

Globally, about 22 million infants are born with a birth weight of <2500 g every year, with India having the third highest incidence of low birth weight (LBW) infants (28%) in the world.¹ Though these LBW infants constitute only about 14% of the total live births, they account for 60-80% of total neonatal deaths.² Most of these deaths can be prevented with extra attention to warmth, prevention of infections and more importantly, optimal feeding.

Nutritional management influences immediate survival as well as subsequent growth and development of LBW infants. Simple interventions such as early initiation of breastfeeding and avoidance of pre-lacteal feeding have been shown to improve their survival in resource restricted settings.³ Early nutrition could also influence the long term neurodevelopmental outcomes; malnutrition at a vulnerable period of brain development has been shown to have deleterious effects in experimental animals.⁴

Feeding of LBW infants: How is it different?

Term infants with normal birth weight require minimal assistance for feeding in the immediate postnatal period - they are able to feed directly from mothers' breast. In contrast, feeding of LBW infants is relatively difficult because of the following limitations:

1. Many LBW infants are born premature and have inadequate feeding skills; they might not be able to breastfeed and would require other methods of feeding such as spoon or gastric tube feeding
2. They are prone to have significant illnesses which often precludes enteral feeding in the first few weeks of life
3. Preterm very low birth infants (VLBW) infants have higher fluid requirements due to excessive insensible water loss
4. Because intrauterine accretion of nutrients occurs mainly in

the later part of the third trimester, preterm VLBW infants have low body stores at birth. Hence, they require supplementation of various nutrients.

5. Because of the gut immaturity, they are more likely to experience feed intolerance necessitating adequate monitoring and treatment.

Protocol for feeding LBW infants

Deciding the initial method of feeding

It is essential to categorize LBW infants into two major groups – *sick* and *healthy* – before deciding the initial method of feeding.

Sick infants

This group constitutes infants with significant respiratory distress requiring assisted ventilation, shock requiring inotropic support, seizures, symptomatic hypoglycemia/hypocalcemia, electrolyte abnormalities, renal/cardiac failure, surgical conditions of gastrointestinal tract, necrotizing enterocolitis (NEC), hydrops, etc. These infants are usually started on intravenous (IV) fluids. Enteral feeds should be initiated as soon as they are hemodynamically stable.

It is important to realize that enteral feeding is important even in sick neonates. Oral feeds should not be delayed in them without any valid reason. Even infants with respiratory distress and/or on assisted ventilation can be started on enteral feeds once the acute phase is over and their color, saturation, and perfusion have improved. Similarly, sepsis - unless associated with shock/sclerema - is not a contraindication for enteral feeding.

Healthy LBW infants

Enteral feeding should be initiated immediately after birth in healthy infants with the appropriate feeding method determined by their gestation and oral feeding skills.

Maturation of oral feeding skills: Breastfeeding requires effective sucking, swallowing and a proper coordination between suck/swallow and breathing. These complex skills mature with increasing gestation (Table 19.1).

Table 19.1 Maturation of oral feeding skills and the choice of initial feeding method in LBW infants⁵

Gestational age	Maturation of feeding skills	Initial feeding method
< 28 weeks	No proper sucking efforts No propulsive motility in the gut	Intravenous fluids
28-31 weeks	Sucking bursts develop No coordination between suck/swallow and breathing	Oro-gastric (or nasogastric) tube feeding with occasional spoon / <i>paladai</i> feeding
32-34 weeks	Slightly mature sucking pattern Coordination between breathing and swallowing begins	Feeding by spoon / <i>paladai</i> /cup
>34 weeks	Mature sucking pattern More coordination between breathing and swallowing	Breastfeeding

How to decide the initial feeding method

Traditionally, the initial feeding method in a LBW infant was decided based on her birth weight. This is not an ideal way because the feeding ability depends largely on gestation rather than the birth weight.

However, it is important to remember that *not all* infants born at a particular gestation would have same feeding skills. Hence the ideal method in a given infant would be to evaluate if the feeding skills expected for his/her gestation are present and then decide accordingly (*Figure 19.1*).

All stable LBW infants, irrespective of their initial feeding method should be put on their mothers' breast. The immature sucking observed in preterm infants born before 34 weeks might not meet their daily fluid and nutritional requirements but helps in rapid maturation of their feeding skills and also improves the milk secretion in their mothers (*'non-nutritive sucking'*).

Spoon/paladai feeding

In our unit, we use paladai feeding in LBW infants who are not able to feed directly from the breast. The steps of paladai feeding are described in Panel 1.⁶

Panel 1: Steps of *Paladai* feeding⁶

1. Place the infant in up-right posture on mother's lap
2. Keep a cotton napkin around the neck to mop the spillage
3. Take the required amount of expressed breast milk by using a clean syringe
4. Fill the *paladai* with milk little short of the brim;
5. Hold the *paladai* from the sides (so that your fingers do not come into contact with the milk)
6. Place the *paladai* tip at the lips of the baby in the corner of the mouth and tilt to pour a small amount of milk into the mouth
7. Feed the infant slowly; he/she should actively swallow the milk
8. Repeat the process until the required amount has been fed
9. If the infant does not actively accept and swallow, try to arouse him/her with gentle stimulation
10. While estimating the milk intake, deduct the amount of milk left in the cup and the amount of estimated spillage
11. Wash the *paladai* with soap and water and then put in boiling water for 20 minutes to sterilize before next feed

