MODULE FOR TRAINING OF SPECIALIST IN PEDIATRICS ON NEWBORN CARE

Module - B
(Care of Low Birth Weight (LBW) Babies)

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In modern times, improvement in knowledge and technology has greatly influenced the health of children. However, past decade was marked by limited progress in reducing infant mortality largely due to a failure in reduction of neonatal mortality.

There is widely shared but mistaken idea that improvement in newborn health requires advanced technologies and highly specialized staff. The reality is that many conditions that result in perinatal death can be prevented or treated without sophisticated and expensive technology. What is required is essential care during child birth and immediate postpartum period and a few critical interventions for the newborn during the first days of life.

In this era of evidence based medicine the criteria of diagnosis and management of illness changes frequently, hence, objective of this training to specialists working at referral/district level is to make them acquaint about the recent trends in the management of common newborn problems. The module for training of pediatricians has been developed in three sections "Module - A" contains care of newborn babies with common problems like Birth asphyxia, Sepsis, Jaundice, Birth injuries and Convulsions, "Module -B" contains Care of Low Birth Weight (LBW) babies and "Module - C" contains Intensive Care of a Sick Newborn.

We hope that these modules will serve as a useful guide during training and afterwards in practice for the specialist in Pediatrics working at referral/district hospitals.
## TRAINING OF SENIOR/JUNIOR SPECIALISTS IN PEDIATRICS
### SESSION WISE PLAN

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<th>Day</th>
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<tr>
<td>1</td>
<td><strong>Resuscitation of Newborn</strong></td>
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<td>Management of Birth Asphyxia</td>
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<td>Preparation and Initial steps of</td>
<td>Chest Compression, Medication and Endotrached Intubation</td>
<td>Practice of resuscitation on Baby Manikin</td>
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<td>Resuscitation Bag &amp; Mask ventilation</td>
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<td>Management of Birth Asphyxia</td>
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<tr>
<td>2</td>
<td>Management of Convulsions</td>
<td>Management of Jaundice</td>
<td>Management of sepsis</td>
<td>Management of Birth injuries</td>
</tr>
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<td>3</td>
<td>Management of LBW babies</td>
<td>Intensive Care of Newborn</td>
<td>Intensive Care of Newborn</td>
<td>Setting up of nursery at district level hospital (Group work)</td>
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<td></td>
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<td>Including use of equipments in NICU- e.g. Incubators phototherapy and warmer etc.</td>
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<td>4</td>
<td>Visit to labour room and OT for demonstrate of Neonatal Resuscitation</td>
<td></td>
<td>Setting up of nursery at district level hospital (Group work)</td>
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<tr>
<td>5</td>
<td>Visit to nursery for intensive care of newborn and demonstration of equipments used in NICU</td>
<td></td>
<td>Setting up of nursery at district level hospital (Presentation)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Visit to Nursery for demonstration on care of LBW, Asphyxia, convulsions, sepsis and Jaundice.</td>
<td></td>
<td>Post test Evaluation &amp; Discussion</td>
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</table>

**No. of participants in each batch:** 10  
**Duration of Training:** 6 days
Day 3 Session I - II (Management of Low Birth Weight Babies)

Objectives:
At the end of the session the trainee should be able to understand:

- Problems of LBW babies.
- General principles of feeding and fluid management of small babies.
- Practice proper method of Kangaroo Mother Care.
- Monitoring the condition of baby, and discharge and follow up guidelines.

Methodology

- Lecture-Discussion
- Demonstration on manikin.
LOW BIRTH WEIGHT BABIES (LBW)

Babies with a birth weight of less than 2,500 g, irrespective of the period of their gestation, are classified as low birth weight babies. These include both preterm and term small for dates babies. Their clinical problems and prognoses are quite different from each other. About 25 to 35 percent of babies in India are LBW as opposed to about 5 to 7 percent of newborns in the west. In India alone 6 to 8 million LBW infants are born annually.

High incidence of LBW babies in our country is accounted for by a higher number of babies with intrauterine growth retardation (small-for-dates) rather than the preterm babies. In the present circumstances, it is not possible to offer special care to all LBW babies. As babies with a birth weight of less than 1,800 g are more vulnerable, they deserve priority in admission to the special care nursery. By this criterion alone, 10 percent of the babies in India qualify for admission to the special care neonatal unit.

PRETERM BABIES (IMMATURE, TRULY PREMATURE, BORN EARLY)

About 10 to 12 percent of Indian babies are born preterm (less than 37 completed weeks) as compared to 5 to 7 percent incidence in the West. These infants are anatomically and functionally immature and therefore their neonatal mortality is high. Causes of preterm birth are shown in the table below:

<table>
<thead>
<tr>
<th>(a)</th>
<th>Maternal factors</th>
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<tbody>
<tr>
<td>1</td>
<td>Medical disease of the mother during pregnancy.</td>
</tr>
<tr>
<td>2</td>
<td>Complications of pregnancy e.g., placenta previa and antepartum hemorrhage</td>
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<tr>
<td>3</td>
<td>Incompetence of cervix</td>
</tr>
<tr>
<td>4</td>
<td>Maternal infections</td>
</tr>
<tr>
<td>5</td>
<td>Previous premature delivery</td>
</tr>
</tbody>
</table>
(b) Fetal factors

1. Multiple pregnancy
2. Congenital malformation

(c) Medical factors

The delivery of the fetus may have to be induced before full term on medical grounds under the following circumstances:

1. Uncontrolled diabetes mellitus in the mother.
2. Severe cardiac illness.
3. Hypertension, toxemia
4. Fetal hypoxia and fetal distress
5. Severe rhesus iso-immunization in the mother or hydrops fetalis.
6. Severe intrauterine growth retardation

(d) Iatrogenic

Improper diagnosis of maturity in elective deliveries

PHYSIOLOGICAL HANDICAP OF PRETERMS

The functional immaturity of various systems result in different clinical problems and their knowledge is essential for the satisfactory management of these babies.

Central nervous system

- The immaturity of central nervous system is expressed as inactivity and lethargy, poor cough reflex and incoordinated sucking and swallowing in babies weighing less than 1,800 g or born before 35 weeks of gestation.
- Resuscitation difficulties at birth and recurrent apneic attacks are common.
- Retrolental fibroplasia due to oxygen toxicity is limited to babies with a gestation of less than 35 weeks. On the other hand, they are more resistant to toxic effects of hypoxia as compared to the term babies.
- They are extremely vulnerable to develop intraventricular-periventricular hemorrhage due to relative deficiency of vitamin-K dependent coagulation factors and increased capillary fragility.
- The blood brain barrier, which is possibly a function of available serum proteins, is inefficient in preterm babies, thus brain damage may occur at lower serum bilirubin levels.

**Respiratory system**
- They pose resuscitation difficulties at birth, often followed by hyaline membrane disease, if associated with deficiency of pulmonary surfactant.
- Pulmonary aspiration and atelectasis are common.
- They are vulnerable to develop chronic pulmonary insufficiency due to bronchopulmonary dysplasia.

**Cardiovascular system**

The closure of ductus arteriosus is delayed among preterm infants. About one-third infants with gestational age of 34 weeks or less manifest clinical evidences of patent ductus arteriosus with or without congestive heart failure.

**Gastrointestinal system**
- Regurgitation and aspiration are common because of incoordinated sucking, small capacity of stomach, incompetence of cardioesophageal junction and poor cough reflex. Gastro-esophageal reflux and its consequences are common.
- Abdominal distension and functional intestinal obstruction are due to hypotonia.
- Enterocolitis occurs when other predisposing factors are present.
- Immaturity of glucuronyl transferase system in the liver leads to hyperbilirubinemia, which may be aggravated by dehydration, delayed
feeding and hypoglycemia. Relatively low serum albumin, acidosis and hypoxia in these babies predispose to bilirubin levels.

