby. Explain the condition, the prognosis and the reasons for referral of the baby to the family. Explain where to go and indicate whom to contact. Inform the referral facility beforehand, if possible. This allays the anxiety of the parents and the other family members. Prior information to the referral facility helps to build the confidence and removes the fears of unknown, thus positively motivating the family for transport.

- **Encourage mother to accompany:** Mother should accompany the baby for breast feeding and for providing supportive care to the baby on the way and in the hospital. In case she cannot accompany the baby immediately, she should be encouraged to reach the facility at the earliest.
- **Arrange a provider to accompany:** A doctor/nurse/health worker should accompany the baby, if feasible, to provide care to the baby en route and to facilitate care at the referral facility.

The mnemonic for preparing baby before transport is STABLE.

- S – Sugar
- T – Temperature
- A – Assist breathing
- B – Blood pressure
- L – Lab work
- E – Emotional support

Ensure Warm Transport

Use one of the following approaches to keep the baby warm during transportation:

- **Skin to skin care (kangaroo mother care):** This is probably the most effective, safe and convenient method. Baby is naked except for a cap and a napkin. Baby is placed facing the mother in skin to skin contact between breasts. Baby's back is the covered by tying the blouse or with a fold of gown/'chunari'. The skin to skin contact can also be provided by another woman or a man (father).
- **Cover the baby:** Cover the baby fully with clothes (or cotton) including the head and the limbs. Nurse the baby next to the mother or another adult during transport.
- **Improvised containers:** Different workers have suggested the use of thermocol box, basket, padded pouch, polythene covering, etc. for ensuring temperature stability during transport. If familiar, you may use one of these innovative methods.
- **Transport incubator:** This is the ideal mode of transport but is rarely available. Avoid hot rubber bottles to prevent accidental burns.

Care During Transport

The accompanying person should be explained to ensure the following:

- **Ensure warm feet:** Whatever method of keeping the baby warm is employed, make sure that the baby's feet are warm to touch. Warm feet indicate that the baby is neither hypothermic nor in cold stress. If the baby passes urine or stool, wipe it promptly. He should not remain wet, otherwise he will lose heat.
- **Ensure an open airway:** Keep the neck of the baby in slight extension. Do not cover the baby's mouth and nose. Gently wipe the secretions from the nose and the mouth with a cotton or cloth covered finger.
- **Check breathing:** Watch baby's breathing. If the baby stops breathing, provide tactile stimulation to the soles to restore it.
- **Provide feeds:** If baby is able to suck on the breast, he should be offered breast feeds. If he can take spoon feeding, expressed breast milk can be provided carefully. If the distance is long, a nasogastric catheter may be inserted and gavage feeding given. In that case, the amount of each feed should be specified. However, it is not easy to train the accompanying members in this modality and should be resorted to only if essential. Intravenous fluid administration during transport is best avoided.

Table 8.4: Summary of safe transport of neonates

I. Prepare well before transport	II. Ensure warm transport by any of these measures	III. Provide care during transportation
• Assess and stabilize • Correct hypothermia • Write a note • Encourage mother to accompany • Arrange a provider to accompany	• Skin to skin care (Kangaroo mother care) • Cover the baby • Use improvised warm containers • Use transport incubator	• Ensure warm feet • Ensure an open airway • Check breathing • Provide feeds

The baby should be taken to the nearest referral facility, by the shortest route, safe mode using the fastest possible mode of transport (avoid too fast travel leading to jerks/bumps due to poor road which may harm the sick baby).

Neonatal transport indeed is a formidable task, in fact a challenge for the family as well as the healthcare provider. A simple, timely, efficient approach without any panic is required. There is a need to educate the providers regarding the ideal neonatal transport. Finally, one must not forget that the family plays a major role and must be a part of the decision-making process right from the beginning. Neonatal transport is summarized in Table 8.4.

NEONATAL EQUIPMENT

NICU has many equipment which serves several purposes. There is equipment to maintain airway of babies, to regulate their temperature, for monitoring their vital parameters and preventing from infection. Some common equipment is described in Table 8.5.

Table 8.5: Common neonatal equipment and their uses

Name	Purpose
Neonatal resuscitation devices: Ambu bag, ET tubes (size — 2.5, 3, 3.5, 4, NG tube, suction catheter, syringes laryngoscope, oxygen masks, shoulder roll	To open and maintain child's airway. To deliver oxygen
Oxygen delivery devices: Oxygen Masks (size 0,00), oxygen hood	To deliver oxygen
CPAP machine	It allows application of continuous pressure during both inspiration and expiration in a spontaneously breathing baby. By providing constant airway pressure, the alveoli are kept open which increases the functional residual capacity (FRC) of the lungs resulting in better gas exchange.
Pulse oximetry	It measures the oxygen saturation in the baby's blood. It's attached to the skin with a sensor taped to the baby's hand or foot.
Incubator	It is a closed system, a canopy-like structure used to regulate child's temperature. It has ports through which baby can be accessed for various procedures.
Radiant warmer	Open care system to maintain normothermia
Skin probe	To assess skin temperature
Umbilical catheters	For exchange transfusion, to administer fluids
Arterial lines	to check blood pressure and measure blood gases.
Feeding equipment: Paladai, katori, spoon	To feed the child
Foley's catheter	To measure urinary output
Measuring tape	To measure circumference of head, chest and abdomen.
Phototherapy equipment with panel, bili lights, bili blankets	Used in the management of hyperbilirubinemia. Child's eyes and genitals need to be covered during phototherapy

Summary

LBW babies are more prone to have long-term consequences, like stunting, low IQ and adult-onset chronic conditions such as obesity and diabetes. Adequate antenatal care, good nutrition and rest are important ingredients for a healthy baby.

Assess Yourself

1. The two main components of KMC are ..... and ..... (skin to skin contact and breastfeeding)
2. What is the eligibility criteria for KMC? List the advantages of KMC.
3. Discuss the physical features of a preterm baby.
4. Define LBW and preterm baby. Discuss the management of low birth weight baby.
5. List the points to be kept in mind while transporting a neonate from a health facility to FRU
6. Write a short note on facility-based newborn care.
7. Discuss the various levels of neonatal unit.

Chapter 9

Management of Neonatal Conditions

Chapter Outline

- Introduction
- Management of Neonatal Conditions
- Respiratory Distress Syndrome
- Neonatal Sepsis
- Neonatal Jaundice
- Neonatal Seizures
- Retinopathy of Prematurity
- Neonatal Hypoglycemia
- Neonatal Shock
- Emergency Triage Assessment and Treatment

INTRODUCTION

A healthy start in life is important to every newborn baby. The first 28 days, called the neonatal period, is especially critical. It is during this time that fundamental health and feeding practices are established. It is also during this time that the child is at highest risk for death. Some common conditions in neonatal include Hypothermia, Hyperthermia, respiratory distress syndrome (RDS), Neonatal sepsis, Hyperbilirubinemia, Neonatal seizures, retinopathy of prematurity (ROP), etc.

MANAGEMENT OF NEONATAL CONDITIONS

Hypothermia

Newborn babies are often not able to keep themselves warm with low environmental temperature resulting in hypothermia. Hypothermia is an important cause of neonatal morbidity and mortality due to lack of attention by health care providers.

Normal axillary temperature of a neonate is 36.5°–37.5°C (97.7°–99.5°C).

Pathophysiology

A newborn is more prone to develop hypothermia because of a large surface area per unit of body weight. A low birth weight baby has decreased thermal insulation due to less subcutaneous fat and reduced amount of brown fat. Brown fat is the site of heat production. It is localized around the adrenal glands, kidneys, nape of neck, inter scapular and axillary region. Metabolism of brown fat results in heat production. Blood flowing through the brown fat becomes warm and through circulation transfers heat to other parts of the body. This mechanism of heat production is called non-shivering thermogenesis. Low birth weight (LBW) babies lack this effective mechanism of heat production.

The four ways a newborn may lose heat to the environment is evaporation, conduction, radiation and convection (Figure 9.1 and Table 9.1).

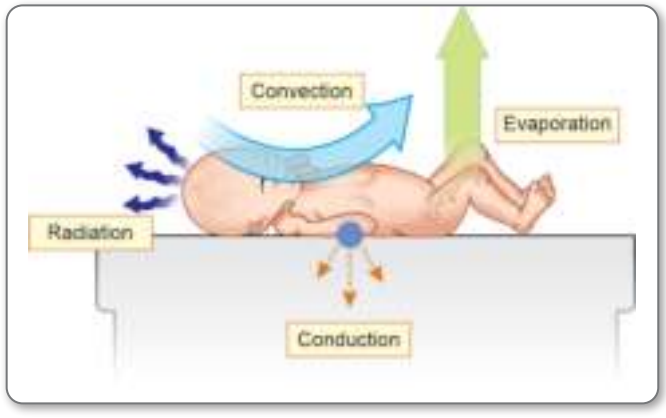


Figure 9.1: Mechanism of heat loss in a newborn

Table 9.1: Mechanisms of heat loss in baby

Evaporation: Involves the loss of heat when a liquid is converted to a vapor. It occurs after birth due to evaporation of amniotic fluid from skin surface	**Conduction:** Involves the loss of body heat to cooler objects which come in direct contact with baby's skin. Example cold table-clothes.	**Radiation:** Involves loss of infant's body heat to cooler solid objects that are not directly in contact with him, e.g., walls.	**Convection:** Involves the flow of heat from the body surface to cooler surrounding air or to air circulating over body surface.
Nursing Implications			
• Keep infant dry • Remove wet nappies • Minimize exposure during baths	• Put the baby on pre-warmed sheet • Cover scales, and X-ray cassettes with warm towel or blanket	• Keep baby cots and incubators away from Outside walls or air conditioners. • Cover the baby if stable.	• Avoid current of air. • Manage babies inside incubator, if possible. • Organize work to minimize opening portholes. • Provide warm humidified oxygen.

Temperature Recording

Normal temperature in a newborn is 36.5°–37.5°C

Temperature can be measured by the following routes:

Axilla: Axillary temperature is as good as rectal and safer (less risk of injury or infection). It is recorded by placing the bulb of thermometer against the roof of dry axilla, free from moisture. Baby's arm is held close to the body to keep thermometer in place (Fig. 9.2).

