Nutrition Practice Care Guidelines for Preterm Infants in the Community

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Revised 2025

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Nutrition Practice Care Guidelines for Preterm Infants in the Community

Goal

These guidelines have been designed to assist WIC and community-based health professionals in caring for the high-risk preterm infant to ensure optimal post-discharge growth and development. Nutrition screening and assessment should be performed routinely for any infant born prematurely and/or with a low birth weight.

Statement of intent

The Oregon Pediatric Nutrition Practice (OPNPG) workgroup has generated a set of guideline recommendations to provide guidance to health care providers on the clinical aspects of nutrition management of the preterm infant while at the same time recognizing the limited evidence that exists. These recommendations are based on evidence available at the time of revision and they also rely heavily on the clinical experiences of the workgroup members.

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Definitions

Preterm Infant: Infants born <37 weeks of gestational age.

- Low Birth Weight (LBW): Birth weight < 2500 grams (5½ lbs)
- Very Low Birth Weight (VLBW): Birth weight < 1500 grams (3 1/3 lbs)
- Extremely Low Birth Weight (ELBW): Birth weight < 1000 grams (2¼ lbs)

Late preterm: Infants born between 34 0/7 - 36 6/7 weeks gestational age.

Appropriate for Gestational Age (AGA): Usually defined as infants born with growth parameters plotting between the 10th and 90th percentile.

Large for Gestational Age (LGA): Infants born with growth parameters greater than two SD from the mean, usually defined as above the 90th percentile.

Small for Gestational Age (SGA): Infants born with growth parameters less than two SD from the mean, usually defined as below the 10th percentile.

Intrauterine Growth Restriction (IUGR): Failure to sustain intrauterine growth at expected rates; can be caused by placental insufficiency, infection, malnutrition, etc. May or may not be born prematurely.

Asymmetric SGA: Infants who have reduced body weight, but growth for head and length have been spared; often indicates short-term intrauterine growth restriction.

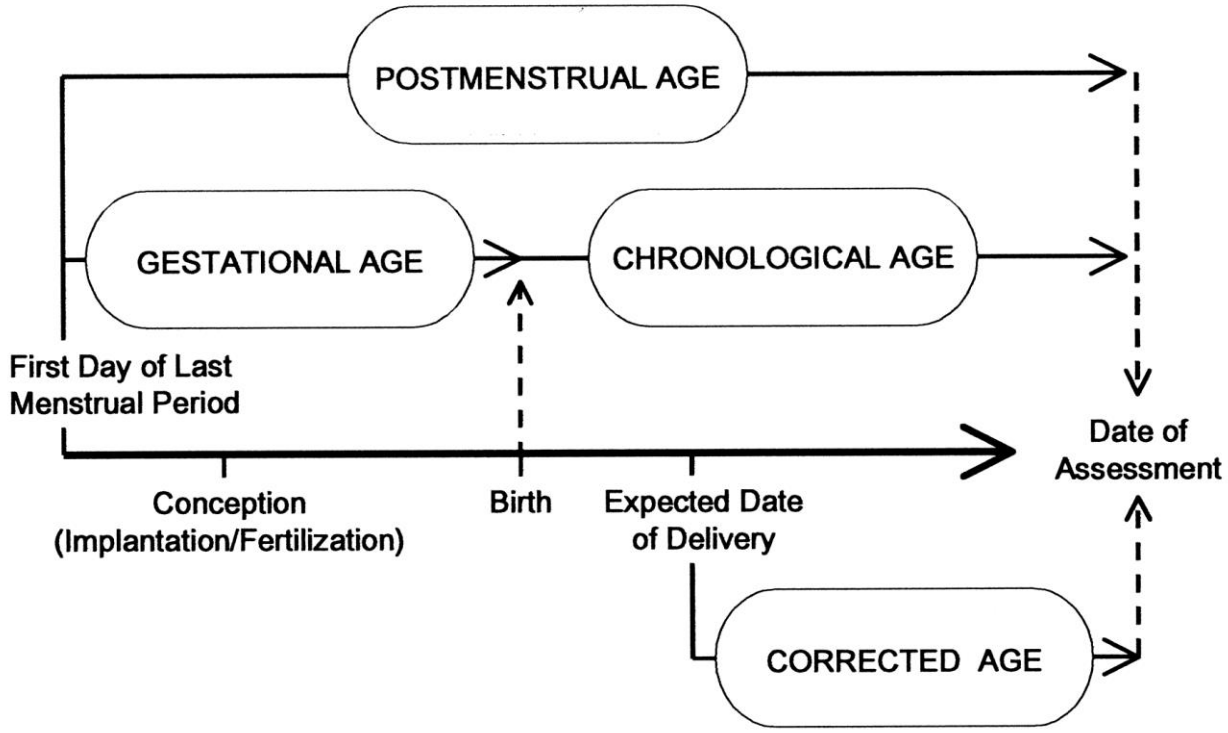
Symmetric SGA: Infants born with small body (weight and length) and head growth; often indicates that the intrauterine growth restriction was prolonged.

NICU: Neonatal Intensive Care Unit

Occipital frontal circumference (OFC): Head circumference

EHM/EMM: Expressed Human Milk / Expressed Mother's Milk

Age terminology and definitions during the perinatal period:



Committee on Fetus and Newborn et al. Pediatrics 2004;114:1362-1364

Gestational Age: Indicates time elapsed between the first day of the last menstrual period and the day of delivery in weeks and days.