- The poor hepatic glycogen stores, delayed feeding, birth asphyxia and respirator distress syndrome contribute to the development of hypoglycemia.

**Thermo-regulation**

Hypothermia is invariable and life threatening unless environmental temperature is monitored. Excessive heat loss is due to relatively large surface area and poor generation of heat due to paucity of brown fat in a baby who is equipped with an inefficient thermostat.

**Infections**

- Infections are an important cause of neonatal mortality in low birth weight babies. The low levels of IgG antibodies and inefficient cellular immunity predispose them to infections.
- Excess handling, humid and warm atmosphere, contaminated incubators and resuscitators expose them to infecting organisms, thus contributing to high incidence of infections.

**Renal immaturity**

- The blood urea nitrogen is high due to low glomerular filtration rate.
- The renal tubular amonia mechanism is poorly developed thus acidosis occurs early.
- They are vulnerable to develop late metabolic acidosis especially when fed with a high protein milk formula.

**Toxicity of drugs**

Poor hepatic detoxification and reduced renal clearance make a preterm baby vulnerable to toxic effects of drugs unless caution is exercised during their administration.

**Nutritional handicaps**
Low birth weight babies are prone to develop anemia around 6 to 8 weeks of age. This is due to diminished total stores of iron due to short gestation and also deficiency of folic acid.

Vitamin E deficiency occurs among infants weighing less than 1,500g, particularly those fed on iron fortified milk formula. These infants are prone to develop hemolytic anemia, thrombocytopenia, and edema at 6 to 10 weeks of age.

**Biochemical disturbances**

These babies are prone to develop hypoglycemia, hypocalcemia, hypoproteinemia, acidosis and hypoxia.

**MANAGEMENT**

High-risk mother should be identified early during the course of pregnancy and referred for confinement to an appropriate health care facility, which is equipped with good quality obstetrical, and neonatal care facilities. Mother is indeed an ideal transport incubator!

**Table: Principles of Management of LBW Infants**

<table>
<thead>
<tr>
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<th>Care at birth</th>
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<tr>
<td>1</td>
<td>Suitable place of delivery 'in-utero' transfer to a place ith optimum facilities if a LBW delivery is anticipated.</td>
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<td></td>
<td>Prevention of hypothermia</td>
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<td>Efficient resuscitation.</td>
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<td>2</td>
<td><strong>Appropriate place of care</strong></td>
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<td>Birth weight &gt; 1800 g: Home care, if the baby is otherwise well.</td>
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<td>Birth weight 1500-1800 g: Secondary level newborn unit</td>
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<td>Birth weight &lt; 1500 g: Tertiary level newborn care (or intensive care)</td>
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<td>3</td>
<td><strong>Thermal protection</strong></td>
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<td>Delay bathing.</td>
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<td>Maternal contact.</td>
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<td>Kangaroo mother care.</td>
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</table>
1. Warm room.
- External heat source (incubator, radiant warmer)

4. Fluids and feeds
- Intravenous fluids for very small babies and those who are sick.
- Expressed breast milk with gavage or katori spoon.
- Direct breastfeeding.

5. Monitoring and early detection of complications
- Weight and other clinical signs.
- Electronic monitoring
- Biochemical monitoring

6. Appropriate management of specific complications

### Arrest of premature labour
Advances in perinatal care including fabrication of a variety of electronic gadgets cannot compare with unique security and optimal care provided to the fetus by the uteroplacental unit. Efforts should always be made to arrest the progress of premature labor.

### Antenatal corticosteroids
Antenatal administration of corticosteroids is one of the most cost-effective perinatal strategies which must be universally exploited. It is associated with 50 percent reduction in the incidence of RDS due to surfactant deficiency. It provides additional benefits by reducing the incidence of intraventricular hemorrhage and necrotizing enterocolitis. The overall neonatal mortality is reduced by 40 percent by this simple and cheap intervention. Injection betamethasone 12 mg IM every 24 hours for 2 doses or dexamethasone 6 mg IM every 12 hours for 4 doses should be administered to the mother if labor starts or is induced before 34 weeks of gestation. Betamethasone is more potent and is associated with reduced risk of side effects.
Table: Antinatal Corticosteroids in Preterm Labor
A Simple Therapy That Saves Lives

**Benefits**
- 50 percent reduction in the incidence of respiratory distress syndrome (RDS)
- 50 percent reduction in the incidence of intraventricular hemorrhage (IVH)
- 40 percent reduction in mortality.

**Indications**
- All mother at risk of preterm delivery between 24 and 34 weeks of gestation.
- Case of preterm premature rupture of membrane at less than 32 weeks of gestation in the absence of overt clinical choioamnionitis.

**Contraindications**
- Clinical choioamnionitis. (Maternal hypertension and diabetes mellitus are no contraindications. Careful monitoring and management of hypertension and hyperglycemia should be ensured).

**Treatment Schedule**
- Inj. Betamethasone 12 mg IM every 24 hours, 2 doses (preferred).
- Inj. Dexamethasone 6 mg IM every 12 hours, 4 doses (only if betamethasone can not be arranged).

**Timing of Effect**
- Optimal effect occurs after 24 h of initiating treatment.
- The effect of one course lasts for 7 days.

The optimal effect is seen if delivery occurs after 24 hours of the initiation of therapy and its therapeutic effect lasts for 7 days. The beneficial effects are better in female babies compared to the male. The need and safety of repeat course of antenatal steroids is controversial and is under investigation by multicentric clinical trials. Tocolytic therapy should be continued concomitantly. Corticosteroids can be given even in the presence of maternal hypertension or diabetes mellitus but should preferably be avoided if premature rupture of membranes (PPROM) is associated with definitive clinical evidences of choioamnionitis.

**CARE OF PRETERM BABIES**

**Optimal management at birth**

When a preterm baby is anticipated, the delivery should be attended by a senior pediatrician, fully prepared to resuscitate the baby. The delayed
clamping of cord helps in improving the iron stores of the baby. It may also reduce the incidence and severity of hyaline membrane disease.

- Elective intubation of extremely LBW babies (< 1000g) is practised in some centers to support breathing and for prophylactic administration of exogenous surfactant.
- The baby should be promptly dried, kept effectively covered and warm. Vitamin K 0.5 mg should be given intramuscularly.
- The baby should be transferred by the doctor or nurse (not a nursing orderly!) to the NICU as soon as breathing is established.

**Monitoring**

The following clinical parameters should be monitored by specially trained nurses. The frequency of monitoring depends upon the gestational maturity and clinical status of the baby.

- Vital signs with the help of multi-channel vital sign monitor (non-invasive with alarms).
- Activity and behaviour.
- Color; Pink, pale, grey, blue, yellow.
- Tissue perfusion Adequate tissue perfusion is suggested by pink color, capillary refill over upper chest of < 3 sec, warm and pink extremities, normal blood pressure, urine output of >1.5 ml/kg/hr, absence of metabolic acidosis and lack of any disparity between paO2 and SaO2.
- Fluids, electrolytes and ABG’s.
- Tolerance of feeds; Vomiting, gastric residuals, abdominal girth.
- Look for development of RDS, apneic attacks, sepsis, PDA, NEC, IVH etc.
- Weight gain velocity.

During daily clinical evaluation of a preterm baby, the following clinical characteristics should be looked for because they suggest that the baby is healthy. The vital signs should be stable. The healthy baby is alert and active, looks pink and healthy (smells good too!), trunk is warm to touch and
extremities are reasonably warm and pink. The baby is able to tolerate enteral feeds and there is no respiratory distress or apneic attacks and baby is having a steady weight gain of 1.0-1.5 percent (10-15g/kg/d) of his body weight every day.

Provide in-utero milieu

Uterus provides ideal ambient conditions to the baby. All attempts should be made to create uterus like baby-friendly ecology in the nursery.