Rectum: Rectal temperature is not used for routine monitoring. However, it can be used as a guide for core temperature in cold (hypothermic) sick neonates. It is recorded by inserting the greased bulb of the special thermometer backward and upward to a depth of 3 cm in a term baby (2 cm in a preterm baby). The difference in rectal and axillary temperature is not clinically significant.

Skin temperature: Skin temperature is recorded by a thermister. The probe of the thermister is attached to the skin over upper abdomen. The thermister senses the skin temperature and displays it on the panel.

Assessment of Temperature by Touch

Baby's temperature can be assessed with reasonable precision by touching with dorsum of hand over abdomen, hands and feet. In newborn, abdominal temperature is representative of the core temperature.

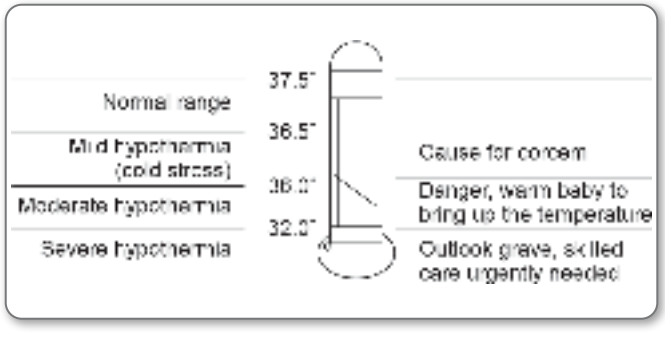


Figure 9.2: Axillary temperature in the newborn infant (°C)

When feet are cold and abdomen is warm, it indicates that the baby is in cold stress. In hypothermia, both feet and abdomen are cold to touch.

In normothermic baby (baby with normal temperature) both abdomen and feet are warm to touch.

Prevention of Hypothermia

Warm Chain

The "warm chain" is a set of 10 interlinked procedures carried out at birth and later, which will minimize the likelihood of hypothermia in all newborns. Baby must be kept warm at the place of birth (home or hospital), during transportation for special care from home to hospital or within the hospital. Satisfactory control of baby's temperature demands both prevention of heat loss and providing extra heat using an appropriate source.

Common situations where cold stress can occur:

- At birth
- After giving bath
- During changing of nappy/clothes
- Malfunctioning heat source or removing the baby from heat source
- While transporting a sick baby

Warm chain can be maintained by the following 10 steps:

1. Warm delivery room (26°–28°C)
2. Warm resuscitation
3. Drying immediately. Dry with one towel. Remove the wet towel and cover with another pre-warmed towel
4. Skin-to-skin contact between mother and baby
5. Breast feeding
6. Postponing bathing and weighing
7. Appropriate clothing, cover head and extremities
8. Keep mother and baby together
9. Warm transportation
10. Awareness raising of healthcare provider

Summary of management of hypothermia is shown in Table 9.2 and Figure 9.3.

Table 9.2: Management of hypothermia

Category	Temp. range	Feel by touch	Clinical features	Action
Normal	36.5°–37.5°C	Warm trunk warm extremities	Normal baby	• Cover adequately with prewarmed cloth • Keep next to mother • Encourage breast feeding
Mild hypothermia (cold stress)	36°–36.4°C	Warm trunk, cold extremities	Extremities bluish and cold Poor weight gain if chronic cold stress	• Skin-to-skin contact • Cover adequately • Ensure room is warm • Provide warmth • Encourage breast feeding
Moderate hypothermia	32°–35.9°C	Cold trunk, cold extremities	Poor sucking, lethargy weak cry fast breathing	• Wrap mother and baby together using prewarmed clothes • Cover adequately • Provide warmth • Vitamin K (if not given) • Reassess every 15 minutes if doesn't improve provide additional heat • Encourage breast feeding
• Severe hypothermia	• Less than 32°C	• Cold trunk and cold extremities	• Lethargic Poor perfusion/mottling • Fast or slow breathing, • Bleeding	• Rapid re-warming till baby is 34°C and then slow re-warming • Oxygen • IV fluids dextrose (warm) • Inj. Vit K

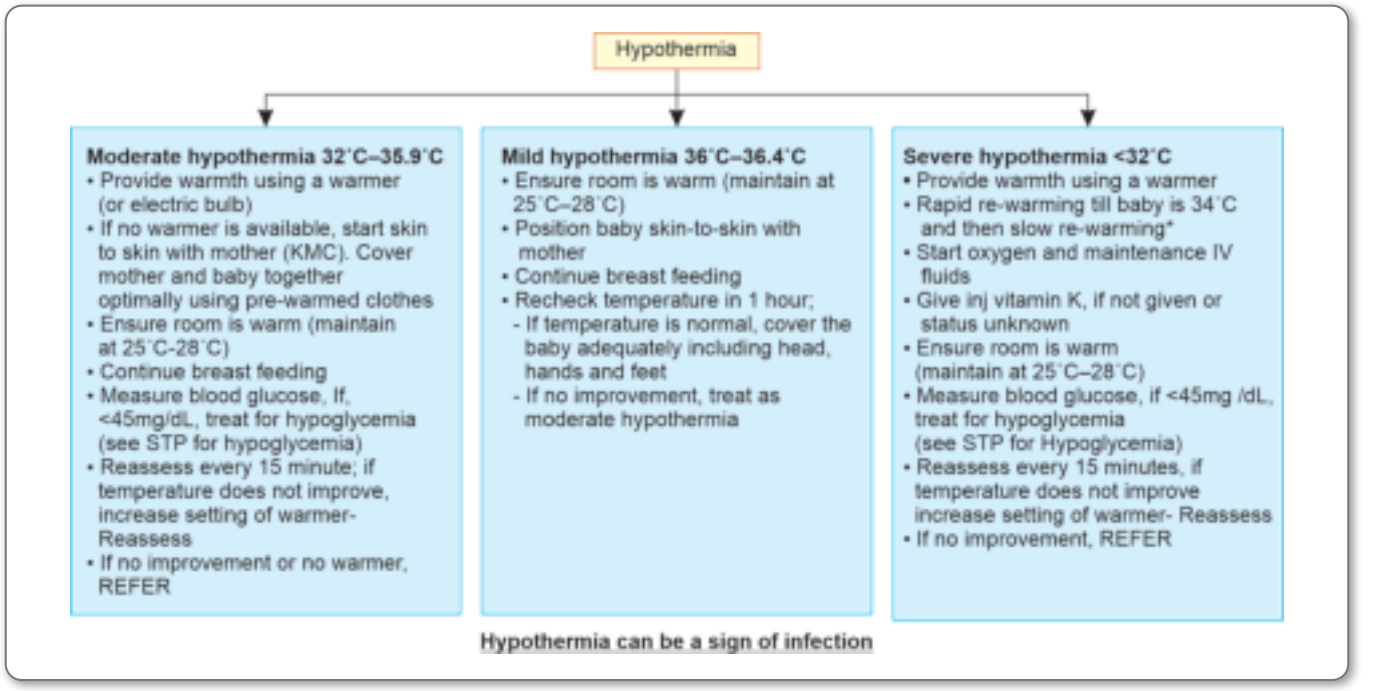


Figure 9.3: Management of hypothermia

Hyperthermia

Hyperthermia, occurs when the body temperature rises above 37.5°C. It is not as common as hypothermia, but it is equally dangerous. The causes of high temperature may be:

- The room is too hot
- The baby has too many covers or clothes
- The baby has an infection

Prevention of Hyperthermia

- Keep the baby away from sources of heat, direct sunlight
- If the baby feels hot remove a layer of clothing

Signs and Symptoms of Hyperthermia

- Irritable baby
- Very warm to touch on abdomen and extremities
- Red flushed skin
- Hot and dry skin
- Lethargy and pallor
- Stupor, coma, convulsions (esp. if temperature >41°C)

Steps to be undertaken if the elevated body temperature is due to overheating.

- Place the baby in a normal temperature environment (25 to 28°C), away from any source of heat.
- Undress the baby partially or fully, if necessary.
- Give frequent breastfeeds.
- Measure the baby's axillary temperature every hour until it is in the normal range.
- If the body temperature is very high (>39°C), sponge the baby with tap water.
- Examine the infant for infection.
- Don't use cold/ice water for sponge. Tap water is good enough.
- If the baby has been under a radiant warmer:
  - Reduce the temperature setting till temperature becomes normal, then dress and cover the baby according to the warming device used.
  - Undress the baby partially or fully till temperature becomes normal, then dress and cover the baby according to the warming device used.
  - Measure the baby's body temperature every hour until it is in normal range.
  - Measure the temperature under the radiant warmer every hour and adjust the temperature setting accordingly.
  - If there is no obvious reason to suspect overheating, inform Doctor who will evaluate.

Both hypothermia and hyperthermia can be signs of sepsis. If a baby has been in a stable temperature environment with fairly constant temperature readings, but begins to have fluctuating temperature readings (low, high or both) inform the Doctor for evaluation.

RESPIRATORY DISTRESS SYNDROME

Introduction

Respiratory distress in a newborn is a challenging problem which accounts for significant morbidity and mortality. It occurs in 4–6% of neonates. Many of the conditions causing respiratory distress are preventable. Early recognition and prompt management is needed. A few may also need ventilatory support.

Predisposing Factors

Predisposing factors for RDS include prematurity, asphyxia and maternal diabetes. Drugs such as antenatal steroids enhance lung maturity and can prevent the neonate from developing RDS.

Pathogenesis

The basic problem in a preterm baby with RDS is surfactant deficiency. Surfactant is needed to decrease alveolar surface tension and keep them open. In a preterm baby, absence of surfactant leads to alveolar collapse during expiration. This affects gas exchange and the baby goes into respiratory failure. The pathogenesis is explained in Figure 9.4.

Clinical Manifestations

The usual manifestations of respiratory distress include tachypnea (RR>60/min), severe chest indrawing, retractions, grunting and apnoea or gasping. Central cyanosis, lethargy and poor feeding may also appear.

Diagnosis

Can be done by history taking and physical examination.