Chronological age (CH) or "actual age": Indicates the time elapsed from the actual day of birth in days, weeks, months, and years. Also known as "postnatal" age.

Corrected Age (CA): Chronological age minus the number of weeks born before 40 weeks in weeks, and months. Also known as "adjusted age" and is the more appropriate term used post discharge to describe children up to 3 years of age who are born preterm.

Postmenstrual Age (PMA): Indicates the time elapsed between the first day of the last menstrual period and birth (gestational age) plus the time elapsed after birth (chronological age) in weeks and days. This is the preferred term used to describe the age of the preterm infant during the perinatal period neonatal hospital stay. After the perinatal period, "corrected age" is the preferred term.

CHAPTER 1

Discharge of the preterm infant into the community

Improvements in medical and nutritional care have resulted in an increase in survival rates for infants born less than 36 weeks gestation. As these smaller infants survive, the morbidity rates for very low birthweight (<1500 g) infants have increased.

Infants are being discharged into the community earlier for many reasons. Earlier discharges decrease the length of time the infant is separated from their parents, improves bonding and reduces the potential negative effects on parenting. Fewer days in the NICU reduces the risk of the infant contracting infections while hospitalized, which would significantly increase the number of days in the hospital.

Another major reason that premature infants may be discharged earlier is to keep medical costs reduced, allowing the NICU to target their resources toward higher risk infants requiring more intensive care. However, some of these infants discharged early are re-admitted due to failure to thrive and feeding problems. This is often due in part to a lack of, or gaps in, coordinated care and follow-up in the community.

Importance of Using Corrected Age for Preterm Infants

Use of Corrected Age: The American Academy of Pediatrics and the Centers for Disease Control and Prevention recommend correcting age for prematurity up until 24 months of age. Using chronological age instead of corrected age for premature infants can lead to incorrect interpretations of a child's growth or developmental progress and may negatively impact their care. Corrected age is used to evaluate the need for catch-up growth, determine age-appropriate foods, and plot the patient on appropriate growth charts.

- Corrected age = Chronological Age – Number of weeks premature
- Number of weeks premature = 40 weeks (full term) – Weeks gestation at birth

Transitioning home

Infants at highest risk post discharge:

- Infants born Very Low Birthweight (VLBW) and Extremely Low Birthweight (ELBW)
- Small for gestational age (SGA) and Intrauterine Growth Restriction (IUGR)
- Primarily breastfeeding with no fortification, depending on gestational age and birth weight
- Infants on special formulas
- Infants who require tube feedings at home
- Infants on total parenteral nutrition (TPN) > 4 weeks during hospitalization or on parenteral nutrition after hospital discharge
- Infants with gastrostomies or tracheostomies

- Infants with slow weight gain prior to hospital discharge (gaining < 20 g/d)
- Infants with any of the following complications of prematurity:
  - Chronic lung disease/Bronchopulmonary dysplasia
  - Chronic renal insufficiency
  - Congenital alimentary tract anomalies
  - Short bowel syndrome
  - Cyanotic congenital heart disease
  - Osteopenia of prematurity
  - Anemia of prematurity
  - Severe neurological impairments
  - Drug and/or alcohol exposure in utero
  - Poverty or low socioeconomic status

Common parental concerns

Parents routinely express concerns in caring for their preterm infants. Community health professionals should be aware of the following concerns and be able to offer recommendations to address these concerns. Please see Chapter 6 and Chapter 8 for interventions regarding these concerns. Others may require referrals to the appropriate resource (see below).

- Growth expectations
- Obtaining special medical formulas and/or fortifiers
- Cost of feedings: supplies, tubing, special nipples
- Oral aversions
- Slow feeding and low feeding endurance
- Reflux
- Determining developmental readiness to start solid foods
- Lack of interest in or enjoyment of food
- New feeding issues that surface once infant starts on solid foods
- Daycare and respite care
- Transitioning off of NG tube feeds
- Constipation

Referral resources

Community health care professionals should be familiar with the referral resources available to premature infants within the community to help bridge the gap of caring for these fragile infants outside the hospital. Community health professionals caring for premature infants should know:

- How to contact/refer to a Community/Public Health Nurse.
- How to contact a home services company or enteral vendor for feeding supplies.
- Where the closest feeding and neurodevelopmental clinics are located and how to contact them.
- How to contact a pediatric dietitian.
- How to contact a lactation consultant.
- How to access breast pump rental resources.
- How to contact Oregon WIC services.
- How to contact or refer to an SLP and/or OT.