- Create a soft, comfortable, "nestled" and cushioned bed.
- Avoid excessive light, excessive sound, rough handling and painful procedures. Use effective analgesia and sedation for procedures.
- Provide warmth.
- Ensure asepsis.
- Prevent evaporative skin loses by effectively covering the baby, application of oil or liquid paraffin to the skin and increasing humidity to near 100 percent.
- Provide effective and safe oxygenation.
- Uterus is able to provide unique parenteral nutrition. Efforts should be made to provide at least partial parenteral nutrition and give trophic feeds with expressed breast milk (EBM).
- Provide rhythmic gentle tactile and kinesthetic stimulation like skin-to-skin contact, interaction, music, caressing and cuddling.

Position of the baby

Most babies love to lie in a prone position, they cry less and feel more comfortable. It relieves abdominal discomfort by passage of flatus and reduces risk of aspiration. Prone posture improves ventilation, increases dynamic lung compliance and enhances arterial oxygenation. Unsupervised prone positioning, beyond neonatal period, has been recognized as a risk factor for SIDS.
Thermal comfort

- A pre-warmed open care system or incubator should be available at all times to receive any baby with hypothermia or with a birth weight of less than 2000g. The baby should be nursed in a thermoneutral environment with a servo sensor geared to maintain skin temperature of mid-epigastric region at 36.5°C so that there is virtually no or minimal metabolic thermogenesis.
- Application of oil or liquid paraffin on the skin reduces convective heat loss and evaporative water losses.
- The extremely LBW baby should be covered with a cellophane or thin transparent plastic sheet to prevent convective heat loss and evaporative losses of water from skin.
- As soon as baby's condition stabilizes he should be covered with a perspex shield or effectively clothed with a frock, cap, socks and mittens.
- After one week or so, stable babies with a birth weight of < 1200 g should preferably be nursed in an intensive care incubator. It is associated with reduced chances of handling, better temperature control, reduced evaporative losses from skin and better weight gain velocity.
- The mother should be encouraged to provide Kangaroo-Mother-Care (KMC) to prevent hypothermia, to promote bonding and breastfeeding and to transmit healing electromagnetic vibrations of love and compassion to her baby.

KANGAROO MOTHER CARE

Kangaroo mother care (KMC) is care of a small baby who is continuously carried in skin-to-skin contact by the mother and exclusively breastfed (ideally). It is the best way to keep a small baby warm and it also helps establish breastfeeding. KMC can be started in the hospital as soon as the baby's condition permits (i.e. the baby does not require special
treatment, such as oxygen or IV fluid). KMC, however, requires that the mother stay with the baby or spend most of the day at the hospital.

- Ensure that the mother is fully recovered from any child birth complication before she begins KMC.
- Ensure that the mother has support from her family to stay at the hospital or return when the baby is ready for KMC and to deal with responsibilities at home. Discuss with the family, if possible, how they can support the mother so she can provide KMC.
- Explain to the mother that KMC may be the best way for care of her baby once the baby's condition permits:
  - the baby will be warm;
  - the baby will feed more easily;
  - episodes of apnoea will be less frequent.
- Take the baby away from the mother only to change napkins (diapers), bathe, and assess for clinical findings according to the hospital's schedule, or as necessary.
- Babies can be cared for using KMC until they are about 2.5 kg or 40 weeks post-menstrual age.

**BEGINNING KMC**

- While the baby is recovering from an illness, the mother can begin to hold the baby in skin-to-skin contact for short periods of time (one to three hours at a time).
- Once the baby's condition is stable and the baby does not require special treatment (e.g. oxygen or IV fluid), the mother can begin continuous KMC.
- When the baby is ready for KMC, arrange with the mother a time that is convenient for her. Ask her to wear light, loose clothing that is comfortable in the ambient temperature, provided the clothing can accommodate the baby.
- Ensure that the room is at least 25°C.
• While the mother is holding the baby, describe to her each step of KMC, demonstrate them, and then allow her to go through the steps herself.

• Clothe the baby with a pre-warmed shirt open at the front, a napkin, a hat and socks.

• Place the baby on the mother's chest:
  – Place the baby in an upright position directly against the mother's skin;
  – Ensure that the baby's hips and elbows are flexed into a frog-like position and the baby's head and chest are on the mother's chest, with the head in a slightly extended position.

• Place the baby on the mother's chest under the mother's clothes (Fig) and cover with a pre-warmed blanket:

**FIGURE: Baby in kangaroo mother care position under mother's clothes**

![FIGURE: Baby in kangaroo mother care position under mother's clothes](image)

**BREASTFEEDING**

• Have the mother attempt to breastfeed either when the baby is waking from sleep or when awake and alert.

• Have the mother sit comfortably, and help her with correct positioning and attachment, if necessary.

• If the baby cannot be breastfed, have the mother give expressed breast milk using an alternative feeding method.
**DAILY LIFE FOR THE MOTHER**

- Emphasize to the mother that it is important that she wash her hands frequently.
- During the day, the mother can do whatever she likes: she can walk, stand, sit, or lie down.
- The best sleeping position for the mother during KMC is a reclining position. If the mother's bed is not adjustable, she can use several pillows to drop herself up. She may also sleep on her side.
- When the mother needs time away from the baby for hygiene or for any other reason, either.
  - have a family member carry the baby in skin-to-skin contact while the mother is not available; or
  - dress the baby, place in a warm bed, and cover until the mother or a family member is available to carry the baby in skin-to-skin contact.

**MONITORING THE BABY'S CONDITION**

- If the baby is in continuous KMC, measure the baby's temperature twice daily.
- Teach the mother to observe the baby's breathing pattern, and explain the normal variations. If the baby stops breathing, have the mother stimulate the baby to breathe by rubbing the baby's back for 10 seconds. If the baby does not begin to breathe immediately, resuscitate the baby using a bag and mask.
- Teach the mother to recognize danger signs (e.g. apnoea, decreased movement, lethargy, or poor feeding).
- Respond to any concerns the mother may have. If the baby is feeding poorly, determine if the mother's technique is incorrect, the baby is still too immature, or the baby is becoming ill.
FEEDING AND NUTRITION OF LBW

Why Concerned?

The preterm / LBW infant faces several nutritional problems due to:

- Immature organ systems & small gastric capacity.
- Weak suck reflex & poor suck-swallow coordination till 34 weeks of gestation.
- Incompetent gastro-esophageal sphincter, poor gag reflex.
- Decreased activity of enzymes – lactases & lipase & decreased bile acid pool. Also decreased activity of other enzymes responsible for catabolism of tyrosine and methionine to cystine.
- Low glomerular filtration rate & decreased concentrating capacity of kidney.
- Postnatally, preterms lose more weight (15% to 20% of birth weight as compared to 5% to 10% in term infant).
- Smaller metabolic reserves: Decreased stores of glycogen/ fat/ vitamins/ minerals. During relative starvation of first days of life, they rapidly deplete their nutrient reserves.
- Greatly increased energy requirements – due to high BMR, increased growth, increased stress & associated metabolic problems like hypoglycemia.
- Many studies show that 90-95% of VLBW(<1500 gms) & ELBW(<1000 gms) neonates are <10th centile of weight, length and head circumference for their gestational age at the time of discharge.
- Long term follow up of these babies indicate that they have poor catch up growth at 1 yr of age, which is the most critical period of brain growth.
- On the other side, there is now growing concern that in-utero & postnatal over nutrition could be associated with adverse outcome,
Feeding the baby so as to meet these greatly increased energy demands remains a nursing & nutritional art because of these special liabilities of these infants. Early nutrition plays a very important role for subsequent long-term growth and neurodevelopment in VLBW babies especially those who are extremely preterm.

Nutritional Goals

- Aim of feeding should be to approximate intrauterine growth.
- The quality of weight gained and composition of tissue accrued is a better determinant of adequacy of nutrition i.e., protein accretion rather than fat accretion & water retention.