- **History:** Assess the baby for gestational age, H/O PROM, Apgar score, meconium stained liquor, any feeding problems.
- **Examination:** Assess the severity of the distress using Downe's score given in Table 9.3.
  - **Interpretation of Downe's score**

  Score 1–6 = Respiratory Distress

  Score >6 = Impending respiratory Failure (May need CPAP or mechanical Ventilation)

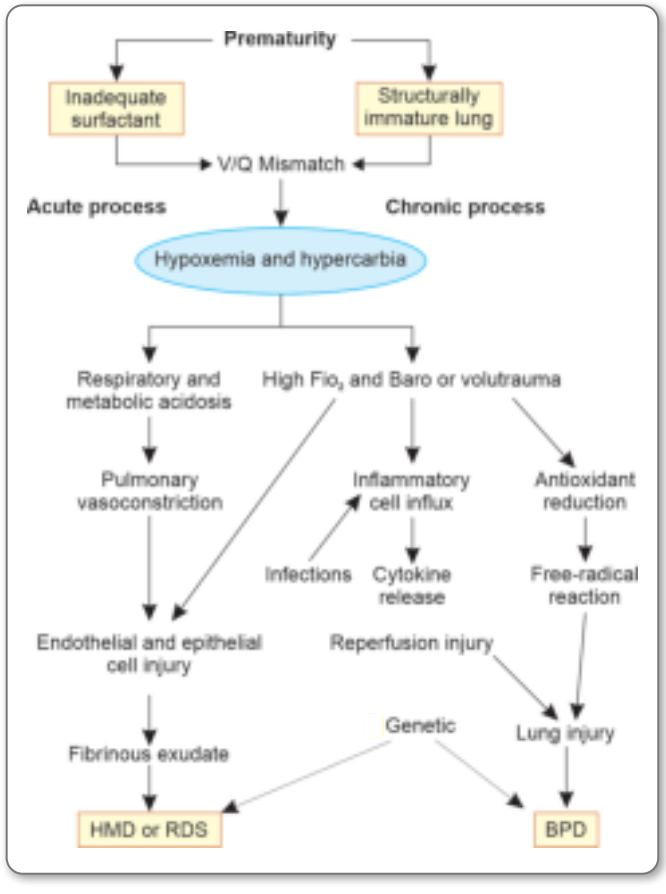


Figure 9.4: Pathogenesis of RDS

Table 9.3: Downe's score

Score	RR	Cyanosis	Air entry	Grunt	Retraction
0	<60/min	Nil	Normal	None	Nil
1	60-80/min	In room air	Mild decrease	Audible with stethoscope	Mild
2	>80/min	In >40 % FiO_2	Marked decrease	Audible with unaided ear	Moderate

Other Investigations

Investigations depends on the possible etiology.

- If prematurity is present, perform shake test. The first gastric aspirate (0.5 mL) is mixed with 0.5 mL of absolute alcohol in test tube. This is shaken for 15 sec. and allowed to stand for 15 minutes. A negative shake test, i.e., no bubbles or bubbles covering less than 1/3 rd of the rim indicates a high risk of developing RDS and the presence of bubbles at more than 2/3 of the rim indicates lung maturity and decreased risk of developing RDS.
- Sepsis screen is indicated if infection is suspected in cases of PROM.
- The most important investigation in a neonate with respiratory distress is a chest X-ray.
- An arterial blood gas if available is a good adjunct to plan and monitor respiratory therapy.

Management

Supportive therapy is most crucial in all neonates with respiratory distress.

- Monitoring of respiratory status, ABG
- Administer IV fluids
- Monitor vitals, blood sugar
- Administer warm and humidified oxygen if saturation is less than 90%. The flow rate should be 2–5 L/min (40–70% O_2). Aim is to maintain saturation between 90–95% to avoid hyperoxia.
- Provide ventilatory support or CPAP (continuous positive airway pressure).
- Specific therapy is surfactant, and ventilatory support will also be needed.

Antenatal Corticosteroids

Antenatal steroids will prevent the occurrence and severity of RDS in preterm babies between 24 and 34 weeks of gestation. Optimal effect of antenatal steroids is seen if delivery occurs after 24 hours of the initiation of therapy. Effect lasts for 7 days. Dose recommended is Inj. Betamethasone 12 mg IM every 24 hours × 2 doses; or Inj. Dexamethasone 6 mg 1M every 12 hours × 4 doses.

Surfactant Therapy

Surfactant therapy should be introduced only if there are facilities for ventilation. The efficacy of surfactant in reducing the duration of ventilation is proven. The main deterrent to its use is the cost factor. Prophylactic surfactant use is recommended for any neonate <28 weeks and <1000 g. This is not yet a routine practice in India. Rescue therapy is using surfactant in a symptomatic neonate. This could be used in any neonate suspected or diagnosed to have RDS.

NEONATAL SEPSIS

Definition: Neonatal sepsis is defined as a clinical syndrome of bacteremia with systemic signs and symptoms of infection in the first 4 weeks of life. When bacteria gain access into the blood stream, they may cause overwhelming infection without much localization (septicemia) or may get predominantly localized to the lung (pneumonia) or the meninges (meningitis).

Neonatal sepsis is the single most important cause of neonatal deaths in the community, accounting for over half of them. If diagnosed early and treated aggressively, it is possible to save most cases of neonatal sepsis.

Etiology

Most cases of neonatal sepsis in the community are caused by *Escherichia coli* and *Staphylococcus aureus*. In hospitals, *Klebsiella pneumoniae* is also a common organism.

Early versus Late Sepsis

Neonatal sepsis can be classified into two types depending upon whether the onset of symptoms is before 72 hours of life (early onset) or later (late onset).

Early-onset infections are caused by organisms prevalent in the maternal genital tract or in the delivery area. The associated factors for early-onset sepsis include low birth weight, prolonged rupture of membranes, foul smelling liquor, multiple per vaginal examinations, maternal fever, difficult or prolonged labor and aspiration of meconium. Early onset sepsis manifests frequently as pneumonia and less commonly as septicemia or meningitis.

Late-onset septicemia is caused by the organisms thriving in the external environment of the home or the hospital. The infection is usually transmitted through the hands of the care-providers. The onset of symptoms is usually delayed beyond 72 hours after birth and the presentation is that of septicemia, pneumonia or meningitis. The associated factors of late-onset sepsis include: low birth weight, lack of breastfeeding, superficial infections (pyoderma, umbilical sepsis), aspiration of feeds, disruption of skin integrity with needle pricks and use of intravenous fluids. These factors enhance the chances

of entry of organisms into the blood stream of the neonates whose immune defenses are poor as compared to older children and adults.

Clinical Features

The manifestations of neonatal septicemia are often vague and demand a high index of suspicion for early diagnosis (Table 9.4). The most common and characteristic manifestation is change in the established feeding behavior in late onset sepsis and respiratory distress in early onset sepsis. The baby, who had been active and sucking well, gradually or suddenly, becomes lethargic, inactive or unresponsive and refuses to suckle. Hypothermia is a common manifestation of sepsis, while fever is infrequent. Diarrhea, vomiting and abdominal distension may occur.

Episodes of apneic spells or gasping may be the only manifestation of septicemia. In sick neonates, the skin may become tight giving a hidebound feel (sclerema) and the perfusion becomes poor (capillary refill time greater than 3 seconds). Cyanosis may appear. A critical neonate may develop shock, bleeding and renal failure.

The additional features of pneumonia or meningitis may be present depending upon the localization of infection in different systems and organs of the body. The evidences of pneumonia include tachypnea, chest retractions, grunting, early cyanosis and apneic spells in addition to inactivity and poor feeding. Cough is unusual. Findings on auscultation of the chest are non-specific and non-contributory. Meningitis is often silent, the clinical picture being dominated by manifestations of associated septicemia. However, the appearance of excessive or high-pitched crying, fever, seizures, blank look, neck retraction or bulging anterior fontanel are highly suggestive of meningitis.

Table 9.4 Clinical manifestations of neonatal sepsis

Lethargy	Cyanosis*
Refusal to suckle	Tachypnea*
Poor cry	Chest retractions*
Not arousable, comatosed	Grunt*
Abdominal distension	Apnea/gasping*
Diarrhea	Fever+
Vomiting	Seizures+
Hypothermia	Blank look+
Poor perfusion	High pitched cry+
Sclerema	Excessive crying/irritability+
Poor weight gain	Neck retraction+
Shock	Bulging fontanel+
Bleeding	
Renal failure	

**Particularly suggestive of pneumonia*
+Particularly suggestive of meningitis

Diagnosis

Can be done by direct or indirect method**:**

- **Direct method:** Isolation of microorganisms from blood, CSF, urine, pleural fluid or pus is diagnostic.
- **Indirect method:** There are a variety of other tests which can be used to predict sepsis but it may be difficult to perform them at all places and hence the clinical acumen remains crucial. A practical positive "sepsis screen" takes into account two or more positive tests which are as follows:
  - Leukopenia (TLC <5000/cubic mm)
  - Neutropenia (Absolute Neutrophil Count <1800/cubic mm)
  - Immature neutrophils (Band cella + Myelocytes+ Metamyelocytes) to total neutrophil (I/T) ratio (>0.20)
  - Micro ESR (>15 mm 1st hour)
  - C- Reactive Protein +ve, i.e., >10 mg/L

If possible, lumbar puncture should be done in all cases of late onset (>72 hours) and symptomatic early onset sepsis because 10–15% of them may have associated meningitis. At a small hospital, one may only depend on the CSF cells. The implications of detecting meningitis in the setting of septicemia include: the need for using antibiotics with a high CSF penetration and provision of antibiotic treatment for at least 3 weeks, administered parenterally throughout.

Treatment

Supportive care and antibiotics are two equally important components of the treatment. It should be realized that antibiotics take at least 12–24 hours to show any effect and it is the supportive care that makes the difference between life and death early in the hospital course.

Supportive Care of a Septic Neonate

- Maintain TABC
- Ensure optimum oxygenation (maintain SpO_2 between 90% and 94%)
- Maintain normoglycemia
- Inject vitamin K 1 mg intramuscularly if active bleeding from any site.
- Avoid enteral feed if very sick, give maintenance fluids intravenously, start orogastric feeds as soon as baby is hemodynamically stable.
- Consider exchange transfusion if there is sclerema.

Antibiotic Therapy

Antibiotic therapy should cover the common causative bacteria, namely, *Escherichia coli*, *Staphylococcus aureus* and *Klebsiella pneumoniae*. A combination of ampicillin and gentamicin is recommended for treatment of sepsis and pneumonia. In case of suspected meningitis, cefotaxime should be used along with an aminoglycoside. Tables 9.5A and B show detailed guidelines about antibiotic therapy.