At time of discharge, preterm infants who are at high risk or displaying growth or feeding "red flags" (described below) should be followed by a feeding clinic to manage their nutrition and growth at home. Primary feedings clinics in Oregon:

- Doernbecher Outpatient Feeding Clinics:
    - Neonatal Transition Clinic (SLP, PT, RD) - after NICU discharge with short-term needs
    - CDRC Feeding Clinic (GI, Developmental MD, SLP/OT, RD) - long-term feeding management, food aversions, G/J-Tubes, sensory issues
- Randall Children's Feeding Clinic
    - Neonatal Nutrition Lactation Clinic (IBCLC, RD) - after NICU discharge
    - Pediatric Development and Rehabilitation Clinic (SLP, RD, OT) - long-term feeding management, food aversions, NG/G/J-Tubes, sensory issues
- Kaiser
    - NICU Multidisciplinary Clinic (MD, RD, SLP)
    - Outpatient RD and SLP follow-up
- Oregon WIC
- Providence St. Vincent's Pediatric Clinics
    - Enteral Nutrition Support Clinic (Peds GI MD, RD, SLP): long-term management of children with feeding tubes
    - Pediatric Gastroenterology and Pediatric Nutrition Clinics (Peds GI MD, RD): short and long-term management of children with pediatric feeding disorder, dysphagia
    - Providence Child Development Clinic (SLP): outpatient SLP follow up for children with dysphagia

Feeding concerns for high-risk newborns at discharge

Preterm infants may have any of the following feeding problems at discharge:

- Sleepiness or fatigue with feeding
- Physiological instability (e.g. apnea)
- Limited endurance
- Poor suck/swallow/breathe coordination
- Impaired swallowing mechanism
- Poor oral motor control/coordination

Can refer to Appendix Table 1.1: Feeding Concerns for High Risk Preterm Infants

Growth and feeding "red flags" requiring post-discharge follow up

These "red flags" should alert the community dietitian/health care professional of the need for further assessment, referral and follow-up (adapted with permission, Cox, JH, ed. *Nutrition Manual for At-risk Infants and Toddlers*. Chicago IL: Precept Press, 1997; pg 186.):

Anthropometric "red flags"

- Assessment of malnutrition - see Ch. 2 for criteria
- Weight loss or significant decline in percentile ranking ("falling away" from expected growth curve percentile) in weight, length, head circumference, or weight-for-length
- Excessive weight gain: crossing 2 percentiles in a short period of time.
- Poor rate of weight gain for corrected age as listed below:

Corrected Age	Indications for referral
36-40 weeks	Less than 25 g/day or <6 oz/wk
Term – 3 months	Less than 20 g/day or < 5 oz/wk
3 – 6 months	Less than 15 g/day or < 3.5 oz/wk
6 – 9 months	Less than 10 g/day or < 2 oz/wk
9 – 12 months	Less than 6 g/day or < 1.5 oz/wk
1 – 2 yrs	Less than 1 kg or < 2 lbs in 6 months

Clinical "red flags"

Medical complications, conditions or chronic illnesses

- Chronic lung disease (CLD)/bronchopulmonary dysplasia (BPD)
- Gastroesophageal reflux (GERD)
- Cardiac anomalies
- Renal compromise
- Necrotizing enterocolitis (NEC)
- Small bowel syndrome, short gut
- Infants discharged home on TPN
- Fetal alcohol syndrome, fetal drug exposure
- Down Syndrome, Cerebral Palsy, Cystic Fibrosis, Spina Bifida
- Other metabolic syndromes
- Discharged on tube feeds
- Discharged with drains (i.e. shunt, with liver disease)

Long-term medication use

- Antibiotics
- Anticholinergics
- Anticonvulsants
- Corticosteroids
- Laxatives
- Diuretics

Vomiting or reflux

- Persistent spit-up; refusal to eat; apnea during feedings which may or may not be accompanied by back arching; accepting feedings only when sleepy.
- Chronic vomiting, especially if accompanied by other signs and symptoms such as diarrhea, dehydration or growth faltering.
- Pain or obvious discomfort or frequent respiratory tract infections (often symptoms of gastroesophageal reflux or GER).

Constipation

- No bowel movements for 3 days and stools are dry, hard, pellet-like and difficult to pass.
- Abdomen is distended and hard.

Diarrhea

- Frequent/chronic loose, watery, large, bulky or unusually foul-smelling stools, especially if accompanied by other signs and symptoms such as vomiting or dehydration.
- Skin breakdown in diaper area.
- Gray, white or pale-colored stools.

Feeding "red flags"

- Infant < 2 months corrected age, feeding fewer than 8 times in 24 hours or with fewer than 6-8 wet diapers in 24 hours.
- Feeding duration > 30 minutes per feeding; < 6 feedings/day.
- Infant taking preterm formula or human milk fortifier if the infant currently weighs more than> 2.5 kg (5½ lbs).
- Concentrating formula beyond standard dilution.
- Adding supplements or fortifiers to formula or breastmilk.
- Improper formula dilution.
- Infant taking soy formula or goat's milk.
- Volume of feeding decreasing with age instead of increasing with age.
- Lethargy, decreased arousal during feedings.
- Infant is fussy or distressed during feedings, has trouble breathing during feeding, difficult to wake for feedings or tires easily, or has difficulty finishing feeding.
- Infant refuses to eat, is difficult to feed or arches backward when feeding, frequently gags, coughs or chokes during feeding.
- Feedings are frustrating and stressful to parent or infant/child.
- Parents or caregivers have difficulty interpreting or responding appropriately to feeding cues.
- Infant > 6 months corrected age and who has not yet started spoon feeding.
- Cow's, goat's milk, or plant based milk offered before 1 year corrected age.