**Estimated Energy Utilization of Growing Preterm and Term Infant**

(Kcal/Kg/Day)

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<tr>
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<th>PRETERM</th>
<th>TERM</th>
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<tbody>
<tr>
<td>Basal</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Activity</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>SDA</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Stool Loss</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Subtotal</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Growth</td>
<td>40-85</td>
<td>20-40</td>
</tr>
<tr>
<td>Total</td>
<td><strong>130-175</strong></td>
<td><strong>110-130</strong></td>
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</tbody>
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- A growth rate of 15 gm/kg/day theoretically requires 90 kcal/kg/day (for maintenance) plus around 40-85 kcal/kg/day (for growth); which equals 130-175 kcal/kg/day.
- Breast milk contains 65-70 kCal/100 ml.
- A Preterm whose energy requirement is around 130 kcal/kg/day would require at least 200 ml/kg/day of Breast milk to meet the needs.
DIETARY PRINCIPLES

Proteins
• 10% of daily calories should be derived from proteins.
• Recommended allowance for LBW neonates is 3-4 gms/kg/day.

Carbohydrates
• Should provide 40% energy.
• Recommended allowance is 10-15 gms/kg/day.

Fats
• Should provide 50% of total energy.
• Recommended allowance is 5.4-7.2 gms/kg/day.

Electrolytes
• Sodium, Potassium, Chloride requirement may be considerably higher in ELBW infants because of significant renal losses.
• However their supplementation is not required for the first 24 to 48 hours.
• Recommendations are 2.5 to 3.5 meq/ kg/ day each.
• Mature Human milk contains 1.1 meq/100 kcal of sodium and premature milk contains 1.9 meq /100 kcal which is often insufficient for VLBW infants.

Calcium & Phosphorus
• Third trimester calcium accretion (120 to 150 mg/ kg/ day) is greater than the amount of calcium a preterm infant can ingest from human milk, even with maximal absorption.
• Preterm formula & HMF (Human Milk Fortifier) are answer to this problem.
• AAP recommends 210mg/kg/day of Calcium and 110 mg/kg/day Phosphorus.
• The currently available milk fortifier in Indian market is HMF sachet, which contains 2gm powder, is mixed with 50 ml of EBM and provides 50 mg Calcium & 25 mg Phosphorus.

• Fortification of Human Milk with Calcium & Phosphorus containing Syrups (in a ratio of 2:1) like OstoCalcium (GLAXO) having 82mg calcium per 5ml is a satisfactory method but risk of creating hyperosmolar milieu in lumen of immature VLBW intestine must be considered.

• If the baby is on Breast milk, Ca & P supplements are continued till the baby is 40 weeks /3 to 3.5 kg.

Iron

• Preterm neonates have diminished stores so; we should provide them with Iron once tolerance of full feeds is achieved.

• Supplementation increases storage and reduces the risk of Iron deficiency in later life.

<table>
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<tr>
<th>WEIGHT</th>
<th>Iron Requirement in mg/kg/day</th>
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</thead>
<tbody>
<tr>
<td>&lt;1000 gms</td>
<td>4</td>
</tr>
<tr>
<td>1000 – 1500 gms</td>
<td>3 – 4</td>
</tr>
<tr>
<td>1500 – 1800 gms</td>
<td>2- 3</td>
</tr>
<tr>
<td>&gt; 1800 gms</td>
<td>2</td>
</tr>
</tbody>
</table>

• Breast milk can provide a maximum of 0.5 mg /kg/day, so it has to be fortified.

• Iron should be started at 6- 8 weeks. If the baby had frequent phlebotomies we can start Iron as early as 4 weeks.
- Iron catalyzes lipid oxidation through generation of free radicals. Adequate Vitamin E is necessary to prevent peroxidation of erythrocyte membrane & resultant hemolytic anemia.
- Iron is continued for at least one year and if weaning is not adequate then continue it till 2 to 3 years of age.

Vitamins
- Vitamin A- An intake of 1500 IU/kg/day is recommended for preterms. It may promote epithelial repair and minimize fibrosis in preterm babies with CLD.
- Vitamin D- Vit. D at 400 IU/day maintains adequate Vit D status and prevents Rickets.
- Vitamin E- Vit. E is recommended for preterm infants in 6 to 12 IU/kg/day. One ml of Evion (E-Merck) contains 50 IU.
- Vitamin K- Vit K is required for hepatic synthesis of coagulation factors II, VII, IX, & X. Administration at birth of 0.5 to 1.0 mg i.m. Vit K can prevent HDN.
- Most preterm formulae contain adequate amount of vitamin B complex & trace elements like Zinc, Copper, Selenium, Chromium, Manganese, Molybdenum and Iodine.
- Many multivitamin drops like Vi-Syneral(Lifeon), AtoZ(Alkem), Hovite(Raptkos), Abdec(Pfizer), Dexvita(wockhardt) are available in the market. If the LBW infant is on EBM, these drops should be started by the end of 2nd week or as soon as infant is receiving full volume feeding and continued at a dose of 0.3ml till discharge and 0.6 ml till the baby reaches 6 mo or is 4.5 kgs.
- These drops do not contain folate because it is unstable in mixed solution. Vitcofol (FDC) 1 ml contains 200µg folic acid. Requirement is 25-50 µgm/kg/day. 8 drops/day initially followed by 4 drops per day
Human Milk Fortifier:

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Unit</th>
<th>Per 2 gm sachet</th>
<th>Per 2 sachet of HMF+100 ml of PT milk of 7th day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Kcal</td>
<td>6.5</td>
<td>81.2</td>
</tr>
<tr>
<td>Protein</td>
<td>g</td>
<td>0.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Fat</td>
<td>g</td>
<td>0.1</td>
<td>4.0</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>g</td>
<td>1.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Calcium</td>
<td>Mg</td>
<td>50</td>
<td>125</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Mg</td>
<td>25</td>
<td>64</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>IU</td>
<td>730</td>
<td>1460</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>IU</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>IU</td>
<td>1.25</td>
<td>2.5</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>mcg</td>
<td>1.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Osmolarity</td>
<td>mOsm/L</td>
<td>---</td>
<td>294.14</td>
</tr>
<tr>
<td>RSL</td>
<td>mOsm/L</td>
<td>---</td>
<td>182.48</td>
</tr>
</tbody>
</table>

In addition it contains Vitamin B complex, minerals and electrolytes in appropriate amount.

**Desirable Formula For Preterm Infant**:

- Proteins – 2 gm / 100 ml
- Fats – 4 gm / 100 ml
- Carbohydrates – 10 gm / 100 ml
- Lactose – 4 gm / 100 ml
- Glucose Polymers – 6 gm / 100 ml
- Calories ~ 80 kcal / 100 ml
- Osmolality ~ 300 mosm / kg H2O
- Renal Solute Load upto 100 mosm / L
- Adequate amount of electrolytes, minerals, vitamins and trace elements.
Comparison of Enteral Intake Recommendation of Premature Infant
(Per kg/ day)*

