Feeding of Preterm Infants

INTRODUCTION: Proper nutrition in infancy is essential for normal growth, resistance to infection, long term health and optimal neurologic and cognitive development. Providing adequate nutrition to preterm infants is challenging because of several problems, some of them unique to these small infants. These problems include immaturity of bowel function, inability to suck and swallow, high risk of necrotizing enterocolitis (NEC), illnesses that may interfere with adequate enteral feeding (*e.g.*, RDS, patent ductus arteriosus) and medical interventions that preclude feeding (*e.g.*, umbilical vessel catheters, exchange transfusion, indomethacin therapy).

PHYSIOLOGY AND PATHOPHYSIOLOGY: The gut has formed and has completed its rotation back into the abdominal cavity by 10 weeks of gestation. By 16 weeks, the fetus can swallow amniotic fluid. GI motor activity is present before 24 weeks, but organized peristalsis is not established until 29-30 weeks and is facilitated by antenatal corticosteroid treatment. Coordinated sucking and swallowing develops at 32-34 weeks. By term, the fetus swallows about 150 cc/kg/day of amniotic fluid, which has 275 mOsm/L, contains carbohydrates, protein, fat, electrolytes, immunoglobulins and growth factors, and plays an important role in development of GI function. Preterm birth interrupts this development. Even if nutrients are provided parenterally, lack of enteric intake leads to decreased circulating gut peptides, slower enterocyte turnover and nutrient transport, decreased bile acid secretion, and increased susceptibility to infection due to impaired barrier function by intestinal epithelium, lack of colonization by normal commensal flora and colonization by pathogenic organisms. For fat digestion, the newborn depends on lingual lipase, which is stimulated by sucking and swallowing and by nutrients in the stomach but not the small bowel. The figure is a chronological representation of GI development during fetal life.

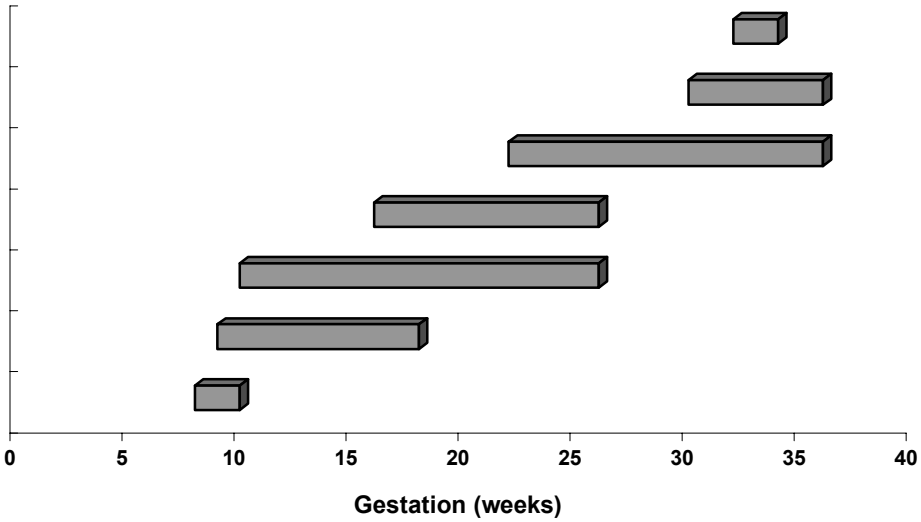

Figure. Chronology of gastrointestinal development in the fetus.

CONTRA-INDICATIONS TO FEEDING: Do not start feeds if the infant:

- •is receiving **indomethacin**, or received it within the previous 48h
- •has a **hemodynamically significant patent ductus arteriosus**
- •has either an **umbilical arterial or venous catheter.** Do not start feedings until the catheters have been removed for ≥8h.
- •is **polycythemic.**
- •has significant **metabolic acidosis.**
- •has severe **respiratory instability** or there is impending endotracheal intubation
- •has **hemodynamic instability** as evidenced by clinical signs of **sepsis, hypotension,** is receiving **dopamine** (at a dose >3 mcg/kg/min) or other vasopressor drugs
- •received an **exchange transfusion** within the past 48h.
- •has **abdominal distension** or other signs of GI dysfunction.
- •has had an episode of **severe asphyxia** (perinatal or post-natal) in the previous 72h.

FEEDING PROTOCOL: The following are guidelines for the initiation and advance of enteral feedings in preterm infants:

1. Method of feeding: Because these infants usually have not yet developed coordinated sucking and swallowing, they must be fed by gavage:

- -Orogastric tubes are usually used. Because infants are obligate nose breathers, it is best not to occlude the nares with a tube. In addition, repeated insertion of a nasal gastric tube can cause inflammation of the nose with subsequent obstruction.
- -Estimate length of tube that must be inserted to reach the stomach.
- -Insert the tube and aspirate to see if gastric contents are returned. While listening over stomach with stethoscope, inject ~5cc of air. If tube is in stomach, you should hear bubbling as you inject air. If you cannot hear any bubbling, tube may be in the trachea. Therefore, do not feed infant until you are certain that tube is in stomach.
- -Do not use duodenal or jejunal tubes for gavage feedings as feedings are less well tolerated and do not stimulate secretion of lingual lipase. In addition, residuals are no longer useful in assessing tolerance of feedings.
- -Nipple feedings can be considered as the infant matures. The best judge of when to start nipple feedings is an experienced Nurse.