Selection of feeding at discharge

Developmental readiness for feeding varies widely for premature infants; feeding strategies and recommendations for the preterm infant need to be evaluated on an individual basis. These guidelines are designed to help the practitioner in making feeding selections to promote optimal nutrition. The type of feeding at discharge is generally decided based upon birth weight, weight at discharge, and NICU course. Breastfeeding after premature birth is recommended and encouraged whenever possible. Lactation consultation is encouraged to promote successful breastfeeding and to facilitate the use of a breast pump if needed.

Babies at high risk of nutritional deficiencies who may need fortification longer include:

- Birthweight <1000 g
- TPN >1 month
- Weight at discharge is less than birthweight percentile on growth chart
- Abnormal markers of bone mineralization

Developing a nutritional care discharge plan for the preterm infant on human milk must consider several variables. For the mother, these include her current supply of stored frozen milk, her intention to continue pumping, her milk output (average ounces per day pumped), and her preferences for feeding following discharge (whether she wants to exclusively breastfeed, combine breast and bottle feeding, or only bottle feed). For the baby, considerations include current nutritional status (including biochemical indices), current health status and treatments that may affect nutrient needs, radiological evidence of bone health, growth pattern during the NICU stay, recent growth velocity, and the ability to take oral feedings at the breast and/or with a bottle.

Upon discharge, preterm infants often have low blood urea nitrogen (BUN) and phosphorus levels, alongside elevated alkaline phosphatase levels, indicating potential protein and mineral deficiencies. Preterm infants fed with human milk are at a greater risk of nutritional inadequacy compared to those fed with preterm formula. Human milk has lower protein-to-energy and nutrient-to-energy density ratios than what is required to meet the nutritional needs of preterm infants, particularly those weighing less than 1250 grams at birth.

Options for feeding at discharge include:

- fortifying breast milk with infant formula
- fortifying breast milk with fortifiers typically used in hospital
- primarily breastfeeding with a few high calorie bottles of formula to boost nutrient intake
- formula feeding
- a combination of the above

Many preterm infants discharge from the NICU receiving post-discharge preterm formula (or transitional formula). See the below table for more information. The research is mixed in regards to how long a formula-fed preterm infant should continue on a transitional formula. A systematic review of 8 randomized control trials found that 6 of the 8 studies showed improvements in growth, paralleled by both lean mass and fat mass, and improvements in bone mineral mass when fed a transitional formula to at least 6 months corrected age. Studies that lasted ≤3 months showed no effect on growth. Three of the 8 studies also showed better growth in boys although 2 of the studies showed benefits for girls as well. The review concluded that for formula-fed VLBW infants the use of a transitional formula should continue until 3-6 months corrected age, possibly as long as 12 months corrected age (Griffen & Cook, 2007).

Once an infant is gaining at least at the 50th percentile expected weight gain for corrected age, or staying on or exceeding his growth curve, a standard term formula can be trialed. Bone mineral labs and growth should be monitored closely (see Chapter 3).

Fortified/Formula Options for Preterm Infants			
Formula	**Description**	**Brand Names**	**Availability**
Premature Human Milk Fortifiers	- Mixed with human milk (mom's milk or donor milk) to 22, 24, 27 or 30 kcal as needed - only available in hospital setting - higher in protein	Similac HMF, Enfamil HMF - Similac is higher in Phos, Ca - Enfamil is higher in kcal, protein and iron	Available In-patient
Premature (Pre-Discharge) Formulas	- Ready to feed - Standard mix is 20, 24, 27 or 30 kcal/oz as needed - Specifically higher in protein to support lean mass growth	Enfamil Premature, Similac Special Care HIgh Protein	Available In-patient
Preterm Discharge/Transitional Formulas	- Standard mix is 22 kcal/oz - Contains higher calcium and phosphorus to promote bone mineralization	Similac Expert Care Neosure, Enfamil EnfaCare, Gerber Good Start Nourish	Available Out-patient

Per Pediatric Nutrition Reference Guide. United States: Texas Children's Hospital. 2022., Moreira DH, Gregory SB, Younge NE. Human milk fortification and use of infant formulas to support growth in the neonatal intensive care unit. Nutr Clin Pract. 2023;38 Suppl 2(Suppl 2):S56-S65. doi:10.1002/ncp.11038

1. Low Risk Infants

Category Definition:

Birth weight > 2000 g (4 ½ lbs)
Gestational age >34 weeks

Formula Feeding Recommendations:

- Offer standard term formula until 1 year corrected age

- May need to increase caloric density (i.e. 22-24 kcal/oz) term formula due to:

  Slow weight gain (<25 g/d)

  Poor intake (<150 ml/kg/day)

Breastfeeding Recommendations:

- Breastfeed on demand

- If milk intake or supply is insufficient, as evidenced by slow growth on WHO growth grid, assess the need for lactation support or supplementation with term formula

- Supplement with 1 ml of standard infant multi-vitamin with iron

2. Moderate Risk Infants

Category Definition:

Infant birth weight between 1500 g (3 ⅓ lbs) – 2000 g (4 ½ lbs) and/or <34 weeks

Infant with good growth and intake with no major medical complications

Alkaline phosphatase and serum phosphorus are within normal limits before discharge

Formula Feeding Recommendations:

- Provide post-discharge (transitional) formula up to 3-6 months corrected age.
- Continue on post-discharge formula unless:
  - Infant cannot tolerate formula
  - Excessive rate of weight gain
  - Calcium and Phosphorus exceed normal limits
- If changing from a post-discharge formula to a term formula or unfortified breastmilk and infant is <3 months corrected age:
  - Check bone labs before making a formula change to ensure adequate bone mineralization and recheck 4-6 weeks after making the change (see Chapter 3)
  - Check weight in 1-2 weeks after making the change to ensure adequate weight gain
- Supplement with 0.5 ml infant multivitamin without iron until infant is taking >32 oz (>1000 ml) per day

Breastfeeding Recommendations:

- Discuss family's breastfeeding goals in order to support breastfeeding while still maintaining infant's growth and lab values

- Supplement breastfeeding with fortified breastmilk or a post-discharge (transitional) formula until infant is able to sustain growth with ad lib milk intake

- Check bone labs 1 month after discharge or 1 month after infant starts exclusively breastfeeding

- Supplement with 1 ml of standard infant multivitamin with iron

3. High Risk

Category Definition:

Birth weight ≤ 1500 g (3 ⅓ lbs)
Slow weight gain (<25 g/day)
Poor intake (< 150 ml/kg/day)
Elevated alkaline phosphatase (> 500 U/L) and/or low phosphorus (< 4 mg/dl)
Complicated NICU course, which could include history of TPN >4 weeks & chronic lung disease
Weight-for-corrected age or weight-for-length < 2nd-5th percentiles on WHO growth grid or decline in percentile ranking ("falling" away from expected growth curve percentiles)

Formula Feeding Recommendations:

- In the majority of cases, these infants will need post-discharge (transitional) formulas up through 6-12 months corrected age
  - Continue on post-discharge formula unless:
    - Infant cannot tolerate formula
    - Excessive rate of weight gain
    - Calcium and Phosphorus exceed normal limits
- If changing from a post-discharge formula to a term formula or unfortified breastmilk:
  - Check bone labs before making a formula change to ensure adequate bone mineralization and recheck 4-6 weeks after making the change (see Chapter 3)
  - Check weight in 1-2 weeks after making the change to ensure adequate weight gain
  - Monitor formula intake to ensure volume of formula hasn't increased dramatically which may be a sign that the infant needs a more calorie dense formula
- Supplement with 0.5 ml infant multivitamin without iron until infant is taking >32 oz (>1000 ml) per day

Breastfeeding Recommendations (see chapter 4):

- Discuss family's breastfeeding goals in order to support breastfeeding while still maintaining infant's growth and lab values

- Supplement breastfeeding with fortified breastmilk or a post-discharge (transitional) formula until infant is able to sustain growth, ad lib milk intake, and lab values are within normal limits

- Supplement with 1 ml of standard infant multivitamin with iron

Chapter 1 references

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CHAPTER 2

Growth assessment

The growth patterns of preterm, very low birth weight infants are known to be considerably different from those of higher birth weight term infants. Despite advances in nutritional support during hospitalization most preterm infants are smaller than term infants, and have higher nutrient requirements due to low body stores of nutrients and deficient bone mineralization at discharge. For example, as noted by Koletzko (Li 2021), if an infant is discharged from hospital with a body weight around 1,800-2000 g, its body mass and overall body nutrient stores represent only about 55-60% of those of an average healthy infant born at term. Nutrient intake must be sufficient to support the continued rapid growth of an infant of that size. Like other term infants, preterm infants exhibit varying growth potentials when provided with appropriate nutrient intake. A significant number of these infants do not return to their birth percentiles by term age or any specific age. Biological variation is natural, and each infant must reach their individual genetic growth potential, which may differ from their in-utero size. It is critical that premature infants are followed carefully in the community to ensure they are meeting their nutritional needs and maintaining proportional growth that supports long term neurodevelopmental and cardiometabolic health.

Measurements most commonly used to assess nutritional status are weight, length, head circumference, and weight-for-length. The Centers for Disease Control and Prevention (CDC) now recommends using the World Health Organization (WHO) 2006 growth charts for infants and children aged <24 months. This chart can be used when premature infants reach term corrected gestation age. All parameters (weight, length and head circumference) should be corrected for gestational age until 2 years of age.

There are several growth charts available to monitor growth of the preterm infant.

- From birth until 40-50 weeks CA use the Fenton growth chart
- From term to 24 months CA use the WHO growth charts
- After 24 months use the CDC growth charts