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>AAP 1998</th>
<th>Tsang et al 1993</th>
<th>Preterm Human Milk</th>
<th>Mature Human Milk</th>
<th>Lactodex LBW</th>
<th>Prelactogen</th>
<th>Dexolac SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cal/100ml</td>
<td>---</td>
<td>---</td>
<td>67</td>
<td>67</td>
<td>87</td>
<td>77</td>
<td>76</td>
</tr>
<tr>
<td>Cal/30ml</td>
<td>---</td>
<td>---</td>
<td>20</td>
<td>20</td>
<td>26/5.3gm</td>
<td>23.3/4.4g</td>
<td>22.7/4.5g</td>
</tr>
<tr>
<td>Cal/150ml</td>
<td>130-175</td>
<td>130-175</td>
<td>110</td>
<td>110</td>
<td>133</td>
<td>115</td>
<td>114</td>
</tr>
<tr>
<td>Protein (gm)</td>
<td>3.5-4</td>
<td>3-4</td>
<td>2.4</td>
<td>1.54</td>
<td>3.35</td>
<td>3.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Carb. (gm)</td>
<td>10.8-15.6</td>
<td>---</td>
<td>11</td>
<td>10.6</td>
<td>14.9</td>
<td>13.1</td>
<td>12.5</td>
</tr>
<tr>
<td>Fat (gm)</td>
<td>5.4-7.2</td>
<td>---</td>
<td>5.3</td>
<td>5.7</td>
<td>6.7</td>
<td>5.7</td>
<td>5.8</td>
</tr>
<tr>
<td>Vitamin A (IU)</td>
<td>90-270</td>
<td>700-1500</td>
<td>72</td>
<td>328</td>
<td>355</td>
<td>402</td>
<td>993</td>
</tr>
<tr>
<td>Vitamin D (IU)</td>
<td>500</td>
<td>150-400</td>
<td>12</td>
<td>3</td>
<td>120</td>
<td>115</td>
<td>118</td>
</tr>
<tr>
<td>Vitamin E (IU)</td>
<td>&gt;1.3</td>
<td>6-12</td>
<td>0.6</td>
<td>0.34</td>
<td>5.3</td>
<td>2.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Folate (µgm)</td>
<td>39.6</td>
<td>25-50</td>
<td>5</td>
<td>7.4</td>
<td>80</td>
<td>71</td>
<td>45</td>
</tr>
<tr>
<td>Sodium (meq)</td>
<td>2.5-3.5</td>
<td>2-3</td>
<td>1.9</td>
<td>1.1</td>
<td>3.5</td>
<td>1.6</td>
<td>1.9</td>
</tr>
<tr>
<td>Potassium, meq</td>
<td>2-3</td>
<td>2-3</td>
<td>1.9</td>
<td>2</td>
<td>3.4</td>
<td>3.1</td>
<td>3</td>
</tr>
<tr>
<td>Chloride (meq)</td>
<td>---</td>
<td>2-3</td>
<td>2.5</td>
<td>1.8</td>
<td>3.75</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>Ca (mg)</td>
<td>210</td>
<td>120-230</td>
<td>38</td>
<td>41</td>
<td>215</td>
<td>151</td>
<td>181</td>
</tr>
<tr>
<td>P (mg)</td>
<td>110</td>
<td>60-140</td>
<td>22</td>
<td>21</td>
<td>107</td>
<td>75.5</td>
<td>93</td>
</tr>
<tr>
<td>Mg (mg)</td>
<td>---</td>
<td>7.9-15</td>
<td>5</td>
<td>5.1</td>
<td>13</td>
<td>8.2</td>
<td>13.7</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>2-3</td>
<td>2</td>
<td>0.14</td>
<td>0.04</td>
<td>1.35</td>
<td>1.74</td>
<td>2</td>
</tr>
<tr>
<td>Zinc (µgm)</td>
<td>&gt;600</td>
<td>1000</td>
<td>560</td>
<td>180</td>
<td>1350</td>
<td>900</td>
<td>1120</td>
</tr>
<tr>
<td>Selenium (µgm)</td>
<td>---</td>
<td>1.3-3</td>
<td>__</td>
<td>2.2</td>
<td>1.7</td>
<td>1.4</td>
<td>11.5</td>
</tr>
<tr>
<td>Iodine (µgm)</td>
<td>6</td>
<td>30-60</td>
<td>27</td>
<td>16</td>
<td>20</td>
<td>11.5</td>
<td>28.5</td>
</tr>
<tr>
<td>RSL</td>
<td>159</td>
<td>89</td>
<td>159</td>
<td>133</td>
<td>133</td>
<td>120</td>
<td>25</td>
</tr>
</tbody>
</table>
All of these formulas also contains copper, chromium, manganese, taurine, carnitine, inositol, choline and vitamin B complex in appropriate amounts.

*Recommendations & calculated intakes of formulas & human milk are based on 150ml/kg/day

**Unique Substances In Human Milk**

- Enzymes – Lysozymes (kills bacteria by disruption of glycosidic bond in bacterial cell wall), Lactoperoxidase (kills bacteria by oxidative mechanisms)
- Bioactive Substances like IgA, IgG, and IgM
- Opsonins & Complements C3, C4.
- Growth Factors & hormones
- Specific Inhibitors – Antiviral, Antistaphylococcal, Antimalarial (PABA)

**Storage of EBM**

<table>
<thead>
<tr>
<th>Storage Method</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>At room temperature</td>
<td>8 hrs.</td>
</tr>
<tr>
<td>Refrigerator (4°C)</td>
<td>24-48 hrs</td>
</tr>
<tr>
<td>Freezer (-20°C)</td>
<td>3 mo to 1 yr</td>
</tr>
<tr>
<td>Thawed frozen milk in refrigerator</td>
<td>24 hrs</td>
</tr>
</tbody>
</table>

**How to Improve Nutrition in LBW**

- Increase the volume of breast milk
- Use Preterm Formula
- Fortification

**Minimal Enteral Feeding / Trophic feeding**


- Luminal starvation leads to mucosal thinning, flattening of villi & bacterial translocation (as early as 2 to 3 days). To maintain the structural and functional integrity of GIT, provision of very small volumes (<10ml/kg/day) is called Trophic feeding.
• The purpose of trophic feeding is induction of gut maturation rather than nutrient delivery.

• Benefits of trophic feeding includes –
  ➢ Earlier progression to full enteral feeds,
  ➢ Improved levels of gut hormones,
  ➢ Improved weight gain,
  ➢ Less feeding intolerance,
  ➢ Improved Ca & P retention,
  ➢ Fewer days on Total Parenteral Nutrition (TPN).

• Begin on LD 2 to 3 with Human milk (preferably) or preterm formula every 4, 6 or 8 hrs.

• Contraindications – Suspected or confirmed NEC, evidence of ileus, hemodynamic instability or other intestinal pathology, patient on indomethacin for PDA.

• Umbilical Artery Catheterization is not a contraindication to trying enteral feeds.

• One situation where we would definitely be cautious before starting enteral feeds is in the IUGR baby who had reversed end-diastolic blood flow in his umbilical artery before birth. This is known to be a very high risk situation for NEC.

• MEN can be started while baby is on ventilator and/or receiving TPN.

• In severe Birth asphyxia MEN should be started after 48 – 72 hrs.

**FEEDING METHODS**

**Nasogastric / Orogastric feeding**

In those who do not have ability to coordinate suck-swallow-breathe patterns due to prematurity (<34 wks gestation) and conditions such as encephalopathy, hypotonia & maxillofacial abnormalities.

Disadvantage of NG feeding: Partial airway obstruction & ↑ airway resistance. Can be given bolus or as continuous feeds.
Transpyloric feedings

In Infants intolerant to NG/OG feeding, those at increased risk for aspiration and with severe gastric retention & regurgitation, & gastrointestinal abnormalities like microgastria.

Should be delivered continuously.

Placed under guided fluoroscopy.

Increased risk of fat malabsorption (as lingual & gastric lipases are bypassed).

Breast Feeding / Bottle Feeding

Gastrostomy Feeding

In Infants who are unable to take sufficient volumes via breast / bottle feeding to maintain adequate growth / hydration status and in infants requiring tube feedings for long i.e., >3-6 months. Has not received general acceptance due to high incidence of local leaks & infections.

FEEDING GUIDELINES

When to start Enteral Feeds?

- As early as LD 2, hypo-caloric (<10 ml/kg/d) enteral feeds should be started.
- Sick babies of any birth weight often have a concomitant ileus. Enteral Feeds should only be started in sick babies if:
  - The baby’s condition is improving even though they are still on IPPV.
  - They do not have abdominal distension.
  - They have passed meconium.
  - They have normal bowel sounds.