Table 9.5A: Antibiotic therapy for septicemia or pneumonia

I. Septicemia or pneumonia,

B wt <2 kg

Antibiotic	Each dose	Frequency		Route	Duration
		0–14 days age	**>14 days age**		
Inj Ampicillin* or	50 mg/kg/dose	12 hourly	8 hourly	IV	7–10 days
Inj cloxacillin#	50 mg/kg/dose	12 hourly	8 hourly	IV	7–10 days
and					
Inj Gentamicin	5 mg/kg/dose	24 hourly	24 hourly	IV	7–10 days

B wt >2 kg

Antibiotic	Each dose	Frequency		Route	Duration
		0-7 days age	**>7 days age**		
Inj Ampicillin* or	50 mg/kg/dose	12 hourly	8 hourly	IV	7–10 days
Inj cloxacillin#	50 mg/kg/dose	12 hourly	8 hourly	IV	7–10 days
and					
Inj Gentamicin**	5 mg/kg/dose	24 hourly	24 hourly	IV	7–10 days

Table 9.5B: Antibiotic therapy for septicemia and meningitis

II. Septicemia IInd line drugs

B wt <2 kg

Antibiotic	Each dose	Frequency		Route	Duration
		0–14 days age	**>14 days age**		
Inj Piperacillin+ Tazobactum***	50 mg/kg/dose	12 hourly	8 hourly	IV	7–10 days
Inj Amikacin**	50 mg/kg/dose	24 hourly	24 hourly	IV	7–10 days

B wt >2 kg

Antibiotic	Each dose	Frequency		Route	Duration
		0–7 days age	**>7 days age**		
Inj Piperacillin+ Tazobactum***	50 mg/kg/dose	12 hourly	8 hourly	IV	7–10 days
Inj Amikacin**	15 mg/kg/dose	24 hourly	24 hourly	IV	7–10 days

III. Meningitis (For confirmed meningitis)

B wt <2 kg

Antibiotic	Each dose	Frequency		Route	Duration
		0–7 days age	**>7 days age**		
Inj Cefotaxime*	50 mg/kg/dose	12 hourly	8 hourly	IV	3 weeks
Inj Amikacin**	15 mg/kg/dose	24 hourly	24 hourly	IV	3 weeks

B wt >2 kg

Antibiotic	Each dose	Frequency		Route	Duration
		0-7 days age	**>7 days age**		
Inj Cefotaxime*	50 mg/kg/dose	8 hourly	8 hourly	IV	3 weeks
Inj Amikacin**	15 mg/kg/dose	24 hourly	24 hourly	IV	3 weeks

IV. Meningitis-IInd line

Antibiotic	Each dose	Frequency		Route	Duration
		0–7 days age	>7 days age		
Inj Meropenem****	40 mg/kg/dose	8 hourly	8 hourly	IV	3 weeks
Inj Amikacin**	15 mg/kg/dose	24 hourly	24 hourly	IV	3 weeks

#Start if pustules/umbilical sepsis
*Infuse as an IV infusion using syringe infusion pump over 30 minutes of longer. Use a concentration not higher than 100 mg/mL for infusion
**Infuse as an IV infusion using syringe infusion pump over 30 minutes of longer. Use a concentration not higher than 5 mg/mL for infusion
***Infuse as an IV infusion using syringe infusion pump over 30 minutes of longer. Use a concentration not higher than 50 mg/mL for infusion
****Infuse as an IV infusion using syringe infusion pump over 30 minutes of longer. Use a concentration not higher than 10 mg/mL for infusion

Prevention of Neonatal Sepsis

- Superficial infections, like oral thrush, pustules, purulent conjunctivitis should be treated with antimicrobial agents.
- Antenatal care: All mothers should be immunized against tetanus. All types of infections should be diagnosed early and treated vigorously in pregnant mothers.
- Exclusive breastfeeding. No pre-lacteal feeds.
- Keep cord clean and dry.
- Practice hand washing

Prevention of Infection in Hospital

- The nursery environment should be clean and dry with 24-hour water supply and electricity. There should be adequate ventilation and lighting.
- The nursery temperature should be maintained between 26 and 28°C.
- Overcrowding should be avoided.
- All procedures should be performed after wearing mask and gloves.
- Unnecessary invasive interventions such as needle pricks and setting up of intravenous lines should be kept to the barest minimum. There should be no compromise in the use of disposables. Every baby must have separate thermometer and stethoscope and all barrier nursing measures must be followed.
- Strict house-keeping routines for washing, disinfection, cleaning of cots and incubators should be ensured and these policy guidelines should be available in the form of a manual in the nursery.
- Initiate early enteral feeds.

NEONATAL JAUNDICE

Jaundice is yellow discoloration of skin and sclera. It is the visible manifestation of chemical bilirubinemia. Immature newborn brain is susceptible to toxicity from unconjugated bilirubin resulting in "Kernicterus" or "bilirubin brain damage". In adults, sclera appears jaundiced when serum bilirubin exceeds 2 mg/dL. In neonates, evaluation of sclera is difficult because of physiological photophobia. Icterus, however, it becomes apparent on the skin when serum bilirubin reaches more than 5 mg/dL.

Almost all neonates (60% Term and 80% Preterm) will have bilirubin greater than 5 mg/dL in the first week of life and about 6% of term babies will have levels exceeding 15 mg/dL.

Bilirubin Physiology

Bilirubin is derived from the breakdown of heme proteins which are present in hemoglobin, myoglobin and certain heme containing enzymes. Three-fourths of the bilirubin comes from hemoglobin catabolism. One gram of hemoglobin results in the production of 34 mg of bilirubin. A normal term newborn produces about 6–10 mg/kg/day of bilirubin.

Metabolism of Bilirubin

- Bilirubin is bound to albumin for transport in the blood. This bound bilirubin does not enter the central nervous system and is nontoxic.
- Upon reaching the liver, only bilirubin enters the liver cell and gets bound to ligandin which helps to transport it to the site of conjugation.
- Conjugation occurs with glucuronic acid to produce mono- and diglucuronides which are water soluble.
- The conjugated bilirubin is transported with the bile to the gut. In the sterile newborn gut, there is an enzyme called beta-glucuronidase which converts bilirubin glucuronide into unconjugated bilirubin which is reabsorbed into the circulation. This is called enterohepatic circulation and is particularly important in babies who are infrequently fed from birth. With frequent feeding early colonization of gut occurs. These bacteria convert bilirubin glucuronide into stercobilin which is excreted in stool, thus inhibiting the enterohepatic circulation (Fig. 9.5).

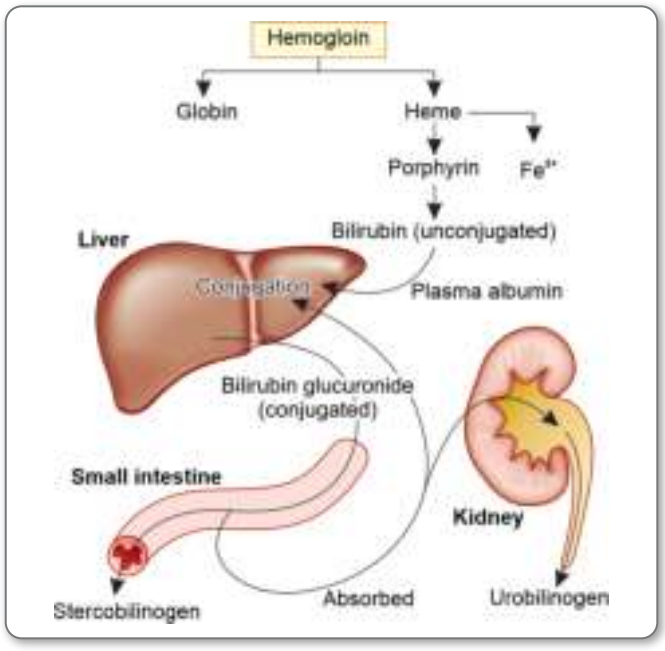


Figure 9.5: Bilirubin metabolism

Figure 9.6: Clinical criteria to assess jaundice (Kramer)

Table 9.6: Causes of jaundice

Appearing within 24 hours of age	Appearing between 24–72 hours of life	Appearing after 72 hours
• Hemolytic disease of newborn: Rh or ABO compatibility, • Infections: intrauterine viral, bacterial; malaria • G-6PD deficiency • Thalassemia	• Physiological • Sepsis neonatorum • Polycythemia • Concealed hemorrhages: cephalohematoma, subarachnoid bleed, IVH. • Increased enterohepatic circulation	• Sepsis neonatorum • Neonatal hepatitis • Extra hepatic biliary atresia • Breast milk jaundice • Metabolic disorders

Causes of Jaundice

Cause of jaundice are usually classified based on the time of onset of jaundice—appearing within 24 hours of age, appearing between 24–72 hours of life, appearing after 72 hours. (Table 9.6).

Clinical Manifestations

Clinical criteria: Clinical jaundice first becomes obvious in the face followed by a downward progression as it increases in intensity. Assessment of jaundice should be done in natural light. The finger is pressed on the baby's skin, preferably over a bony part, till it blanches. The underlying skin is noted for yellow color. Extent of jaundice thus detected gives a rough estimate of serum bilirubin. Clinical estimation of bilirubin by experienced person, though reliable, has to be confirmed by laboratory methods. Baby must be assessed for Kernicterus or bilirubin toxicity. It is identified by lethargy and poor feeding, poor or absent Moro's reflex, opisthotonos posture or convulsions. Kramer's criteria are used to clinically estimate severity (Fig. 9.6). If jaundice is restricted to face and trunk then Serum bilirubin <12 mg% and if jaundice is on hands and feet then Serum bilirubin is >15 mg%.

Diagnosis for Pathological Jaundice

Review Maternal and Perinatal History

- Family history of jaundice, liver disease
- Previous sibling with jaundice for blood group incompatibility
- Maternal illness during pregnancy
- Previous history of malaria
- Traumatic delivery, delayed cord clamping, oxytocin use
- Birth asphyxia, delayed feeding, delay in meconium passage
- Breast feeding

Physical Examination: Assess for

- Prematurity
- **Small for gestation:** Polycythemia, hepato-splenomegaly, cataract, rash.
- **Extravascular bleed:** Cephalhematoma
- **Pallor:** Hemolysis, blood loss
- **Petechiae:** Sepsis, toxoplasmosis rubella cytomegalovirus herpes and other agents (TORCH) infections
- **Hepatosplenomegaly:** Rh-isoimmunization, sepsis, TORCH infections

Lab Tests

- Serum bilirubin total and direct

- Blood group and Rh for mother and baby
- Direct Coombs test on infant
- Hematocrit- decreased in hemolysis
- Reticulocyte count- increased in hemolysis
- Sepsis screen
- Liver and thyroid function tests in cases with prolonged jaundice
- TORCH titers

Types of Jaundice

Basically there are two types of jaundice: Physiological and pathological (Table 9.7).