Intra-gastric tube feeding

The steps of intra-gastric tube feeding are given in *Panel 2*. Some of the controversial issues in gastric tube feeding are discussed below:

Naso-gastric vs. oro-gastric feeding: Physiological studies have shown that naso-gastric (NG) tube increases the airway impedance and the work of breathing in very preterm infants.⁷ Hence, oro-gastric tube feeding might be preferable in these infants. *We employ only oro-gastric tube feeding in our unit.*

Intermittent bolus vs. continuous intragastric feeding: There are no differences in the time to reach full enteral feeding or somatic growth or the incidence of NEC between infants fed by intermittent bolus or continuous intra-gastric feeding.⁸ Studies have shown that gastric emptying and duodenal motor responses are enhanced in infants given continuous intra-gastric feeding.⁹ But a major disadvantage of this method is that the lipids in the milk tend to separate and stick to the syringe and tubes during continuous infusion resulting in significant loss of energy and fat content. *We use intermittent bolus feeding in our unit.*

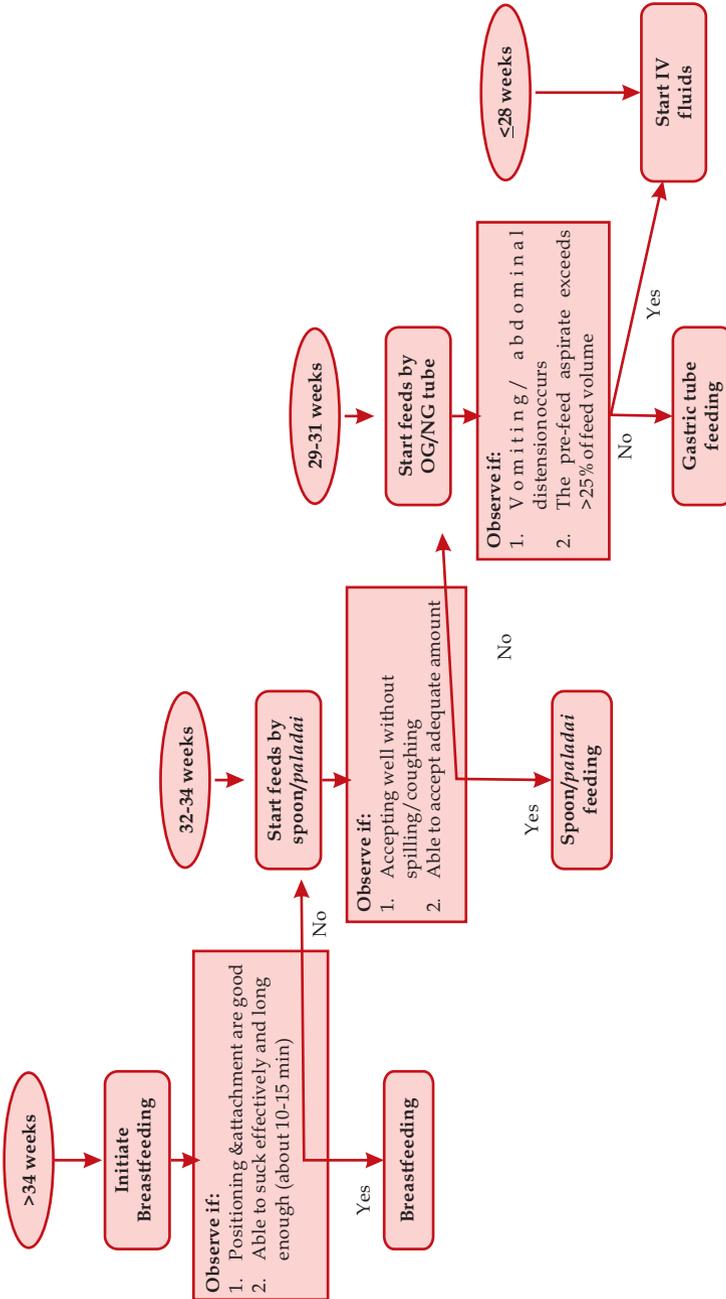


Figure 19.1: Deciding the initial feeding method in LBW infants

Panel 2: Steps of intra-gastric tube feeding⁶

1. Before starting a feed, check the position of the tube
2. Remove the plunger the syringe (ideally a sterile syringe should be used)
3. Connect the barrel of the syringe to the end of the gastric tube
4. Pinch the tube and fill the barrel of the syringe with the required volume of milk
5. Hold the tube with one hand, release the pinch and elevate the syringe barrel
6. Let the milk run from the syringe through the gastric tube by gravity; *DO NOT force milk through the gastric tube by using the plunger of the syringe*
7. Control the flow by altering the height of the syringe. Lowering the syringe slows the milk flow, raising the syringe makes the milk flow faster
8. It should take about 10-15 minutes for the milk to flow into the infant's stomach
9. Observe the infant during the entire gastric tube feed. Do not leave the infant unattended. Stop the tube feed if the infant shows any of the following signs: breathing difficulty, change in colour/ looks blue, becomes floppy, and vomiting
10. Cap the end of the gastric tube between feeds; if the infant is on CPAP, the tube is preferably left open after about half an hour
11. Avoid flushing the tube with water or saline after giving feeds.