2. Content of feeding: Begin with either:

- -**Breast milk** (preterm breast milk is 290 mOsm/L) *or*
- -**Formula for preterm infants** (*e.g.*, Premature Enfamil™ or Similac Special Care™, 260 mOsm/L).
- -Some physicians use half-strength feedings, but there is no evidence that this is beneficial. In fact, hypo-osmolar solutions may slow gastric emptying, leading to increased incidence of residuals and feeding intolerance.
- -Remember that fetuses swallow amniotic fluid, which is 275 mOsm/L, and this swallowing begins at 16 weeks gestation.

3. Guidelines for Feeding: Initiation of feedings, their volume and the rate of advance of feedings are related to birth weight, gestational age and how the infant has tolerated feeds to date. General guidelines include:

- •Initial volume is **2 cc/kg per feeding with a minimal absolute volume of 2 cc**

- •Do not advance feedings faster than **20 cc/kg/d**.
- •**Do not advance feedings if there are any signs that the baby is not tolerating feeds.** Aggressive advances of feedings increase the risk of NEC.
- •A small volume, even if not advanced, is much better than nothing at all. Even very small volumes stimulate maturation of gut motility and production of enteric peptides.
- •Bolus feedings are preferable to continuous feedings.
- •The goals for "full feedings" are:
  - -Volume: 150-160 cc/kg/d
  - -Calories: 110-120 kcal/kg/d
  - -Some SGA infants will require a higher caloric intake to achieve consistent weight gain.

Detailed recommendations for feeding are shown in the following table.

Table. Recommendations for feeding of preterm infants.

Gestational Age (weeks)	Volume of first feed (cc/kg)	Rate of feeding	
		Frequency	advance
24 to 26	2 or 2 cc total	q6-8h	None for 5-7d, then 10-15 cc/kg/d
26-28	2	q4-6h	None for 3-5d, then 10-20 cc/kg/d
28-32	2	q4h	As tolerated, but aim to reach full feeds only after 7d

FORTIFYING FEEDINGS not only provides mores calories but also improved intake of calcium, phosphorus and protein. Fortify feedings (breast milk and formula) as follows:

- -When infant is tolerating ≥100 cc/kg/d, feedings may be fortified to 22 cal/oz.
- -When infant has been tolerating ≥150 cc/kg/d for at least 2d, feedings may be fortified to 24 cal/oz.

INTOLERANCE TO FEEDINGS is common among very small preterm infants, and most such infants will have episodes that require either temporary discontinuation of feedings or a delay in advancing feedings. Although most episodes resolve spontaneously and without sequelae, any signs of feeding intolerance should be regarded as potentially serious because of the increased risk of NEC among these infants. Signs that indicate possible intolerance of feeding include:

- -Gastric residuals or emesis
- -Blood in the stool (gross or occult)
- -Metabolic acidosis
- -Onset of apneic episodes
- -Abdominal distension
- -"Loose stools" or diarrhea
- -Temperature instability
- -Hyperglycemia

MANAGEMENT OF FEEDING INTOLERANCE should be related to the type and severity of the presenting signs, as described below:

1. **Gastric residuals:**
   - Non-bilious residuals:
     - -If these are smaller than the volume of a feeding and are not increasing in volume, and if the infant otherwise appears well, feeding can continue but the infant should be observed carefully for other signs of feeding intolerance. If the infant has any other worrisome findings, hold the feedings, consider obtaining an abdominal radiograph and observe the infant.
     - -If the residuals are greater than the volume of a feeding or are progressively increasing in volume, hold the feedings and observe closely.
   - Bilious residuals are a serious sign. Hold feedings, evaluate infant closely, and consider further workup including abdominal radiograph, CBC and platelets.
2. **Abdominal distension** is a serious sign. Discontinue feedings, obtain abdominal radiograph, and consider further evaluation and treatment (see section on NEC, P. 133).
3. **Blood in stools**: Discontinue feedings, consider obtaining clotting studies and abdominal radiograph.
4. If **metabolic acidosis** occurs, hold feedings, evaluate closely for NEC, sepsis, hypotension and a patent ductus arteriosus. Metabolic acidosis in the presence of NEC is a grave prognostic sign.
5. **Loose stools, temperature instability, apnea, hyperglycemia:** Hold feedings and evaluate infant carefully.

If feedings have to be stopped for any of these reasons, notify the Neonatology Fellow and/or the Attending Physician, so that they can follow the infant's condition with you. **If there is any doubt about how well an infant is tolerating feedings, it is best to hold feedings, evaluate the infant and discuss the case with the other members of the team.**

Experienced ICN Nurses are experts at feeding small preterm infants and are valuable resources for advice on feeding problems.