Table 9.7: Types of jaundice

Physiological jaundice	Pathological jaundice
• It represents physiological immaturity of neonates to handle increased bilirubin production. First appears between 24 and 72 hours of age • Maximum intensity seen on 4-5th day in term and 7th day in preterm neonates • Does not exceed 15 mg/dL • Clinically undetectable after 14 days. • No treatment is required but baby should be observed closely for signs of worsening jaundice.	• Clinical jaundice detected before 24 hours of age • Rise in serum bilirubin by more than 5 mg/dL/day • Total Serum bilirubin more than 15 mg/dL • Clinical jaundice persisting beyond 14 days of life • Clay/white colored stool and/or dark urine staining the clothes yellow • Direct bilirubin >2 mg/dL at any time Treatment is required in the form of phototherapy or exchange blood transfusion. One should investigate to find the cause of pathological jaundice.

Management of Pathological Jaundice

Management of jaundice is directed toward reducing the level of bilirubin and preventing CNS toxicity. This includes:

- Prevention of hyperbilirubinemia by (i) early and frequent feeding and (ii) adequate hydration and
- Reduction of bilirubin: This is achieved by phototherapy or/and exchange transfusion.

The decision to treat depends on the severity and the cause of jaundice.

For 35 weeks or higher

According to American Academy of Pediatrics (AAP) 2004 guidelines for neonates with hyperbilirubinemia who are 35 weeks of gestation or higher, hour-specific bilirubin level treatment guidelines are used for initiating phototherapy/ exchange transfusion which are provided in the form of a nomogram (Figs 9.7 and 9.8).

Under these guidelines, jaundiced neonates are divided into three groups:

1. Infants at lower risk (>38 weeks and well)
2. Infants at medium risk (>38 weeks – risk factors or 35–37 weeks and well)
3. Infants at higher risk (35–37 weeks – risk factors)

Risk factors include iso-immune hemolytic disease, glucose-6-phosphate dehydrogenase (G6-PD) deficiency, asphyxia,

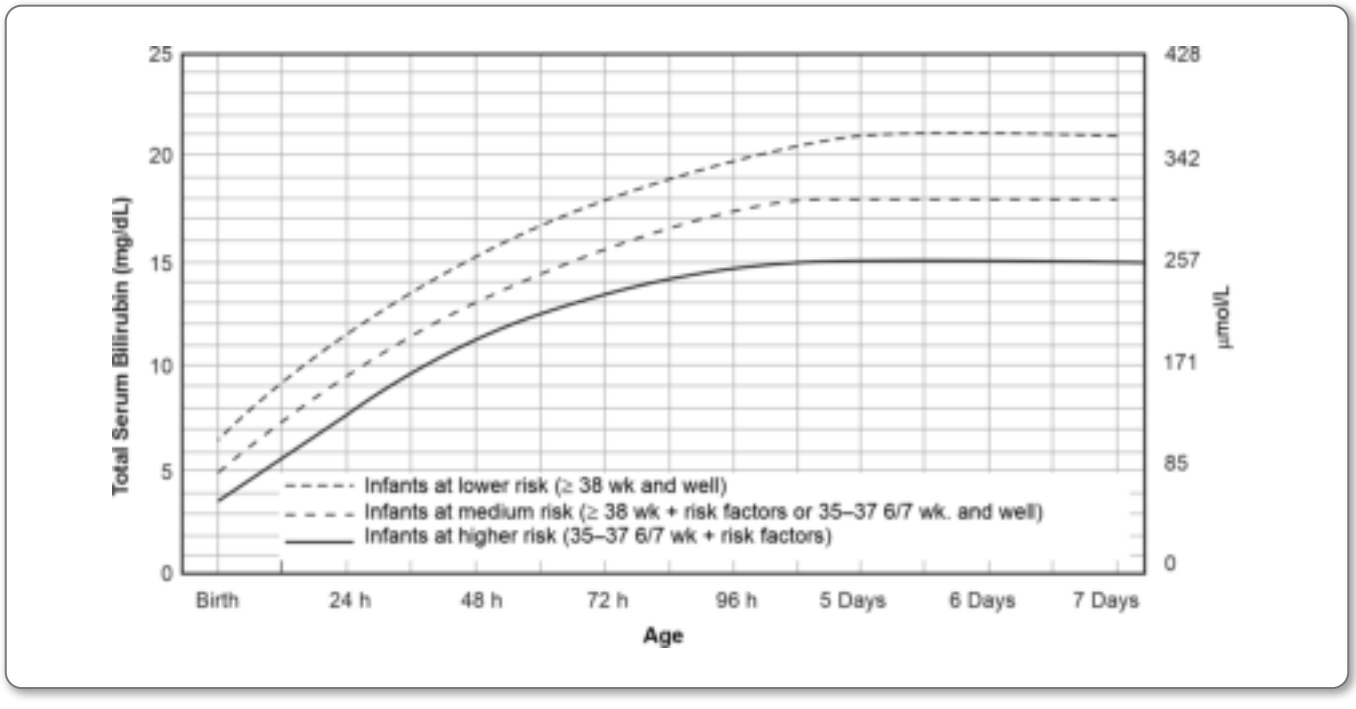


Figure 9.7: Nomogram for initiating phototherapy

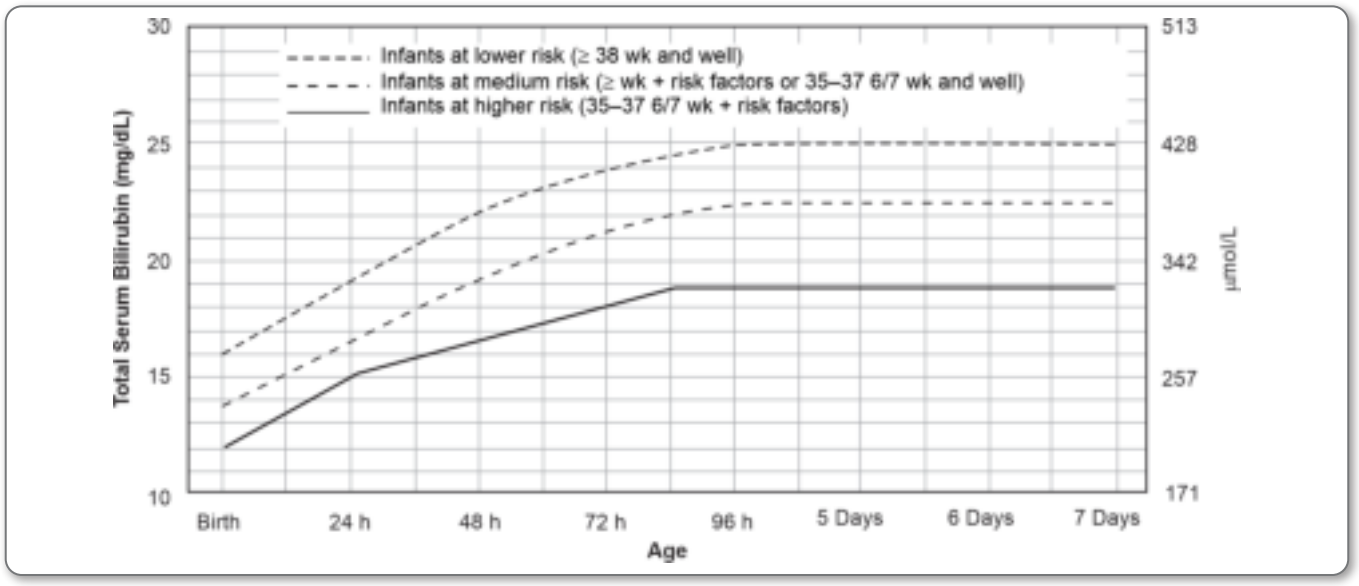


Figure 9.8: Nomogram for instituting exchange transfusion

significant lethargy. Temperature instability, sepsis, acidosis, serum albumin <3.0 g/dL

Rebound rise in bilirubin has been reported in about 7% neonates after stopping phototherapy (PT).

Phototherapy

Action: This involves exposure of the naked baby to blue, cool white or green light of wave length 450–460 nm. The light waves convert the bilirubin to water soluble nontoxic forms which are then easily excreted. Every attempt should be made to find out the cause of jaundice. The advantages of phototherapy are that it is noninvasive, effective, inexpensive and easy to use.

Technique

- Six to eight daylight tubes or four blue tubes are mounted on a stand and all electrical outlets are well grounded. Inexpensive commercial phototherapy units are freely available. Tubes are changed after every 1000 hours or 3 months of use. One may use 150 watt halogen bulb (life 1000 hours) for providing effective phototherapy. Blue CFL lamps may also be used which should be changed every 3000h.
- Check effectivity of phototherapy with help of fluxmeter. Ideal 6–8 μw/cm/nm.
- A Plexiglas shield should be used to cover the tube lights, if the unit is locally made.

Other effective techniques of phototherapy are:

- LED Phototherapy Machine (Fig. 9.9)
- Billiblanket

Care During Phototherapy

- Protect the eyes with eye patches/covers

Figure 9.9: LED phototherapy unit

- Keep the baby naked with a small nappy to cover the genitalia
- Place the baby as close to the lights as the manufacturers' instructions allow.
- Use white cloth or aluminum foil around the light source to reflect light back onto the baby, making sure not to impede the airflow that cools the bulbs
- Do not place anything over the top of the phototherapy unit. This may block air vents or light and items may fall on the baby
- Encourage frequent breastfeeding. Unless there is evidence of dehydration, supplementing breastfeeding or providing IV fluids is unnecessary
- Change position from supine to prone after each feed in order to expose the maximum surface area of baby to phototherapy

- Keep diaper area dry and clean
- Phototherapy does not have to be continuous and can be interrupted for feeding, clinical procedures, and to allow maternal bonding
- Monitor temperature every 4 hours and weight every 24 hours. Giving frequent feeding will prevent excessive weight loss and temperature from rising
- Measure serum bilirubin every 12–24 hours. Visual assessment of jaundice during phototherapy is unreliable
- Change tube lights every 6 months (or usage time >1200 hrs) whichever is earlier; or if tube ends blacken or if tubes flicker. Life of Compact Fluorescent lamps is 3000 hours while that of LED bulbs is 30,000 to 50,000 hours

Side Effects of Phototherapy

- **Increased insensible water loss:** Provide more frequent and for longer duration extra breast feeding.
- **Loose green stools:** Weigh often and compensate with breast milk.
- **Skin rashes:** Harmless, no need to discontinue phototherapy
- **Bronze baby syndrome:** Occurs if baby has conjugated hyperbilirubinemia. If so, discontinue phototherapy.
- **Hypo or hyperthermia:** Monitor temperature frequently.