Special situations

Extremely low birth weight infants: They are usually started on parenteral nutrition from day one of life. Enteral feeds in the form of trophic feeding or minimal enteral nutrition (MEN) are initiated once the infant is hemodynamically stable. Further advancement is based on the infant's ability to tolerate the feeds (*See protocol on 'Minimal enteral nutrition'*).¹⁰

Severe IUGR with antenatally detected doppler flow abnormalities: Fetuses with abnormal Doppler flow such as absent/reversed end diastolic flow (A/REDF) in the umbilical artery are likely to have had mesenteric ischemia *in utero*. After birth, they have a significant risk of developing feed intolerance and NEC.¹¹ Enteral feeding in preterm neonates with A/REDF is usually delayed for 24 hours (*See protocol on 'Feeding in preterm neonates with antenatally diagnosed A/REDF'*).

Infants on CPAP/ventilation: These infants can be started on OG tube feeds once they are hemodynamically stable. But it is important to leave the tube open intermittently to reduce gastric distension. We usually keep the tube closed for 30 minutes after a feeding session and leave it open thereafter till the next feed.

Progression of oral feeds

All LBW infants, irrespective of their gestation and birth weight, should ultimately be able to feed directly from the mothers' breast. For preterm LBW infants started on IV fluids/OG tube/*paladai* feeding, the steps of progression to direct and exclusive breast feeding are summarized in *Figure 19.2*.

Term LBW infants started on IV fluids (because of their sickness) should be put on the breast once they are hemodynamically stable.

Choice of milk for LBW infants

All LBW infants, irrespective of their initial feeding method should receive ONLY breast milk. This can be ensured even in those infants who are fed by *paladai* or gastric tube by giving expressed breast milk (mothers' own milk or human donor milk).

Expressed breast milk (EBM): All preterm infants' mothers should be counseled and supported in expressing their own milk for feeding their infants. Expression should ideally be initiated within hours of delivery so that the infant gets the benefits of feeding colostrum. Thereafter, it should be done every 2 to 3 hours so that the infant is exclusively breastfed. This would also help in maintaining the lactation in the mother. Expressed breast milk can be stored for about 6 hours at room temperature and for 24 hours in refrigerator.

The steps of breast milk expression are given in *Panel 3*. We counsel mothers for expression of breast milk soon after delivery by demonstration and by using poster & videos (available on our website: www.newbornwhocc.org)

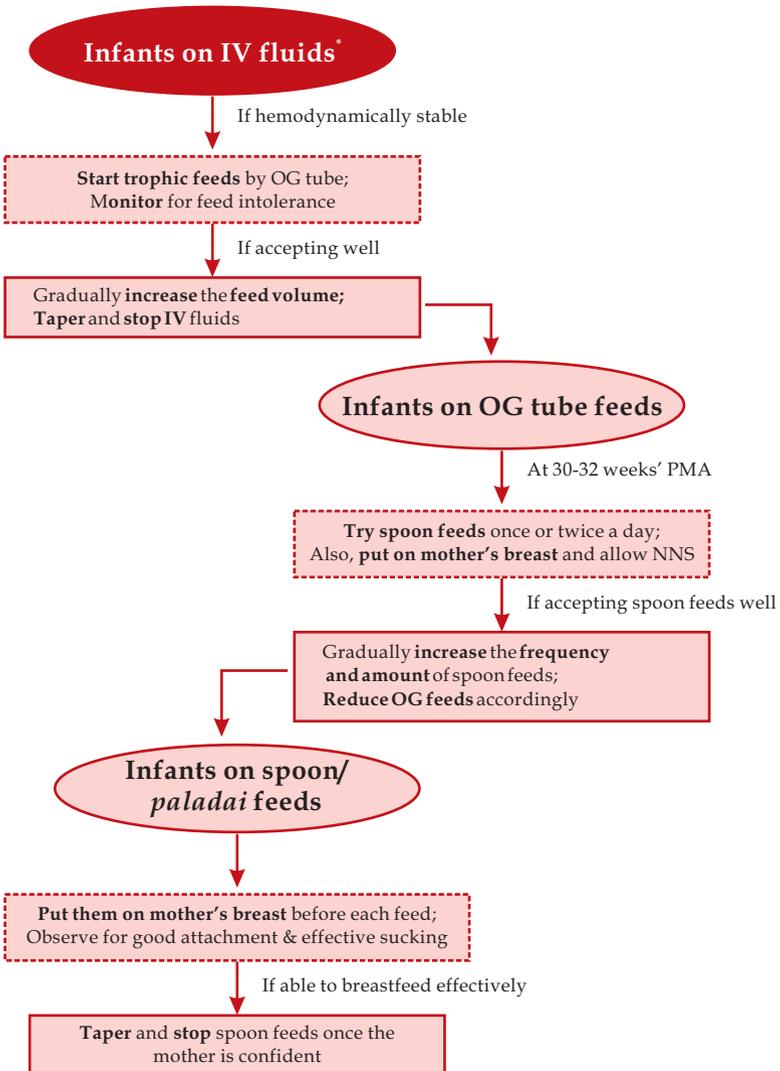


Figure 19.2: Progression of oral feeding in preterm LBW infants

(IV, intravenous; OG, oro-gastric tube; PMA, postmenstrual age; NNS, non-nutritive sucking)