Which feeding method to commence & how much to advance in LBW babies?

- <1200gms/30 weeks-
  - Start iv fluids at birth.
Start 10 ml/kg/d feed by gavage as soon as hemodynamically stable (MEN).

Advance by 20ml/kg/d if tolerance is good. (AG, Residuals, Vomiting)

Frequency of feeding 2 hrly, intermittent bolus.

Reach up to 180- 200 ml/kg/d, if tolerating.

Try katori spoon and breast feed later.

- **1200- 1500 gms/30-32 wks**-
  - No iv fluids, if the baby is stable.
  - Start with 60ml/kg/d by gavage.
  - Advance by 20-30ml/kg/d.
  - Frequency of feeding 2hrly.
  - Try katori spoon after assessing swallow and respiratory coordination.
  - Breast feed later.

- **1500- 1800gms/32-34 wks**-
  - Total enteral feeds should be started by gavage for non distressed infants.
  - Graduate soon to spoon and breast feeds.
  - In sick babies on iv fluids, feeds are advanced at a rate of 30ml/kg/d after stabilization.

- **>1800gms / >34 wks**-
  - Start breast feed from day 1, if asymptomatic.
  - Compliment with katori spoon if not taking breast feed adequately.
  - Monitor weight gain. Feeding inadequacy is very common.

**What Milk?**
Three Choices –

1. EBM with Fortifier
2. EBM + Ca, P & Vitamin supplements
3. Preterm Formula
First Choice Milk – EBM with HMF supplementation. For infants with a birth weight <1500g, caloric density is ↑ from 20 to 24 cal/30 ml when baby starts tolerating 100 ml/kg/day. For >1500 g infants, caloric density is advanced after achieving full volume feedings.

Second Choice Milk – EBM with Ca, P & Vitamin supplements

Third Choice Milk - Preterm Formula

Animal Milk – Advantages of fresh dairy milk is an easy availability, affordability & less chances of infection. Diluting it & adding sugar to match the protein & energy content of breast milk quantitatively can humanize it but there are definite qualitative differences in the various components, which are not optimal for growth of LBW infant. The disadvantages are high solute load, different whey: casein ratio (80:20), allergic properties and paucity of essential fatty acids, iron & minerals.

AAP has recommended against use of dairy milk in 1st 6 months of life. This is obviously impractical in our country where cows milk is a cheaper alternative to breast milk.

What if NG feeds is not tolerated?

- Posture: Babies stomach empty better if they lie on their right side or prone.
- Continuous infusion of milk through NG tube → Use a syringe infusion pump to infuse the milk the NG tube. A new supply of milk every 6 to 8 hrs.
- Nasojejunal Feeding
- I.V. glucose electrolyte solutions and I.V. Feedings.
- Cisapride is contraindicated in PTIs because it induced prolonged QT interval.
When should the enteral feeds be stopped?

- If the gastric aspirate every 3 hours is consistently larger than 25% of the volume of milk given in previous feed.
- If the AG ↑ by 2 cm, a pre-feed aspirate should be checked, which if >25% of milk given in previous feed (at least 3 – 4 ml in a small feed), feeding should be stopped.
- If the aspirate is dirty / blood or bile stained or there are signs of intestinal obstruction.
- If feeding triggers apnoeic attacks.
- In babies who are having repeated convulsions.
- During exchange transfusion.
- Suspected of inborn errors of metabolism.

When to stop HMF or preterm formula?

There is little evidence on which to base this question but consider changing preterm to standard formula or stopping adding HMF to EBM when babies reach 2.5 kgs in weight and 40 weeks of gestational age.

Non-Nutritive Sucking

- Used during gavage feeding & in the transition from gavage to breast feeding in preterm infants.
- Facilitates the development of sucking behavior.
- Improves digestion of enteral feedings.
- NNS may be done with empty breasts or with a pacifier.

Once rooting is noted, mother should pump her breast before skin to skin holding sessions (KMC), so that, the baby while latching-on & practicing does not get overwhelmed by the milk “let-down” reflex and lots of milk at once.

Causes of Inadequate Weight gain

- Inadequate calories provided / consumed. This is a very common problem encountered due to spillage and amount & number of feeds given being lesser than advised.
- Cold stress
- Anemia
- Underlying systemic illness e.g., CHD with heart failure, steatorrhea (cystic fibrosis), endocrinopathies (hypothyroidism), and brain damage.
- Late hyponatremia
- Late metabolic acidosis due to inability to excrete H\(^+\) produced by growth and bone formation, the breakdown of nitrogen and sulphur from aminoacids in ingested protein and incomplete oxygenation of organic acids. Blood gas analysis should be done and if academia is present, oral sodium bicarbonate can be given (2 to 4 mmol/kg/24 hrs)
- Urinary Tract Infection → check urine → Treat

**Always remember**
- Breast milk is the ideal food for babies of all weights and all gestations.
- When starting enteral nutrition in VLBW infant, breast milk is better tolerated than formula.
- Babies less than 1800 g at birth fed preterm formula thrived better compared to normal term formula or EBM.
- Babies fed EBM had less NEC and better development quotients.
- Minimal Enteral Feeding should be started early with EBM only and stopped only if there is clear evidence of gastrointestinal disease.
- Once enteral nutrition is established, breast milk is not suitable as sole diet in VLBW infant.
- Target weight gain for a preterm baby on full enteral feeds is 15 gm/kg/day (range 10 - 20). Weight gain in excess of 25 gm/kg/day should raise concerns about fluid retention.
- In Babies who commence on i.v. Fluids at birth – rate of increase needs to be individualized to that baby. Increases up to 30 ml/kg are safe if they are tolerated.
• In defining rate of increase the following needs to be considered –
  o Gestation & weight of the baby
  o How sick the baby has been
  o How well the milk is being tolerated (vomited / large residuals)
  o Any abdominal signs like distention
• A final feed volume should be between 180-200 ml/kg/day.
• The rapid rate of advancement of feeding results in overall reduction in days to full enteral feeding and days to regain birth weight and there is no effect on NEC.
• When the baby is on gavage or katori spoon feeds, it is important that the baby is put on breast if possible before every feed to boost the mother’s morale & thus promote lactation and enable the baby to learn how to suck.

OXYGEN THERAPY

Oxygen should be administered only when indicated, given in the lowest ambient concentration and stopped as soon as its use is considered unnecessary. It is difficult to judge the need for oxygen therapy on clinical grounds in preterm babies. The oxygen should be administered with a head box when SaO₂ falls below 85 percent and it should be gradually withdrawn when SaO₂ goes above 90 percent. The lowest ambient concentration and flow rates should be used to maintain SaO₂ between 90%-95% and paO₂ between 60-80 mm Hg (Detailed description in Module -C).

PHOTOTHERAPY

Jaundice is common in preterm babies due to hepatic immaturity, hypoxia, hypoglycemia, infections and hypothermia. Due to immaturity of blood brain barrier, hypoproteinemia and perinatal distress factors, bilirubin brain damage may occur at relatively lower serum bilirubin levels. Early phototherapy is advised to keep the serum bilirubin level within safe limits inorder to obviate the need for exchange blood transfusion.
PREVENTION OF NOSOCOMIAL INFECTIONS

A preterm baby, who survives the initial stormy and unstable period of one week, is likely to do well if protected against infections and provided with nutrition. The handling should be reduced to bare minimum. Vigilance should be maintained on all in the nursery. High index of suspicion, early diagnosis and effective treatment of infections are essential for improved survival (Detailed description in Module -C).

GENTLE RHYTHMIC STIMULATION

Availability of sophisticated high technology has revolutionized the care of preterm and sick newborn babies. But the technology should not be allowed to become a barrier against the communication, compassion and concern of the treating team and the family.