Exchange Transfusion

It is still the most effective and reliable method to reduce serum bilirubin. Anticipation and early referral to a higher center is indicated.

Choice of blood for exchange blood transfusion is:

- **In ABO incompatibility:** Use O cells of same Rh type, ideal is to have O cells suspended in AB plasma.
- **In Rh isoimmunization:** In emergency use O-ve blood. Ideal is O -ve cells suspended in AB plasma. One may use baby blood group but Rh –ve blood also.
- **Other conditions:** Baby's blood group.

Indications of exchange transfusion:

- Early: It is performed to correct anemia in infants severely affected with erythroblastosis and hydrops.
- To prevent or correct hyperbilirubinemia that might lead to neurological sequelae.

Single volume and double volume transfusion: Exchange transfusions usually involve double the volume of the infant's blood; this is termed a two or double volume exchange. The blood volume of an infant is usually 80 mL/kg; therefore, the exchange transfusion uses 160 mL/kg of blood. A single -volume exchange removes 72% of the infant's blood volume. A double volume exchange removes 87% of the infant's blood volume.

NEONATAL SEIZURES

Neonatal seizures are abnormal electrical discharges in the central nervous system of neonates and usually manifest as stereotyped muscular activity or autonomic changes. Diagnosis is confirmed by electroencephalography. Treatment depends on the cause.

Etiology of Neonatal Seizure Disorders

The abnormal central nervous system electrical discharge may be caused by a:

- Primary intracranial process, (e.g., meningitis, ischemic stroke, encephalitis, intracranial hemorrhage, tumor, malformation)
- Systemic problem, (e.g., hypoxia-ischemia, hypoglycemia, hypocalcemia, hyponatremia, other disorders of metabolism)

Types of Neonatal Seizures

Neonatal seizures are usually focal and may be difficult to distinguish from normal neonatal activity because they may manifest as chewing or bicycling movements.

- **Subtle:** These are the commonest and may be:
  - Repetitive blinking, eye deviation, or staring
  - Repetitive movements of mouth or tongue
  - Purposeless movement of the limbs, as bicycling or swimming
- Clonic (Repetitive movements of the limbs or face)
- **Tonic:** Seen primarily in preterm. Characterized by flexion or extension of axial or appendicular muscle groups. May be focal or generalized. Child may have posturing like:
  - Decerebrate (tonic extension of all limbs) or
  - Decorticate (flexion of upper limbs and extension of lower limbs)
- **Myoclonic:** It is characterized by myoclonic single or multiple lightning fast jerks of the upper or lower limbs. These are usually distinguished from clonic movements because of more rapid speed of myoclonic jerks, absence of slow return and predilection for flexor muscle groups.

Spasms due to tetanus and Jitteriness should not be confused with seizures.

Spasms due to tetanus	Jitteriness
• Appear after 48 hrs • Involuntary contraction of muscles • Fists often persistently and tightly clenched • Trismus, Opisthotonus • Triggered by touch, light, or sound • Baby is conscious throughout, often crying with pain	• Provoked by a stimulus • Abolished by restraining • Not associated with autonomic changes, (e.g., tachycardia, BP fluctuations) or eye movements. • The examination of the neonate is normal between seizure episodes • EEG is always normal

Diagnosis

Diagnosis of neonatal seizure disorders

- Electroencephalography (EEG)
- Laboratory testing, (e.g., serum glucose, serum ionised calcium, cerebrospinal fluid analysis, urine and blood cultures; sometimes genetic testing)
- Cranial imaging

Evaluation begins with a detailed family history and a physical examination.

Treatment

Stepwise treatment of neonate with seizure is explained in the flowchart (Fig. 9.10).

RETINOPATHY OF PREMATURITY

Retinopathy of prematurity (ROP) is a vaso-proliferative disorder of the retina among preterm infants. Neonates born at less than 32 weeks of gestation are at risk of developing ROP. However preterm infants born at 32 weeks or later can also develop severe ROP if they had required prolonged oxygen therapy.

First screening examination should be carried out at 32 weeks of post-menstrual age or 4 weeks of postnatal age whichever is later.

Prevention of ROP

- **Antenatal steroids:** Use of prenatal steroids is a well-known approach to prevent respiratory distress and intraventricular hemorrhage, two important risk factors of ROP. Though antenatal steroids have not reduced occurrence of ROP, it saves smaller babies who are at higher risk of developing ROP, as it reduces sickness level in preterm infants. Prenatal steroids are likely to reduce severe ROP.
- **Judicious oxygen therapy:** Oxygen is a drug and it should be used judiciously. Each neonatal unit should have a written policy regarding when and how to use oxygen and target saturations.

  If a preterm neonate <32 weeks gestation needs resuscitation at birth, inhaled oxygen concentration (FIO,) should be titrated to prevent hyperoxia and achieve gradual increase in oxygen saturation (70% at 3 minute and 80% at 5 minute after birth). During acute care of a sick preterm neonate,

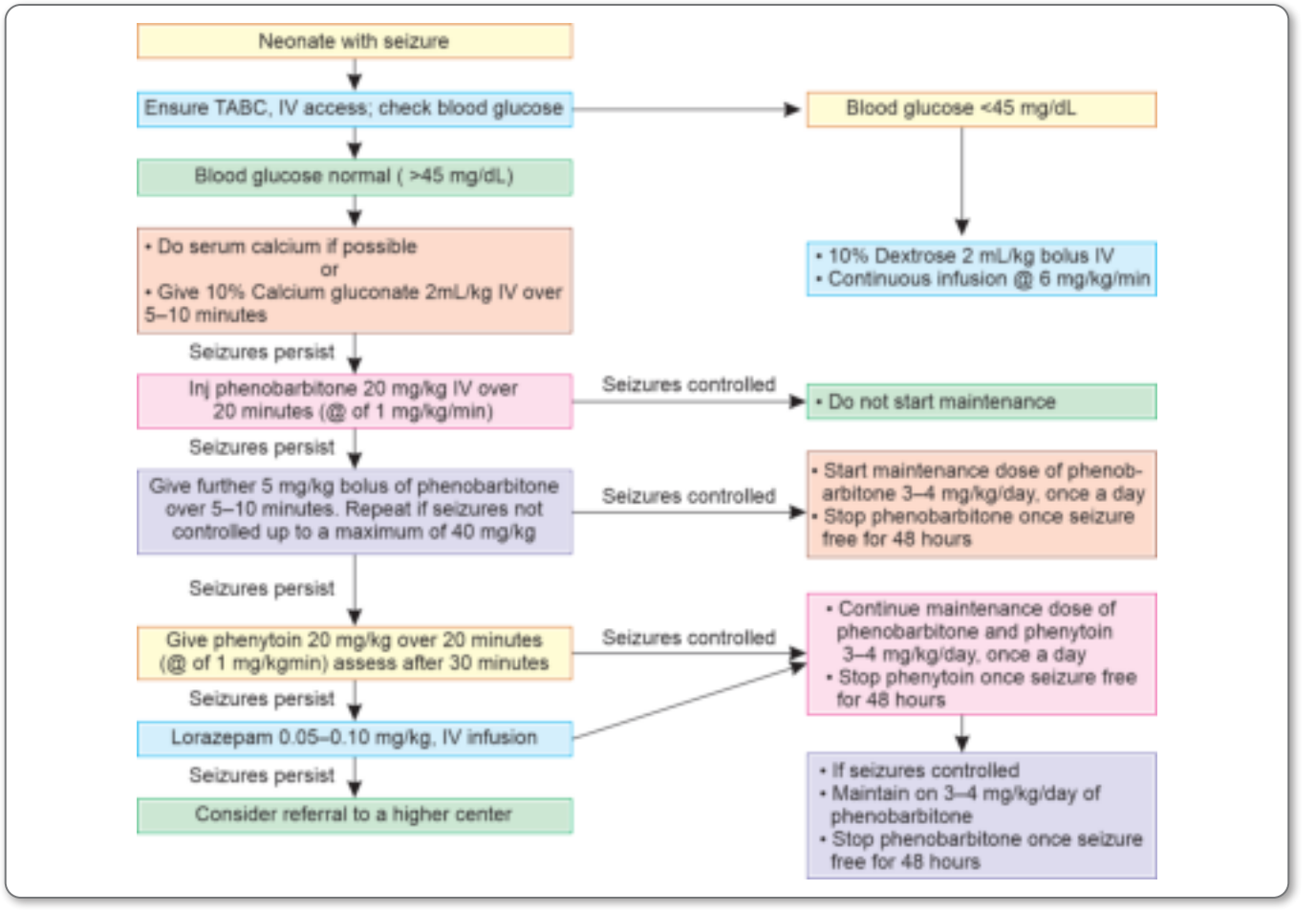


Figure 9.10: Flowchart for management of neonatal seizure

ROP is more likely to develop if partial pressure of oxygen in arterial blood is more than 80 mm Hg.

Oxygen level in blood should be continuously monitored using pulse oximetry keeping a saturation target of 90% to 93%, with limits set at 88% and 95%.

- Judicious use of blood transfusions

  Transfusion of packed RBCs is another risk factor of ROP. Adult RBCs are rich in 2, 3 DPG and adult Hb binds less firmly to oxygen, thus releasing more oxygen to the retinal tissue.

NEONATAL HYPOGLYCEMIA

Definition: Hypoglycemia is defined as blood glucose level of less than 45 mg/dL in all newborns.

Hypoglycemia may be symptomatic or asymptomatic. It can cause brain damage and must be treated early.