* Term and near-term sick infants started on IV fluids can be initiated on breastfeeding once they are hemodynamically stable;

Some infants may have to be given spoon feeding for some period even after they start accepting breastfeeding

Donor human milk: In centers where optimal milk banking facilities are available, donor human milk can be used. At present, only a few centers in India have standardized human milk banking facilities.

Special situations

Sick mothers / contraindication to breastfeeding: In these rare circumstances, the options available are

1. Formula feeds
 - a. Preterm formula –in VLBW infants and
 - b. Term formula –in infants weighing >1500g at birth
2. Animal milk: e.g. cow's milk

Once the mother's condition becomes stable (or the contraindication to breastfeeding no longer exists), these infants should be started on exclusive breastfeeding.

How much milk is to be given?

It is essential to calculate the fluid requirements and feed volumes for infants on *paladai*/gastric tube feeding.

Fluid requirement: The daily fluid requirement is determined based on the estimated insensible water loss, other losses, and urine output. Extreme preterm infants need more fluids in the initial weeks of life because of the high insensible water loss.

We usually start fluids at 80 mL and 60 mL/kg/day for infants birth weights of <1500g and 1500-2500g, respectively. Further requirements are calculated by daily estimation of weight loss/gain, serum sodium, urine output and specific gravity. The usual daily increment would be about 15-20 mL/kg/day so that by the end of first week, 150 mL/kg/day is reached in both the categories. We usually reach a maximum of 180 mL/kg/day by day 14.¹²

Feed volume: After estimating the fluid requirements, the individual feed volume to be given by OG tube or *paladai* (2-hrly/3-hrly) should be determined.

Panel 3: Steps of expression of breast milk⁶

1. The mother should wash her hands thoroughly.
2. She should hold a clean wide mouthed container near her breast.
3. Ask her to gently massage the breast for 5-10 minutes before expressing the milk (using the pulp of two fingers or with knuckles of the fist in a circular motion towards the nipple as if kneading dough). Massage should not hurt her.
4. Ask her to put her thumb ABOVE the nipple and areola, and her first finger BELOW the areola opposite the thumb. She should support the breast with her other fingers.
5. Ask her to press her thumb and first finger slightly inward towards the chest wall.
6. She should press her breast behind the nipple and areola between her fingers and thumb; thus pressing on lactiferous sinuses beneath the areola.
7. Press and release, press and release. This maneuver should not hurt-if it hurts, the technique is wrong. It may take some time before milk starts coming.
8. Ask her to press the areola in the same way from the sides, to make sure that milk is expressed from all segments of the breast.
9. She should express one breast first till the milk flow slows; then express the other side; and then repeat both sides.
10. **Avoid** rubbing or sliding her fingers along the skin.
11. **Avoid** squeezing the nipple itself. Pressing or pulling the nipple cannot express the milk.

3. Nutritional supplementation in LBW infants

LBW infants, especially those who are born preterm require supplementation of various nutrients to meet their high demands. The requirements of VLBW infants differ significantly from those with birth weights of 1500 to 2499 grams.

Supplementation in VLBW infants

These infants who are usually born before 32 to 34 weeks' gestation have inadequate body stores of most of the nutrients. The amount of protein, energy, calcium, phosphorus, trace elements (iron, zinc) and vitamins (D, E & K) present in expressed breast milk is often unable to meet their high daily requirements (*Table 19.3*). Hence, these infants require multi-nutrient supplementation till they reach term gestation (40 weeks postmenstrual age). After this period, their requirements

are similar to those infants with birth weights of 1500-2499 grams.

Multi-nutrient supplementation can be ensured by one of the following methods:

1. Supplementing individual nutrients - e.g., calcium, phosphorus, vitamins, etc.
2. By fortification of expressed breast milk by using either human milk fortifiers (HMF) or preterm formula

Supplementing breast milk with individual nutrients: The following nutrients have to be added to the expressed breast milk:

1. Calcium and phosphate supplements¹
2. Vitamin A, B complex and zinc supplements²- usually in the form of multivitamin drops
3. Vitamin D₃ drops³
4. Folate drops⁴
5. Iron drops⁵

Since supplementation of minerals and vitamins would not meet the high protein requirements of these infants, this method is usually not preferred. If used, the supplements should be added at different times in the day to avoid abnormal increase in the osmolality.