Developmental origins of health and disease

Optimal nutrition in the neonatal period is critical for successful health outcomes after discharge from the neonatal intensive care unit and into childhood. Equally important is the careful monitoring of growth, recognizing that an excessive rate of catch-up growth may have adverse consequences for long term health and yet an optimal rate of catch-up growth is not yet known. These concerns arise from newly emerging research in the area of developmental origins of health and disease (DOHaD) or "fetal programming" (Barker, 2004). This developmental programming has linked low birth weight with intrauterine compromise setting the infant up to be vulnerable to the development of chronic disease in later life. The combination of poor growth in the womb with rapid catch-up growth may enhance chronic disease risk. The nutrition of the fetus depends on several factors including the mother's nutrition before and during pregnancy, and the placenta's ability to transport nutrients from mother to fetus. The effectiveness of the placenta to perform this function is measured by its ability to transport an appropriate quantity of nutrients as well as the types of nutrients (e.g. changes in the types of fatty acids transported may reflect maternal diet); placental function in turn impacts alterations in organ structure, function, alterations in metabolism, as well as increased vulnerabilities to postnatal stressors. Research has demonstrated that poor placental development and slow fetal growth in early gestation is linked with increased vulnerability to cardiovascular disorders, including hypertension (Barker, 1988) and obesity in adulthood. Nutrient restriction during late gestation, when a fetus is growing rapidly, is associated with disruptions in intermediate metabolism leading to an increased risk of diabetes decades later in life (Guilloteau, et al, 2009). Undernutrition during pregnancy generally, are strongly associated with increased risk of hypertension, obesity, insulin resistance, and dyslipidemia later in life (Vickers, Sloboda, 2012). However, research indicates that, despite concerns, preterm infants do not have a higher risk of obesity compared to those born at term. Although, obesity and overweight are typically assessed using body mass index (BMI), which is widely regarded as an unreliable measure of adiposity, especially in children.

It is important to note that the risk of chronic disease is not limited to premature infants as fetal growth restriction can occur in infants of any weight. However, the risk appears to be compounded in preterm infants when intrauterine growth restriction (IUGR) is coupled with rapid postnatal catch-up growth. Additional research is needed to determine when catch-up growth presents as "excess growth" in premature infants. For the preterm infant discharged into the community, the importance of a nutrient dense diet of breastmilk and/or a postdischarge formula and monitoring the rate of weight gain is now even more important. For the infant who is term but SGA or IUGR, current research suggests that breastfeeding on demand offers neurodevelopmental protection with the least risk of increased adiposity that is often seen between the ages of 2 and 6 years in children who were formula fed (Guilloteau, et al, 2009)

Table 2.1: Growth Charts Commonly Used to Monitor Preterm Infants

Growth Chart	Description of Data Included	Usage	Advantages	Disadvantages
Fenton Intrauterine Growth charts, 2025	o Larger international sample size compared to 2013 Fenton charts of 4.8 million infants (174,184 infants < 30 weeks gestational age). Data from 15 countries: Australia, Brazil, Canada, China, Finland, Israel, Italy, Japan, Netherlands, New Zealand, Sweden, Switzerland, Spain, UK, and US o Curves smoothed to equal WHO standard at 50 weeks o Data collected between 2002-2019 o Includes weight, length, and head circumference o Sex specific growth charts, 22 to 50 weeks gestation	o Recommended for preterm infants until 40-50 weeks gestational age	o Better represents intrauterine growth in comparison to 2013 charts	o Validity of this growth chart is limited by heterogeneity of the data sources o May result in more diagnosis of SGA infants in comparison to 2013 charts
Fenton Intrauterine Growth Charts, 2013	o Meta-analysis of published reference studies from 1991 to 2007 o Large international	o Recommended for preterm infants until 40-50 weeks gestational age	o 100 gm graph increments o Percentile curves (3,10, 50, 90- and 97th)	o Validity of this growth chart is limited by heterogeneity of the data sources o Data prior to 2007

	sample size 3.9 million births from Australia, Canada, Germany, Italy, Scotland o Curves smoothed to equal WHO standard at 50 weeks o Includes weight, length, and head circumference o Sex specific growth charts, 22 to 50 weeks gestation		o Starts at 22 weeks gestation o Curve smoothed to WHO standard at 50 weeks o Endorsed by AAP, AND, Merck manual, and more	
New Intrauterine Growth Curves Irene Olsen, 2010	o Based on contemporary, large, racially diverse U.S. dataset o Data from 248 U.S. NICUs from 33 U.S. states o 1998-2006 o Includes weight, length, and head circumference for age curves o Sex specific, 23 to 41 weeks	o Recommended for preterm infants until 40-50 weeks CA	o Offer updated tool for growth and assessment of preterm infants in U.S. NICUs o May decrease misclassification of SGA and LGA high risk infants o Endorsed by AAP, AND	o More research needed on the ability of the new SGA and LGA cutoffs to identify high-risk infants appropriately o Requires further validation in comparison to other available growth curves
Intergrowth 21st Charts	o Data from 8 large cities worldwide with various ethnic origins, in communities without socioeconomic constraints o 2009-2014; published	o Not recommended for use with infants <36 weeks GA per AAP	o Strict selection criteria of healthy infants o Diverse population	o Low sample sizes and limited extremely preterm births included in data population o Found to yield a varying different prevalence of SGA and LGA than national or