Neonates at risk of hypoglycemia include:

- Premature and LBW neonates
- Infants of diabetic mother
- Sick neonates: Perinatal asphyxia, hypothermia, delayed feeding, shock, sepsis, RDS, polycythemia
- IUGR babies

Testing Blood Sugar

It can be done by needle stick puncture on heel or in any vein. Heel lancing site is shown in Figure 9.11.

Symptoms of Hypoglycemia

- Jitteriness, irritability
- Lethargy, limpness
- Weak or high pitched cry
- Poor feeding, vomiting
- Tachycardia
- Sweating
- Hypothermia
- Poor respiratory effort, apnea
- Cyanosis
- Seizures, coma

Figure 9.11: Heel lancing site

Management

Management of hypoglycemia is explained in Figure 9.12. Achieving appropriate glucose infusion rate (GIR) for neonates using a mixture of Dextrose 10% and Dextrose 25% is shown in Tables 9.8A and 9.8B for neonates with birthweight above and below 1500 g.

NEONATAL SHOCK

The term shock denotes a clinical state of poor perfusion of the body tissues in which the body's demands of oxygen and nutrients are not met. This can result in tissue hypoxia and metabolic acidosis causing irreversible tissue damage.

Sign and Symptoms of Shock

- Tachycardia, HR >160/min. This is an early sign of shock
- Capillary refill time more than 3 secs.
- Poor peripheral pulses
- Pallor
- Mottling of skin
- Cold extremities
- Decreased urine output
- Lethargy or obtundation
- Lower blood pressure-this is the late sign of shock

Types of Shock

According to classification based on etiology, shock may be grouped as:

- Hypovolemic shock secondary to:
  - Blood loss due to fetomaternal or twin to twin transfusion, birth trauma, disseminated intravascular coagulation, pulmonary hemorrhage, or IVH.
  - Fluid loss due to excessive insensible water loss, poor fluid intake, vomiting, diarrhea, polyuria or pathologic renal losses.
- Cardiogenic shock due to low cardiac output as birth asphyxia, patent ductus arteriosus, congenital heart disease, arrhythmias, hypoglycemia, acidosis, sepsis, etc.
- Obstructive shock Aortic stenosis, Coarctation of aorta, Tension pneumothorax, pericardial tamponade, etc.
- Distributive shock due anaphylaxis, (loss of sympathetic vascular tone) and drugs
- Septic shock: It multiple etiologies, i.e., hypovolemia

Management

Supportive management includes:

- Maintain temperature, airway, breathing, circulation (TABC)
- Manage hypoxia by oxygen administration to maintain oxygen saturation between 90% and 94%
- Manage hypoglycemia, maintain blood glucose above 45 mg/dL
- Maintain normothermia

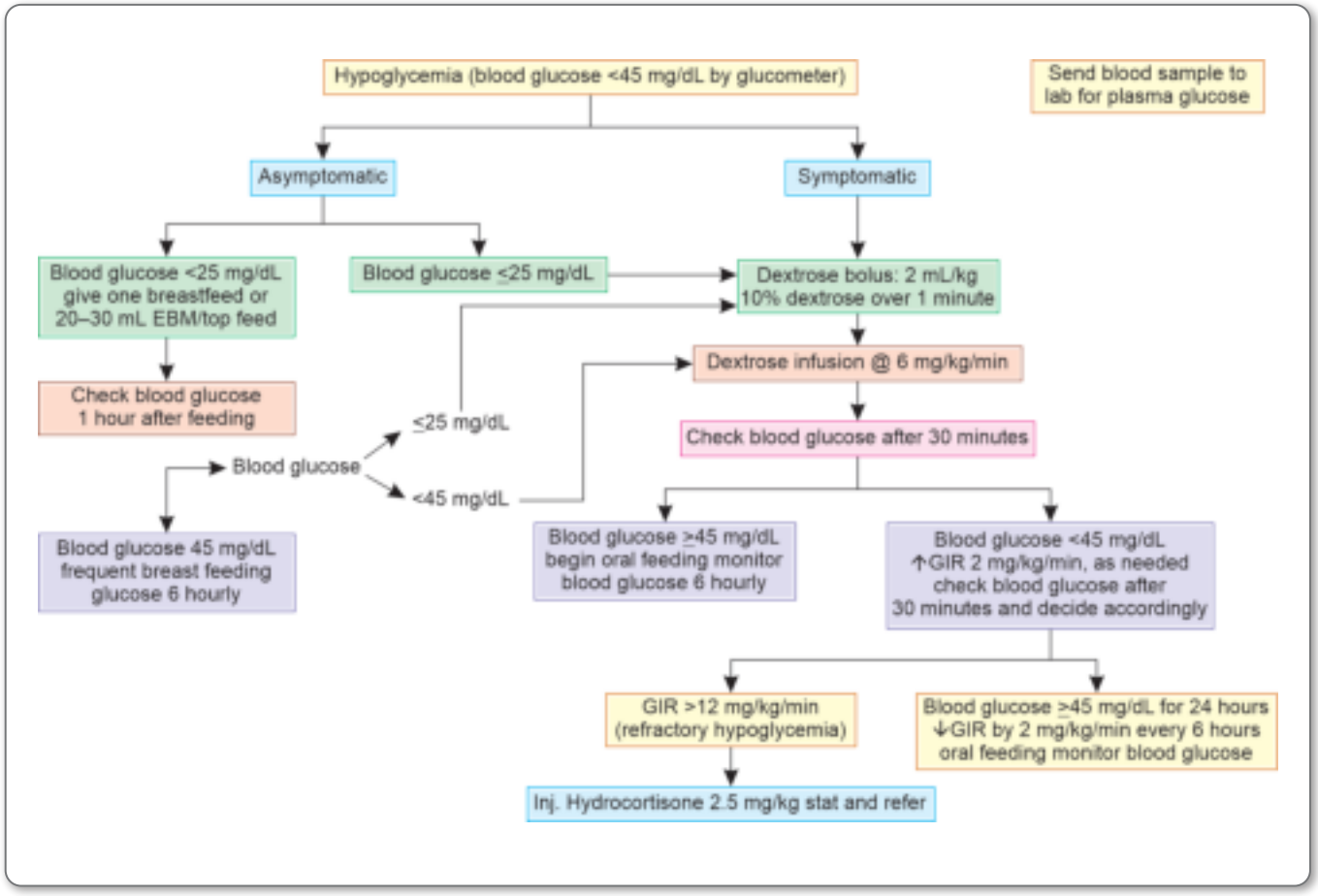


Figure 9.12: Management of hypoglycemia

Table 9.8A: Achieving appropriate glucose infusion rate (GIR) for neonates with birthweight ≥1500 g using a mixture of D10 and D25

Volume (mL/kg/day)	Glucose infusion rate				Glucose infusion rate				Glucose infusion rate			
	6 mg/kg/min				8 mg/kg/min				10 mg/kg/min			
	D10 (mL/kg/day)	D25 (mL/kg/day)	Normal saline (mL/kg/day)	Distill water (mL/kg/day)	D10 (mL/kg/day)	D25 (mL/kg/day)	Normal saline (mL/kg/day)	Distill water (mL/kg/day)	D10 (mL/kg/day)	D25 (mL/kg/day)	Normal saline (mL/kg/day)	Distill water (mL/kg/day)
60	42	18	–	–	24	36	–	–	5	55	–	–
75	68	7	–	–	49	26	–	–	30	45	–	–
90	60	10	20	–	40	30	20	–	20	50	20	–
105	85	–	20	–	65	20	20	–	45	40	20	–
120	86	–	20	14	88	12	20	–	70	30	20	–
135	86	–	20	29	115	–	20	–	95	20	20	–
150	86	–	20	44	115	–	20	15	120	10	20	–

Table 9.8B: Achieving appropriate glucose infusion rate (GIR) for neonates with birthweight <1500 g using a mixture of D10 and D25

Volume (mL/kg/d)	Glucose infusion rate				Glucose infusion rate				Glucose infusion rate			
	6 mg/kg/min				8 mg/kg/min				10 mg/kg/min			
	D10 (mL/kg/day)	D25 (mL/kg/day)	Normal saline (mL/kg/day)	Distill water (mL/kg/day)	D10 (mL/kg/day)	D25 (mL/kg/day)	Normal saline (mL/kg/day)	Distill water (mL/kg/day)	D10 (mL/kg/day)	D25 (mL/kg/day)	Normal saline (mL/kg/day)	Distill water (mL/kg/day)
80	76	4	–	–	55	25	–	–	35	45	–	–
95	87	–	–	8	80	15	–	–	60	35	–	–
110	87	–	20	–	70	20	20	–	50	40	20	–
125	87	–	20	18	70	20	20	15	75	30	20	–
140	86	–	20	34	70	20	20	30	100	20	20	–
150	86	–	20	44	115	–	20	15	120	10	20	–

Specific management includes:

- Fluid resuscitation- infuse fluid bolus of 10 mL/kg of normal saline over 20–30 minutes. A repeat bolus may be given if no improvement in tachycardia or CRT.
- Vasopressors:
  - Dopamine- 5–10 µg/kg/min, if no improvement occurs, increase dose by 5 µg/kg/min every 20–30 minutes to a maximum of 20 µg/kg/min.
  - Dobutamine
  - Hydrocortisone

Weaning from Inotropes

Once hypotension improves (normal BP for 4–6 hours) and tissue perfusion improves, inotropes should be tapered slowly @5 µg/kg/min every 1–2 hourly.

EMERGENCY TRIAGE ASSESSMENT AND TREATMENT

Many deaths occur even after reaching the hospital emergency due to procedural delays in initiating treatment. These can be prevented by triaging or rapid screening of neonates who require immediate attention for life-threatening conditions. The word 'triage' means sorting. A sequential process for managing sick neonates as soon as they arrive in the health facility (SNCU).

Guidelines of emergency triage assessment and treatment (ETAT) identify neonates with immediate life-threatening conditions such as significant hypothermia, obstruction of airway and breathing problems, shock, altered central nervous system function (coma or convulsions) and severe dehydration. ETAT is a tool to reduce facility mortality rates, particularly in first 24-hour in the hospitals, where basic laboratory facilities and inexpensive essential drugs are available.