Fortification with HMF: Fortification of expressed breast milk with HMF increases the nutrient content of the milk without compromising its other beneficial effects (such as reduction in NEC, infections, etc.). Experimental studies have shown that the use of fortified human milk results in net nutrient retention that approaches or is greater than expected intrauterine rates of accretion in preterm infants.¹⁶ The Cochrane review on fortification found short term improvement in weight gain, linear and head growth without any increase in adverse effects such as NEC.¹⁷

The standard preparations of human milk fortifiers (HMF) used in developed countries are not available in India. One of the preparations available (*Lactodex-HMF*, 1 g/sachet; *Raptakos*, Brett

& Co. Ltd; Rs. 21/- per sachet) has optimal quantities of calories and proteins along with micronutrients except zinc. It is available as 1 g sachet to be added in 25 mL EBM. Another preparation (HIJAM; 1 g/sachet; Endocura Pharma; Rs. 25/- per sachet) having almost similar composition except for a higher content of calcium, phosphate and iron, is also available. There are a few other preparations including PreNAN HMF (1 g/sachet; Nestle; Rs. 30/- per sachet) and Similac HMF (0.9 g/sachet; Abbott Nutrition); however, these preparations are costlier and not readily available in many Indian markets. One sachet of PreNAN HMF has to be added in 20 mL EBM, therefore requiring 5 sachets (5 g) for every 100 mL EBM.

The recommended dietary allowances (RDA) and the estimated intakes with fortified human milk are given in Table 19.3. As seen from the table, VLBW infants on fortified breast milk with Lactodex-HMF would require zinc supplementation while those on fortified breast milk with PreNAN-HMF would require vitamin D supplements.

Fortification with preterm formula: The other option available for fortification is preterm formula (e.g. Dexolac Special Care [Wockhardt Co.], Pre-NAN [Nestle Co.], Lactodex LBW [Raptakos, Brett & Co. Ltd]). The recommended concentration is **0.4g per 10mL** of breast milk. Though more economical than fortification by HMF, this method has two major drawbacks – (1) it is difficult to measure such small amounts of formula powder; and (2) the RDA of calcium, phosphorus, vitamin D, folic acid and iron etc. are not met even after fortification. While the former problem can be managed to a certain extent by using a small scoop of 1g size for 25mL of human milk, the later needs to be circumvented by additional supplementation (Table 19.3).

The protocols for nutritional supplementation in VLBW infants until 40 weeks PMA and beyond are described in Tables 19.4 & 19.5.

¹e.g. Syr. Ostocalcium (Glaxo Smith Kline Co.), Syr. Ossopan-D (TTK Healthcare)

²e.g. Dexvita (Tridoss Co.), Visyneral-zinc drops (Lifeon Co.)

³e.g. Arbivit (Raptakos, Brett & Co.), Sunsips (Endura Co.)

⁴e.g. Folium (Speciality Meditech Co.), Folvite (Wyeth Lederle Co.)

⁵e.g. Ferrochelate (Albert David Co.), Tonoferon (East India Co.)

Table 19.3: Recommended dietary allowance (RDA) in preterm LBW infants and the estimated intakes with fortified and unfortified human milk

	RDA* (Units/kg/day)	At daily intake of 180 mL/kg							
		Only expressed breast milk*	EBM fortified with new Lactodex-HMF (4g/100mL)	EBM fortified with HIJAM-HMF (4g/100mL)	EBM fortified with Pre NAN HMF (5g/100mL)	EBM fortified with Preterm formula (4g/100mL; Dexolac Special care)	Lactodex LBW formula	PreNAN formula	Dexolac Special Care formula
Energy (kcal)	110-135	117	141	142	144	153	160	142	142
Protein (g)	3.5-4.0 ^e	2.5	4.4	4.3	4.1	3.5	4.0	3.4	3.6
Carbohydrates (g)	11.6-13.2	11.6	15.1	12	17.7	15.4	17.8	16.4	15.6
Fat (g)	4.8-6.6	6.8	7.1	8.6	6.8	8.6	8.0	7.0	7.4
Calcium (mg)	120-140	43	157	223	151	90	256	176	181
Phosphate (mg)	60-90	22	79	112	87	45	128	88	91
Vitamin A (IU)	1330-3330	680	2120	1796	2383	1224	481	856	1821
Vitamin D (IU/day)	800-1000	3.5	960	724	220	46	144	151	166
Vitamin E (mg)	2.2-11	1.8	7.8	6.3	7.6	2.9	6.4	2.3	6.7
Vitamin B6 (mcg)	45-300	25.7	206	116	205	72.5	81	144	182
Folic acid (mcg)	35-100	6	96	150	64	22.2	96	57	63

contd.....

	RDA* (Units/kg/day)	At daily intake of 180 mL/kg							
		Only expressed breast milk*	EBM fortified with new Lactodex-HMF (4g/100mL)	EBM fortified with HIJAM-HMF (4g/100mL)	EBM fortified with Pre NAN HMF (5g/100mL)	EBM fortified with Preterm formula (4g/100mL; Dexolac Special care)	Lactodex LBW formula	PreNAN formula	Dexolac Special Care formula
Zinc (mg)	1.1-2.0	0.6	0.88	0.89	1.86	0.87	1.6	0.9	1.1
Iron (mg)	2-3	0.2	2.4	2.8	2.8	1	3.8	2.2	3.2
Remarks		Deficient in protein, calcium, phosphate, and vitamins B6 and D; Zinc content is slightly less than the RDA	Deficient in zinc	Deficient in zinc and vitamin D	Deficient in vitamin D	Deficient in calcium, phosphate, vitamins A,D folic acid and B6, zinc, and iron; protein is slightly less	Deficient in vitamin A and D	Deficient in protein, vitamin A, D and zinc	Deficient in vitamin D