- Gentle touch, massage, cuddling, stroking and flexing by the nurse or preferably by the mother provide useful tactile stimuli to the baby.
- Rocking bed or placing a preterm baby on inflated gloves rhythmically rocked by a ventilator provide useful vestibular-kinesthetic stimuli for prevention of apneic attacks of prematurity. Soothing auditory stimulican be given to the preterm baby in the form of taped heart beats, family voices or music.
- Music has been shown to reduce the stress of procedure and enhance weight gain velocity of preterm babies.
- Visual inputs can be provided with the help of colored objects, diffuse light and eye-to-eye contact.

PREVENTION, EARLY DIAGNOSIS AND PROMPT MANAGEMENT OF COMMON PROBLEMS IN PRETERMS

Respiratory distress syndrome (RDS) or Hyaline Membrane Disease (HMD)

RDS almost always occurs in preterm babies often less than 34 weeks of gestation. It is the commonest causes of respiratory distress in a preterm neonate. The overall incidence is 10-15% but can be as high as 80% in neonates < 28 weeks. In addition to prematurity, asphyxia, acidosis maternal diabetes and cesarean section can increase the risk of developing RDS.
Clinical Features

Respiratory distress usually occurs within the first 6 hours of life. Clinical features include tachypnea, retractions, grunting, cyanosis, and decreased air entry. Diagnosis can be confirmed by chest X-ray. Radiological features include reticulogranular pattern, ground glass opacity, low lung volume, air bronchogram, and a whiteout lung in severe disease.

Prenatal diagnosis can be made by determining the L/S (Lecithin/sphingomyelin) ratio in the amniotic fluids. L/S ratio > 2.0 indicates adequate lung maturity. A simple bedside test-shake test can be done on the amniotic fluid or gastric aspirate to determine lung maturity. The gastric or amniotic fluid is mixed with absolute alcohol and shaken for 15 seconds and allowed to settle. Copious bubbles are formed in the presence of adequate surfactant indicating extent of lung maturity.

RDS should be differentiated from other pulmonary conditions causing respiratory distress in newborn (table).

### Table: Pulmonary Causes of Respiratory Distress

<table>
<thead>
<tr>
<th>Cause</th>
<th>Time of onset</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDS</td>
<td>First 6 hours of life</td>
<td>Disease of preterm neonates.</td>
</tr>
<tr>
<td>Meconium aspiration syndrome</td>
<td>First few hours of life</td>
<td>Common in term, post-term and SFD babies; history of meconium present.</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Can occur at any age</td>
<td>Often bacterial, neonates may be septic</td>
</tr>
<tr>
<td>Transient tachypnea of newborn</td>
<td>First 24 hrs of life</td>
<td>High rates, mainly tachypnea, minimal distress</td>
</tr>
<tr>
<td>Persistent pulmonary hypertension</td>
<td>Any age</td>
<td>Severe cyanosis and severe distress</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>Any age</td>
<td>Seen often in ventilated babies, sudden deterioration.</td>
</tr>
<tr>
<td>Cogenital malformations, TEF,</td>
<td>Any age</td>
<td>Dysmorphic features, other malformations, polyhydramnios in TEF</td>
</tr>
<tr>
<td>Diaphragmatic hernia, Lobar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>emphysema etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper airway obstruction - bilateral choanal atresia, vascular rings etc.</td>
<td>Usually first 24 hours of life</td>
<td>Associated with stridor</td>
</tr>
</tbody>
</table>
Management

Neonates suspected to have RDS need to be in the neonatal intensive care, and given IV fluids and oxygen. Mild distress can be managed without ventilator. The neonate may be ventilated if respiratory distress is significant or is associated with hypoxemia, hypercarbia or acidosis. Intermittent mandatory ventilation (IMV) is required in severe disease, while the baby with moderate disease can be managed with continuous positive airway pressure (CPAP).

Oxygen should be used judiciously in preterm neonates as this may cause oxygen toxicity. Prognosis is good if appropriate treatment is given. Survival can be as high as 60-80% in babies > 1000 g. In the absence of ventilatory support, most neonates with severe disease will die.

Since surfactant deficiency is the basis of RDS, exogenous surfactant is now recommended as a treatment in neonates with RDS. Surfactant is indicated in all neonates with RDS; the route of administration is intratracheal. It can either be given as a rescue treatment in neonates diagnosed to have RDS or prophylactically in all neonates less than 28 weeks of gestation. Even those babies who have been given surfactant will need ventilatory support.

Surfactant decreases ventilation requirement in neonate and therefore improves outcome. The high cost of surfactant however prohibits its liberal use in developing nations.

Neonatal sepsis.

Preterm babies are at higher risk of developing sepsis because of immaturity of immune system and exposure to frequent interventions during intensive care. Strict house keeping routines and high index of suspicion should be maintained to prevent and make early diagnosis of nosocomial infections (Detailed description in module -A).

Necrotizing enterocolitis. Ensure feeding with human milk, trophic feeds, avoidance of hyperosmolar feeds and over infusion.
**Intraventricular hemorrhage.** Antenatal corticosteroids, avoidance of rough handling, excessive CPAP and bolus administration of sodium bicarbonate may reduce the incidence of IVH.

**Hypothermia.**
Nurse in a thermoneutral environment.

**Aspiration.**
Availability of trained nurses is essential for safe administration of enteral feeds and for prevention of aspiration of feeds.

**Patent ductus arteriosus**
Avoid over infusion.

**Chronic lung disease.**
During assisted ventilation, airway pressure should be kept at the bare minimum without compromising gas exchange.

**Retinopathy of prematurity.** Maintain PaO\(_2\) below 90mm Hg, avoid excessive light, blood transfusions and ensure feeding with human milk.

**Late metabolic acidosis.** Protein intake should be restricted to 3 g/kg/d and avoid administration of formula feeds.

**Nutritional disorders.** Provide supplements with calcium, phosphorus, vitamin D, vitamin E, iron and folic acid.

**Drug toxicity.** Side effects of drugs can be reduced by giving lower doses at 12 hourly intervals.

**WHAT TO AVOID IN THE CARE OF PRETERM BABIES?**
In the care of preterm babies, at times greater harm is done by unnecessary therapeutic interventions which may lead to iatrogenic
disorders. The following interventions should be avoided because they are unnecessary, useless and often associated with serious side effects.

- Routine oxygen administration without monitoring.
- Intravenous immunoglobulins for prophylaxis of neonatal sepsis.
- Prophylactic antibiotics (except during assisted ventilation?)
- Prophylactic administration of indomethacin or high doses of vitamin E.
- Unnecessary blood transfusions (Definite indications include hematocrit of < 40% in a sick neonate, < 30% in a symptomatic neonate and < 25% in an asymptomatic neonate).
- Formula feeds
- Rough handling, excessive light and sound.

**IMMUNIZATIONS**

Preterm babies are able to mount a satisfactory immune response and they can be vaccinated at the usual chronological age like term babies. The dose of vaccine is not reduced in preterm babies.

Because during their stay in the NICU, there is no risk of contracting vaccine-preventable diseases, administer O-day vaccines (BCG, OPV, HBV) on the day of discharge from the hospital. This policy seems more logical and appropriate to ensure more satisfactory immune response against various vaccines.

**FAMILY SUPPORT**

The prolonged stay of preterm and sick newborn babies in the NICU is associated with emotional trauma, uncertainty, anxiety and lack of bonding with the baby on the part of parents. The family dynamics are greatly disturbed apart from tremendous physical stress and fiscal implications due to high cost of neonatal intensive care. These issues and problems should be handled with equanimity, compassion, concern and caring attitude of the health team.

- The frightening scene of NICU should be demystified and family should be constantly informed and involved in the care of their baby.
The mother should be encouraged to touch and talk with her baby and provide routine care under the guidance of nurses.

She should be assisted to provide partial kangaroo-mother-care to her baby in the NICU, which would enhance bonding and promote breast feeding.

She should provide visual and auditory stimuli to her baby and try to establish eye-to-eye contact.