Process and Steps of Management of Sick Neonates

Triage should be the first step in assessing neonates referred to a health facility. Sick newborns are triaged into the following categories:

E- Emergency- Need Emergency treatment
P- Priority- Need assessment and rapid action
N- Non Urgent- Need assessment and counselling

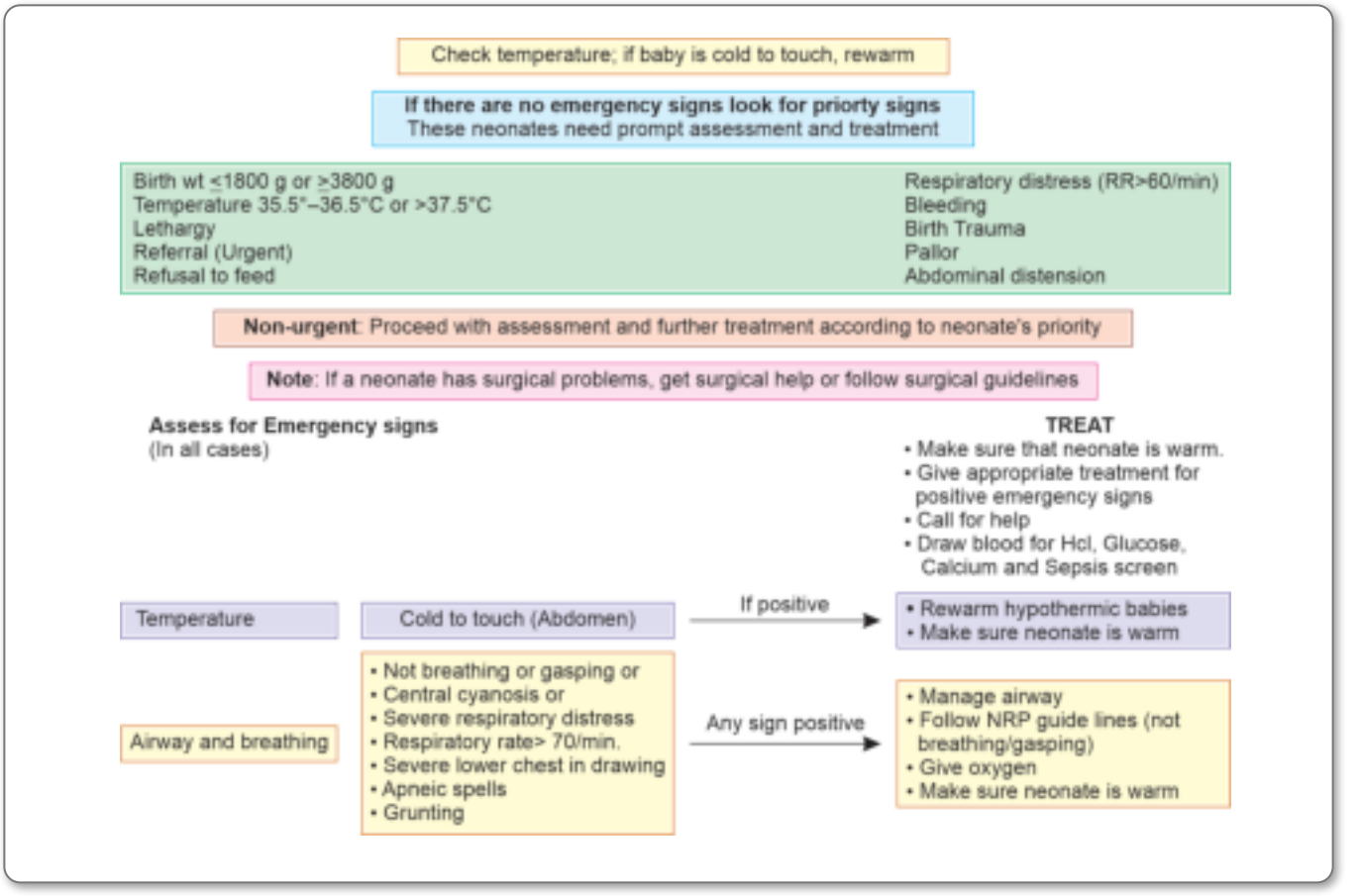
Assessing triage signs: It can be done as given in Table 9.9.

How to Triage

The reception and resuscitation area of casualty of the hospital managing sick neonate should be earmarked as the triaging area. All the staff involved in the initial management of neonate should be trained in the triaging process. The most experienced doctor who is trained in neonatal care should undertake the responsibility of emergency treatment and management following TABCD steps: Temperature, Airway, Breathing, Circulation, Coma, Convulsions, and Dehydration. The process of triage is shown in Figure 9.13.

Table 9.9: Signs for triage

Emergency signs	Priority sings	Non urgent signs
Hypothermia (Temp <35.5°C) Apnea or gasping respiration Severe respiratory distress (rate >70, severe retractions, grunt) Central cyanosis Shock (cold periphery, CFT >3 secs, weak and fast pulse) Coma, convulsions or encephalopathy	Tiny neonate (<1800 g) Temp 36.4°–35.5°C Respiratory distress (rate>60 but no or minimal retractions) Irritable/restless/ jittery Refusal to feed Abdominal distension Severe jaundice (appears in <24 hours/ stains palms and soles/lasts >2 weeks) Severe pallor Bleeding from any site Major congenital malformations (Tracheo esophageal fistula, Menigomyelocele, Anorectal malformation Large baby >3, 8 kg or according to the percentile charts	Jaundice Transition stools Developmental peculiarities Minor birth trauma Possetting Superficial infections Minor malformations All cases not categorized as Emergency/Priority
Neonates with emergency signs are at high risk and require urgent intervention and emergency measures. These neonates with emergency signs after stabilization are to be admitted in the SNCU (Special Newborn Care Unit)	**Action** Neonates with priority signs are sick and would need immediate assessment. They should be attended to on a priority basis. These will also need to be admitted to SNCU	In neonates with no emergency or priority signs, proceed with assessment and further treatment according to neonate's requirement



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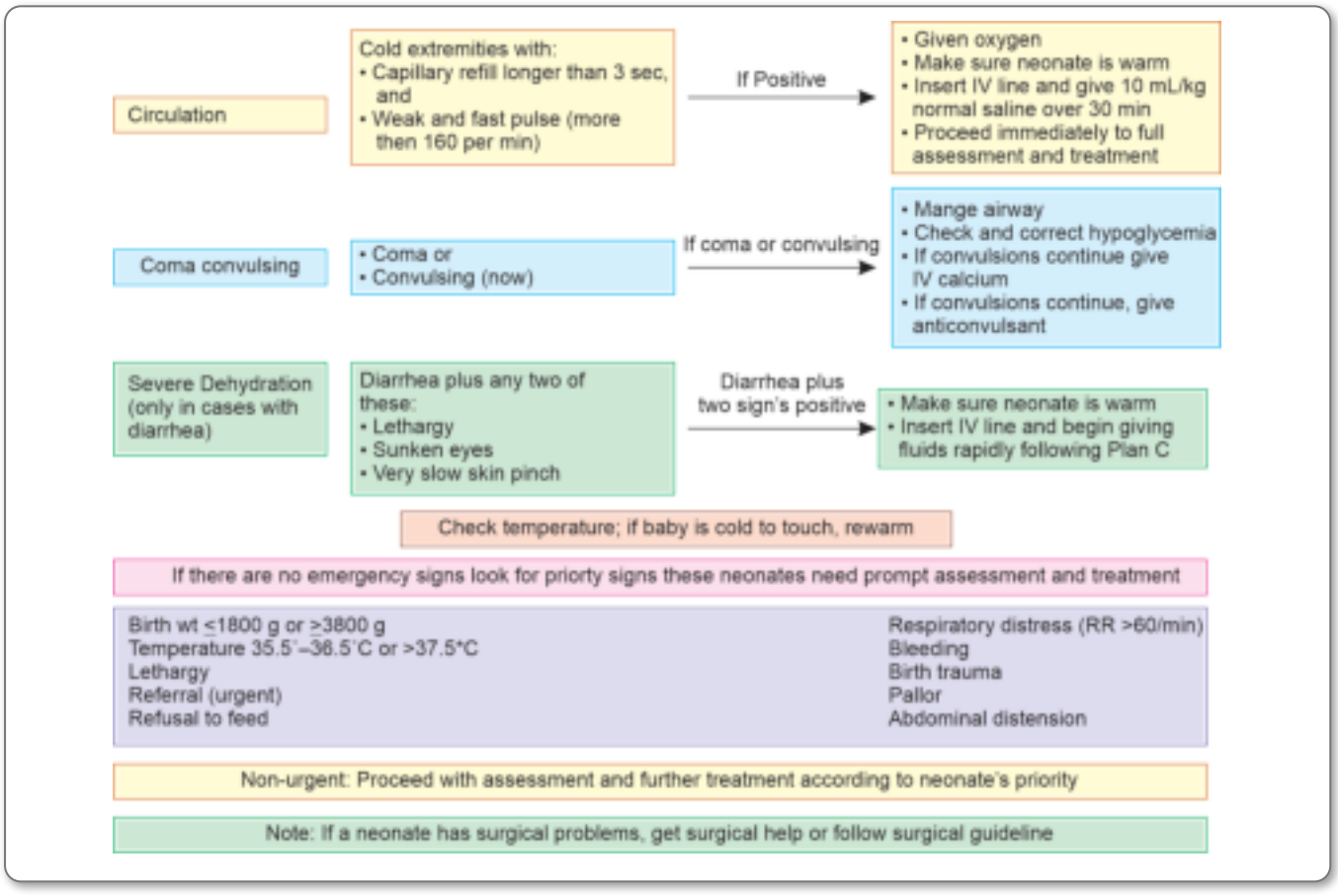

Figure 9.13: Triage

Summary

Newborns need tender loving care, a compassionate heart and an eye for keen observation. The nursing officers on duty need to be aware of all the conditions and update themselves regularly in the management of these common neonatal problems.

Assess Yourself

1. Discuss the nursing interventions for a child with Hypothermia, RDS, and Hypoglycemia
2. Differentiate between physiological and pathological jaundice.
3. Name the 4 mechanisms of heat loss in body.
4. Hypothermia is temperature below ..... (36.5°C)
5. Cold stress refers to temperature between ..... and ..... (36°-36.5°C)
6. VLBW means weight below..... and ELBW means weight below..... (1500, 1000 g)
7. Bronze baby syndrome is side effect of ..... (phototherapy)