*ESPGHAN 2010¹⁵

Based on preterm mature milk

€ 4 to 4.5 g/kg/day for ELBW infants

(RDA, recommended dietary allowance; EBM, expressed breast milk)

Table 19.4: Nutritional supplementation in preterm VLBW infants until 40 weeks PMA

Nutrients	Type of feeding		
	Only expressed breast milk*	EBM fortified with <i>Lactodex-HMF</i> *	EBM fortified with Preterm formula
Calcium	Start calcium supplements (140-160 mg/kg/day) once the infant is on 100 mL/kg/day (e.g. Syr. <i>Ostocalcium</i> at 8-10mL/kg/d)	Not needed	Start calcium supplements to meet the RDA once the infant is on 100 mL/kg/day (e.g. Syr. <i>Ostocalcium</i> at 5-6mL/kg/d)
Phosphorus	Start supplements (70-80 mg/kg/day) once the infant is on 100 mL/kg/day (e.g. Syr. <i>Ostocalcium</i> at 8-10mL/kg/d)	Not needed	Start supplements to meet the RDA once the infant is on 100 mL/kg/day (e.g. Syr. <i>Ostocalcium</i> at 5-6mL/kg/d)
Zinc and vitamins A, B6, etc.	Start multivitamin supplements once the infant is on 100 mL/kg/day (e.g. <i>ViSyneral zinc / Dexvita</i> drops at 1.0 mL/day)	Start multivitamin supplements once the infant is on 100 mL/kg/day (e.g. <i>ViSyneral zinc / Dexvita</i> drops at 1.0 mL/day)	Start multivitamin supplements once the infant is on 100 mL/kg/day (e.g. <i>ViSyneral zinc / Dexvita</i> drops at 1.0 mL/day)
Vitamin D	(Usually obtained from multivitamin drops and calcium supplements that contain vitamin D)	Not needed	Start <i>vitamin D3</i> drops if the total intake is less than the RDA (e.g. <i>Arbitrit / Sunsips</i> at 0.5 mL/day)
Folic acid	Start supplements once the infant is on 100 mL/kg/day (e.g., <i>Folvite/folium</i> drops at 0.3 mL/day)	Not needed	Start supplements once the infant is on 100 mL/kg/day (e.g., <i>Folvite/folium</i> at 0.1 mL/day)
Iron	Start iron (2 mg/kg/d) at 4 weeks of life (e.g. <i>Tonoferon</i> drops at 2 drops/kg/day)	Not needed	Start iron (2 mg/kg/d) at 4-6 weeks of life (e.g. <i>Tonoferon</i> drops at 2 drops/kg/day)

(PMA, postmenstrual age; EBM, expressed breast milk; HMF, human milk fortifier)
 Note: The examples quoted are only indicative; Readers are encouraged to use similar products of their choice.

We use HMF fortification for all preterm (<32 weeks) or VLBW (<1500 g) infants. It is started once they reach 100 mL/kg/day of enteral feeds in the dose recommended by the manufacturer (1 lactodex-HMF and HIJAM sachet per 25 ml EBM; 1 PreNAN-HMF sachet per 20 ml EBM). We supplement vitamin D in the dose of 800 IU/day when using PreNAN-HMF (currently available in the unit) for fortification.

If HMF is unavailable, we use preterm formula (0.4g/10 mL) for fortification. Since the intake of calcium, phosphorus, vitamin D, zinc, and iron is low even after fortification with formula, we supplement these nutrients additionally (Table 19.4).

We continue fortification till the infant reaches 40 weeks PMA or attains 2 kg (whichever is earlier).

Table 19.5: Nutritional supplementation in preterm VLBW infants after 40 weeks PMA

Nutrients	Method of supplementation	Dose	Till when?
Vitamin D*	Vitamin D3 drops	800-1000 IU/day	Till 2 years of age
Iron	Iron drops/syrup	2 mg/kg/day (maximum 15 mg/day)	Till 2 years of age

Supplementation for infants with birth weights of 1500-2500g

These infants who are more likely to be born at term or near-term gestation (≥ 32 weeks) do not require multi-nutrient supplementation or fortification of breast milk (cf. VLBW infants). However, vitamin D, iron, and zinc might still have to be supplemented in them.

We supplement both vitamin D and iron in infants with birth weights of 1500-2499 grams; vitamin D (400 IU) is started at 2 weeks and iron (2 mg/kg/day) at 4 weeks of life; both are continued till 2 years of age (Table 19.6).

Table 19.6: Nutritional supplements for infants with birth weights of 1500-2499 g

Nutrients	Method of supplementation	Dose	When to start	Till when?
<i>Vitamin D</i>	Multivitamin drops/syrup	1 mL/day (so as to provide 400 IU/day of vitamin D)	2 weeks of age	Till 2 years of age
<i>Iron</i>	Iron drops/syrup	2 mg/kg/day (maximum 15 mg/day)	4 weeks of age	Till 2 years of age

Growth monitoring of LBW infants

Regular growth monitoring helps in assessing the nutritional status and adequacy of feeding; it also identifies those infants with inadequate weight gain. All LBW infants should be weighed daily till the time of discharge from the hospital. Other anthropometric parameters such as length and head circumference should be recorded weekly.