	2015 ○ 33 weeks - 42 weeks ○ Based on postnatal growth - developed to compare the postnatal growth of preterm infants to that of healthy preterm infants rather than the fetus ○ Weight and BMI gender-specific curves			customized charts
World Health Organization for infants and children < 24 months, 2006	○ Multicentre Growth Reference Study cross-sectional component during 1997-2003 with sites in the following locations: Pelotas Brazil, Accra Ghana, Delhi India, Oslo Norway, Muscat Oman, Davis, CA ○ 100% of reference population breastfed for 12 months and were predominately breastfed for at least 4 months. ○ Exclusion criteria included maternal smoking, birth <37wks or >42 weeks, multiple birth, substantial morbidity, low	○ Recommended chart to use for infants born term to 24 months CA ○ Use for premature infants after reached 40 wks CA with correction for prematurity	○ Worldwide standard birth to 5 years ○ Healthy breastfed infant is standard against which all other infants are compared	○ Graph starts at term corrected age ○ It is recommended to change to CDC growth charts at 24 months; switch may create disjunction in growth classification

	socioeconomic status, and unwillingness of mother to follow feeding criteria ○ Separate chart for boys and girls			
CDC 2000 Growth Charts	○ Data from NHANES I, II, & III ○ Represents racial/ethnic diversity of US only ○ Includes both formula-fed and breastfed infants ○ Does not include growth data from preterm & very low birth weight infants (<1500 gm) ○ Separate charts for boys and girls	○ Recommended chart to use after 24 months CA - 18 years old	○ Includes weight for length for birth to 24 months and BMI for children over 24 months ○ U.S. data birth to 20 years	○ Does not include VLBW infants, and age is chronological age, not adjusted gestational age ○ Not an exclusively breastfed cohort

Adapted with permission from: *Nutritional Care for High-Risk Newborns,* 3rd Edition; Groh-Wargo, S., Thompson, M., Cox, J. (Editors) pp 571. (2000). Precept Press, Chicago, IL.
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Measurements of growth

Weight Gain Velocity
Both the WHO International and CDC Growth Charts show similar growth velocity data for healthy infants from birth to age 2. Weight gain velocity is calculated in weight between two time points (usually a week to a month) and typically expressed as grams per day of weight gain. The median weight gain for infants from term to 3 months is 6 to 8 ounces each week. From term until 3 months corrected age boys gain slightly more than girls but only by about 10%. From 3 to 6 months corrected age, the growth velocity of both boys and girls slows to about 4 ounces a week. Infants who need catch-up growth should gain at a higher velocity over time.

When assessing weight gain velocity in a preterm infant, it is important to compare that velocity to the appropriate reference. See table 2.2 below.

Length
Length measurements are crucial for tracking infant growth and an indicator of lean body mass. Accurate length measurements can help identify growth trends and potential growth delays or conditions like malnutrition and slow length growth has been associated with poor neurodevelopmental outcomes. It is also not affected by an infant's fluid status. Measuring length requires precise and consistent measurements, which can make it difficult to obtain. It is recommended to use a length board as it allows for proper positioning of the infant, keeping the head and body straight and ensuring the legs are fully extended. Using a length board reduces the risk of measurement errors, which can occur if the infant is not properly aligned, and contributes to more reliable growth assessments.

Head Circumference
Monitoring head circumference in preterm infants is important, as it serves as a key indicator of brain development and overall growth. Preterm infants are at higher risk for developmental delays and neurological issues, so tracking head growth helps detect potential concerns early. Abnormalities in head circumference, whether too small or too large, can signal underlying health problems, allowing for timely interventions to support healthy growth and development.

MUAC
Measuring mid-upper arm circumference (MUAC) helps identify malnutrition or undernutrition by providing a quick indicator of muscle and fat stores. Since MUAC is less affected by fluid retention or dehydration, it can be a reliable tool in assessing overall health, especially in resource-limited settings. Regular MUAC measurements allow healthcare providers to detect early signs of growth issues and intervene to improve an infant's nutritional well-being.

Z Scores
Z-scores are utilized to monitor the growth trajectory of infants and pediatric patients. A Z-score, also known as a standard deviation score, indicates how many standard deviations a value is from the mean or average. On a growth curve, the 50th percentile corresponds to a Z-score of zero. The magnitude of a Z-score reflects its distance from the 50th percentile: Z-scores above the 50th percentile are positive, while those below are negative. Assessing changes in Z-scores for weight, length, or head circumference is the most effective method for monitoring an infant's growth trajectory, and significant changes in Z score can be an indicator of preterm infant malnutrition.

Table 2.2 Growth Velocity / Length / OFC Expectations

Age	Weight (g/d)	Height (cm/wk)	OFC (cm/wk)
Premature <2 kg*	15-20 g/kg/d	0.8-1.1	0.8-1.1
Premature >2 kg*	20-30	0.8-1.1	0.8-1.1
0-4 months	23-34	0.8-0.93	0.38-0.48
4-8 months	10-16	0.37-0.47	0.16-0.2
8-12 months	6-11	0.28-0.37	0.08-0.11

*Use CA ≥4 months and based on current weight (rather than birth weight)
**Weight for length to be used over BMI until 24 months CA

Malnutrition criteria for preterm infants

There is now specific criteria for malnutrition specific to the preterm infant population. The published criteria for early identification and documentation of pediatric malnutrition are intended for use in infants older than 30 days and beyond 37 weeks of corrected gestational age. Neonatal malnutrition criteria is typically used during inpatient NICU stay while pediatric malnutrition is typically utilized in the outpatient setting based on age at discharge.

It is also important to recognize that many healthcare providers commonly refer to pediatric malnutrition as "failure to thrive." However, the preferred terminology is "malnutrition" or "growth faltering," as these terms more accurately reflect the condition and its clinical implications.