The anxiety and concern of the family should be cushioned by providing necessary emotional support and guidance.

**TRANSFER FROM INCUBATOR TO COT**

A baby who is feeding from the breast cup and spoon and is reasonably active with a stable body temperature, irrespective of his weight, qualifies for transfer to the open cot. The baby should be observed for another 12 hours after putting the incubator off to see whether he can maintain his body temperature. The infant should stay in the incubator for as short a period as possible because incubators are a potent source of nosocomial infection.

**DISCHARGE POLICY**

The mother should be mentally prepared and provided with essential training and skills for handling a preterm baby before she is discharged from the hospital.

- The mother-baby dyad should be kept in a step-down nursery where she is able to independently look after the essential needs of her baby like maintenance of body temperature, ensuring aspsis, feeding with a cup and spoon/paladey or breast feeding, toilet needs etc.

- The baby should be stable, maintaining his body temperature and should not have any evidences of cold stress.

- At the time of discharge, the baby should be having daily steady weight gain velocity of at least 10g/kg.
The home conditions should be satisfactory before the baby is discharged.

The public health nurse should assess the home conditions and visit the family at home every week for a month or so.

**FOLLOW-UP PROTOCOL**

After discharge from the hospital, babies should be regularly followed up for assessment of the following parameters.

- Common infective illnesses, reactive airway disease, hypertension, renal dysfunction, gastro esophageal reflux.
- Feeding and nutrition.
- Immunizations.
- Physical growth, nutritional status, anemia, osteopenia/rickets.
- Neuromotor development, cognition and seizures.
- Eyes: Retinopathy of prematurity, vision and strabismus.
- Hearing.
- Behaviour problems, language disorders and learning disabilities.

**PROGNOSIS**

Prognosis for survival is directly related to the birth weight of the child and quality of the neonatal care. Over three-fourth of neonatal deaths occur among low birth weight babies. Therefore, in countries with high incidence of LBW babies, neonatal mortality is likely to be higher.

- The risk of neurodevelopmental handicaps is increased 3 fold for LBW babies and 10 fold for very LBW babies (<1500g).
- The prognosis for mental development is good if the baby had not suffered from birth asphyxia, apneic attacks, respiratory distress syndrome, hypoglycemia or hyperbilirubinemia.
- Their physical growth correlates better with their conceptional age rather than the age calculated from the date of birth. Preterm AFD babies catch up in their physical growth with term counterparts by the age of 1 to 2 years.
Long term follow up studies of infants with a birth weight of 1500 g and less have revealed 15 to 20 percent incidence of neurological handicaps in the form of cerebral palsy, seizures, hydrocephalus, microcephaly, blindness (due to ROP), deafness and mental retardation.

The incidence of neurological handicaps is related to the quality of obstetrical and neonatal services. Neurological prognosis is adversely affected by degree of immaturity, intrauterine growth retardation, severity of perinatal hypoxia, intraventricular hemorrhage, periventricular leukomalacia and severity of respiratory failure demanding assisted ventilation.

**SMALL-FOR-DATES BABIES (LIGHT-FOR-DATES, SMALL-FOR-GESTATIONAL AGE, INTRAUTERINE GROWTH RETARDATION)**

There is lack of consensus regarding the definition of small-for-dates babies. Some pediatricians classify a baby as small-for-dates if its weight falls below 10th percentile for the period of gestation, while others accept the dividing line of 2 SD or 3rd percentile.

**Classification of small-for-dates babies**

The babies with intrauterine growth failure do not constitute a homogeneous group and are composed of at least three types of babies.

**Malnourished small-for-dates babies (asymmetric IUGR).** The fetus gets malnourished during the latter part of gestation due to placental dysfunction and appears long, thin and marasmic. The ponderal index can be calculated as follows:

\[
P.I. = \frac{\text{Weight in grams}}{(\text{Length in cm})^3} \times 100
\]

The index is usually less than 2 in these infants (as compared to ponderal index of more than 2.5 in term-AGA infant). The growth retardation is mainly due to reduction in the size of cells whereas the number of cells are...
unaffected. Thus, they retain the potentiality for normal growth on nutritional rehabilitation.

**Hypoplastic small-for-dates babies (symmetric IUGR).** Intrauterine infections and certain genetic and chromosomal disorders exert their adverse influence from early embryonic life and result in reduced growth potential of the fetus. The baby is proportionately small in all parameters including the head size. The ponderal index is usually more than 2. They have a high incidence of congenital anomalies including abnormal palmar creases and dermatoglyphics. Their cell population is also reduced, resulting in permanent mental and physical growth retardation.

**Mixed small-for-dates babies** They are the outcome of adverse intrauterine environmental influences operating from early or mild pregnancy.

**COMMON PROBLEMS IN SMALL-FOR-DATES BABIES**

Their clinical problems and outcome are very different as compared to preterm babies as shown in table.

**Table  differences between preterm and term small-for-dates babies**

<table>
<thead>
<tr>
<th>Problems</th>
<th>Preterm</th>
<th>Term small-for-dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrauterine hypoxia</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Respiratory difficulties</td>
<td></td>
<td>++</td>
</tr>
<tr>
<td>- Birth asphyxia</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>- Aspiration in - utero</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>- Hyaline membrane disease</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>- Apneic attacks</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Feeding difficulties</td>
<td></td>
<td>++</td>
</tr>
<tr>
<td>- Inability to suck and swallow</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>- Aspiration of feeds</td>
<td>++</td>
<td>0</td>
</tr>
<tr>
<td>- Functional obstruction and exterocolitis</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Problems</td>
<td>Preterm</td>
<td>Term small-for-dates</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Symptomatic hypoglycemia</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Polycythemia</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Hyperbilirubinemia</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Susceptibility to infections</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Congenital malformations</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Intraventricular</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>- Pulmonary</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Prognosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Immediate</td>
<td>High mortality</td>
<td>Better prognosis but increased mortality when compared with normally grown babies.</td>
</tr>
<tr>
<td>b) Future physical and mental development</td>
<td>Good if no perinatal complications occur except in extremely preterm babies</td>
<td>Poor especially in hypoplastic and severe IUGR babies. There is increased risk of development of hypertension, coronary artery disease and diabetes mellitus later in life.</td>
</tr>
</tbody>
</table>

**MANAGEMENT**

- Early delivery is indicated if there is arrest of fetal growth and pulmonary maturity is satisfactory.
- Fetal hypoxia may necessitate emergency cesarean section and the pediatrician should be prepared to receive an asphyxiated baby.
- The suctioning of glottic area under direct vision is essential if baby is meconium stained.
- The baby should be screened for any congenital malformations.
- Early and adequate feeding must be ensured to prevent hypoglycemia. Breast feeding should be initiated immediately after birth.
Symptomatic polycythemia should be managed with partial exchange with plasma or physiological saline. The blood glucose and hematocrit should be monitored during first three days of life.

When adequately fed, they do not lose weight and start gaining weight after 2 to 3 days of age. Their initial weight gain is rapid which subsequently slows down after three months of age.

**PROGNOSIS**

The immediate outlook for small-for-dates babies is better than the preterm babies of identical weight but their mortality is 2 to 3 times higher when compared with appropriately grown babies of identical maturity.

Depending upon the duration and severity of intrauterine environmental constraints, postnatal physical growth may be retarded. It has been shown that body weight of SGA infant at 2 years of age is about 10 percent lower as compared to AGA infant of identical maturity.

The hypoplastic babies remain permanently physically and mentally handicapped.

Malnourished small-for-dates babies with symptomatic hypoglycemia and polycythemia during neonatal period are also likely to manifest evidences of brain damage later in life.

Long-term follow-up studies of uncomplicated malnourished small-for-dates babies have also shown higher incidence of clinical manifestations of minimal brain dysfunction, learning disability and suboptimal physical growth.

**REFERENCE**