Both term and preterm LBW infants tend to lose weight (about 10% and 15% respectively) in the first 7 days of life; they regain their birth weight by 10-14 days. Thereafter, the weight gain should be at least 15-20 g/kg/day till a weight of 2-2.5 kg is reached. After this, a gain of 20 to 30 g/day is considered appropriate.¹⁸

LBW infants should be discharged after they:

- o reach 34 weeks gestation and are above 1600g AND
- o show consistent weight gain for at least 3 consecutive days

Growth charts: Using a growth chart is a simple but effective way to monitor the growth. Serial plotting of weight and other anthropometric indicators in the growth chart allows the individual infant's growth to be compared with a reference standard. It helps in early identification of growth faltering in these infants.

Two types of growth charts are commonly used for growth monitoring in preterm infants: intrauterine and postnatal

growth charts. Of these, the postnatal growth chart is preferred because it is a more realistic representation of the true postnatal growth and also shows the initial weight loss that occurs in the first two weeks of life. The two postnatal charts that are commonly used for growth monitoring of preterm VLBW infants are: Wright's and Ehrenkranz' charts.^{19, 20} *We use both of them in our unit.* For preterm infants weighing 1500-2499 g at birth, *we use Fenton's chart for monitoring growth.* Once the preterm LBW infants reach 40 weeks PMA, WHO growth charts are used for growth monitoring.

For term LBW infants, *we follow WHO growth charts.*

Management of inadequate weight gain

Inadequate weight gain is a common and pertinent problem in LBW infants. It starts from birth and continues after discharge resulting in failure to thrive and wasting in the first year of life. The common causes are summarized in *Panel 4*.

Panel 4: Causes of inadequate weight gain

1. Inadequate intake

Breastfed infants:

- Incorrect feeding method (improper positioning/attachment)*
- Less frequent breastfeeding, not feeding in the night hours*
- Prematurely removing the baby from the breast (before the infant completes feeds)

Infants on spoon/paladai feeds:

- Incorrect method of feeding* (e.g. excess spillage)
- Incorrect measurement/calculation
- Infrequent feeding
- Not fortifying the milk in VLBW infants
- Energy expenditure in infants who have difficulty in accepting spoon feeds

2. Increased demands

Illnesses such as hypothermia/cold stress*, bronchopulmonary dysplasia Medications such as corticosteroids

3. Underlying disease/pathological conditions

- Anemia*, hyponatremia, late metabolic acidosis
- Late onset sepsis
- Feed intolerance and/or GER

* Common conditions

(EBM, expressed breast milk; GER, gastroesophageal reflux)

Management of inadequate weight gain consists of the following steps:

1. Proper counseling of mothers and ensuring adequate support for breast feeding their infants; includes assessment of positioning/attachment, managing sore/flat nipple, etc.
2. Explaining the frequency and timing of both breast feeding and spoon/*paladai* feeds: Infrequent feeding is one of the commonest causes of inadequate weight gain. Mothers should be properly counseled regarding the frequency and the importance of night feeds. A time-table where mother can fill the timing and amount of feeding is very helpful in ensuring frequent feeding.
3. Giving EBM by spoon/*paladai* feeds after breastfeeding also helps in preterm infants who tire out easily while sucking from the breast.
4. Proper demonstration of the correct method of expression of milk and *paladai* feeding: It is important to observe how the mother gives *paladai* feeds; the technique and amount of spillage should be noted. This should be followed by a practical demonstration of the proper procedure.
5. Initiating fortification of breast milk when indicated
6. Management of the underlying condition(s) such as anemia, feed intolerance, etc.
7. If these measures are not successful, increase either the
 - a. Energy (calorie) content of milk by adding MCT oil, corn starch, etc to EBM; infants on formula feeds can be given concentrated feeds (by reconstituting 1 scoop in 25 mL of water) OR
 - b. Feed volume to 200 mL/kg/day.

Feed intolerance

The inability to tolerate enteral feedings in extremely premature infants is a major concern for the pediatrician/neonatologist caring for such infants. Often, feed intolerance is the predominant factor affecting the duration of hospitalization in these infants.

There are no universally agreed-upon criteria to define feed intolerance in preterm infants.¹⁷ Various clinical features that are

usually considered to be the indicator(s) of feed intolerance are summarized below (*Panel 5*):

Panel 5: Indicator(s) of feed intolerance¹⁷

Symptoms:

1. Vomiting (altered milk/bile or blood-stained)*
2. Systemic features: lethargy, apnea

Signs:

1. Abdominal distension (with or without visible bowel loops)*
2. Increased gastric residuals: >2mL/kg or any change from previous pattern
3. Abdominal tenderness
4. Reduced or absent bowel sounds
5. Systemic signs: cyanosis, bradycardia, etc.

* *Common signs*

Of these, vomiting, abdominal distension, and increased gastric residual volume form the 'triad' for defining feed intolerance.

Vomiting: The characteristic of vomitus is important in assessing the cause - while altered milk is usually innocuous, bile- or blood-stained vomiting should be thoroughly investigated.

Abdominal distension: It is essential to serially monitor the abdominal girth in all preterm LBW infants admitted in the ICU. This helps in early identification of feed intolerance and eliminates the need for routine gastric aspirate.

Gastric residual volume: It indicates the rapidity of gastric emptying. Since several factors (both systemic and local) influence the gastric emptying, the residual volume is a poor and non-specific indicator of feed intolerance. Measures to enhance the specificity such as quantifying the volume or using different cut-offs for defining feed intolerance have not been found to be much useful. Moreover, repeated gastric aspiration to look for residuals could injure the delicate mucosa aggravating the local pathology.

We monitor the abdominal girth every 2 hours in all preterm LBW infants admitted in the nursery. We do not routinely aspirate the gastric contents before giving next feed. Aspiration is done only if there is an increase in abdominal girth by ≥ 2 cm from the baseline.

Management of feed intolerance

The common factors attributed to feed intolerance in preterm infants are: immature intestinal motility, immaturity of digestive enzymes, underlying medical conditions such as sepsis, inappropriate feed volume, and giving hyperosmolar medications/feedings, and importantly, necrotizing enterocolitis (NEC).

While issues such as feed volume and osmolality can be controlled to an extent, feed intolerance due to immaturity is rarely amenable to any intervention; conservative management till the gut attains full maturity is often the only option left. The steps in evaluation and management of an infant with feed intolerance are given in *Figure 19.3*.

Conclusion

Optimal feeding of LBW infants is important for the immediate survival as well as for subsequent growth. Unlike their normal birth weight counterparts, these infants have vastly different feeding abilities and nutritional requirements. They are also prone to develop feed intolerance in the immediate postnatal period. It is important for all health care providers caring for such infants to be well versant with the necessary skills required for feeding them. It is equally important to have a protocol based approach to manage various issues that occur while feeding them.

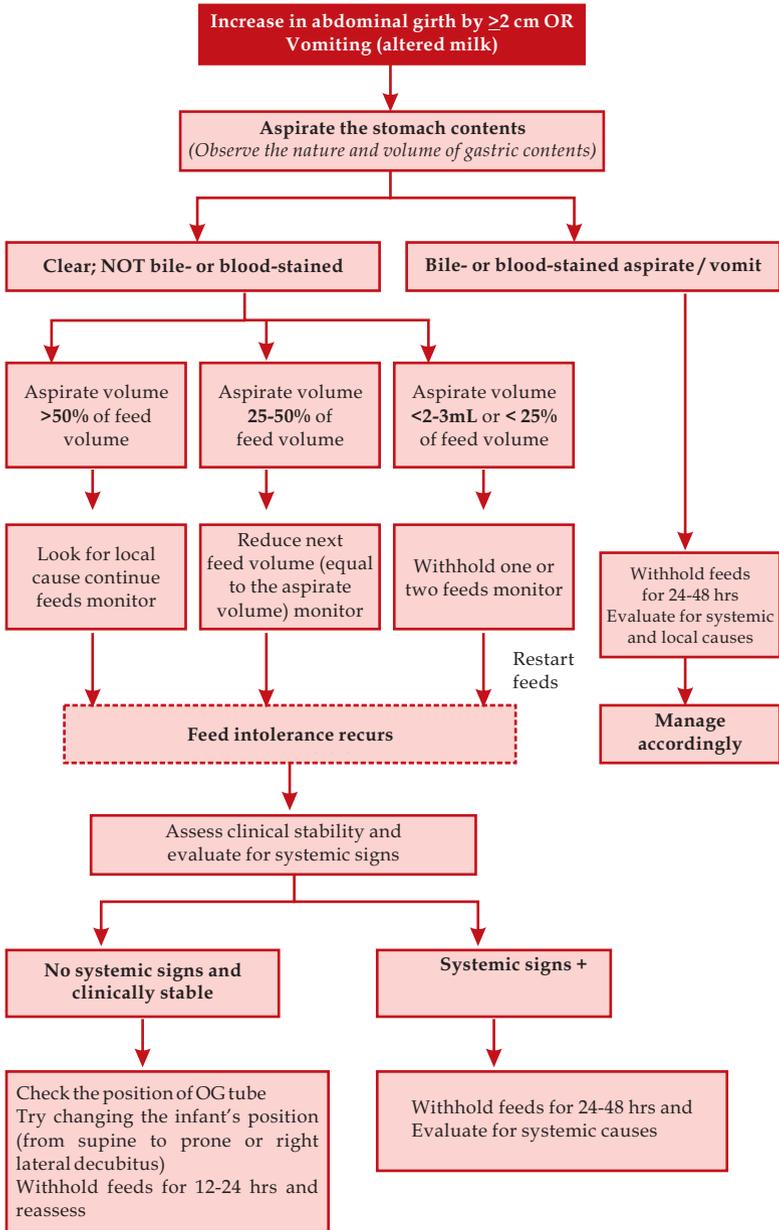


Figure 19.3: Approach to feed intolerance in LBW infants

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