Additionally, EUGR (Extrauterine Growth Restriction) has often been defined in the literature similarly to SGA (Small for Gestational Age) but at hospital discharge, meaning a weight below the 10th percentile. However, having a weight below the 10th or 3rd percentiles at hospital discharge has not been shown to predict adverse neurodevelopment in preterm infants. Some researchers suggest discontinuing the use of the term EUGR for diagnosing infants with weight below the 10th or 3rd percentiles around NICU discharge, at 36-40 weeks postmenstrual age.

This recommendation stems from the term's lack of predictive value for adverse outcomes and its failure to account for the fact that preterm infants, due to postnatal weight loss, are often positioned lower on growth chart curves. It is recommended instead to use malnutrition criteria to quantify and monitor poor growth.

Table 2.3 Pediatric Malnutrition Guide

Pediatric Malnutrition Criteria			
Indicators	**Mild Malnutrition**	**Moderate Malnutrition**	**Severe Malnutrition**
Single Data Point			
Weight-for-height Z Score	-1 to -1.9 z score	-2 to -2.9 z score	≥ -3 to -3.9 z score
BMI-for-age Z Score	-1 to -1.9 z score	-2 to -2.9 z score	≥ -3 to -3.9 z score
Length/Height Z Score	-1 to -1.9 z score	-2 to -2.9 z score	≥ -3 to -3.9 z score
MUAC (6-60 months)	-1 to -1.9 z score	-2 to -2.9 z score	≥ -3 to -3.9 z score
Two or More Data Points			
Weight gain velocity (<2 years)	<75% of norm of expected weight gain	<50% of norm of expected weight gain	<25% of norm of expected weight gain
Weight Loss (2-20 years)	5%	7.5%	≥10%
Decline of weight for length z score	Decline of 1 z score	Decline of 2 z score	Decline of ≥3 z score
Inadequate Nutrient Intake	<75% estimated intake	<50% estimated intake	≤25% estimated intake

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CHAPTER 3

Energy, nutrient and biochemical recommendations

At the time of discharge, the nutritional needs of preterm infants are higher than those of term born infants. (Koletzko 2021) Post discharge nutrition for the preterm infant can be further complicated by inpatient growth trajectory, comorbidities, nutritional needs, oral feeding ability, difficulty of feeding preparation, and family's plan for breastfeeding. (Taylor 2022). As a result, the nutritional needs of preterm infants after discharge are complex, highlighting the inadequacy of a uniform approach to nutrition for this population.

Human milk is the standard for infant nutrition and is the optimal nutrition for VLBW infants. (Parker 2021). Preterm infants discharging on human milk, especially exclusive human milk, may require closer nutritional monitoring to assure optimal growth. Even exclusively breastfed babies who are gaining weight adequately may not be consuming adequate calcium and phosphorus with unfortified breast milk. Therefore, it is important to monitor growth closely and may be important to check bone labs to ensure nutritional needs are being met.

Nutrient recommendations for preterm and term infants

Table 3.1: Nutrient and Energy Recommendations for Preterm and Term Infants

Nutrient	Preterm*	0-6 months	7 – 12 months
Energy *These are baseline energy goals, an infant may need more/less based on clinical state.*	110 - 130 kcal/kg	See Estimated Energy Requirement (EER) below	See EER equation
Protein	3.5 - 4.5 g/kg	*1.5 g/kg/day OR 9.1 g/day*	*1.2 g/kg/day OR 11 g/day*
Vitamin D	400 – 800 IU/day	*10 mcg/day or 400 IU/day*	*10 mcg/day or 400 IU/day*
Calcium	120 - 220 mg/kg	*200 mg/day*	*260 mg/day*
Phosphorous	70 - 120 mg/kg	*100 mg/day*	*275 mg/day*
Iron	1-3 mg/kg	*0.27 mg/day*	*11 mg/day*

Per:
Pediatric Nutrition, edited by Frank R. Greer and Steven A. Abrams, American Academy of Pediatrics, 2025.
Dietary Reference Intakes for Energy. Published online March 28, 2023. doi:https://doi.org/10.17226/26818

**In most cases, use the lower value in the recommended range for preterm infants in the community setting. This lower value should be the goal for nutrient intake until there is either attainment of term-corrected age and/or catch-up in weight on an appropriate growth chart. Former pre-term infants, who are healthy, have overcome remaining problems of prematurity (such as iron deficiency) and have transitioned to breastfeeding and/or standard formulas should transition gradually to nutrient recommendations based on corrected age. (Groh-Wargo, S. & Sapsford, A. 2009.)*

Table 3.2: Estimated Energy Requirement Equations (EER)**

Age of Infant	Estimated Energy Requirement by Sex	
	Female	Male
0 – 3 months	–69.15 + (80.0 x age) + (2.65 x height) + (54.15 x weight) + 180	–716.45 – (1.00 x age) + (17.82 x height) + (15.06 x weight) + 200
3 – 6 months	–69.15 + (80.0 x age) + (2.65 x height) + (54.15 x weight) + 60	–716.45 – (1.00 x age) + (17.82 x height) + (15.06 x weight) + 50
6 – 12 months	–69.15 + (80.0 x age) + (2.65 x height) + (54.15 x weight) + 60	–69.15 + (80.0 x age) + (2.65 x height) + (54.15 x weight) + 60

Assume height in centimeters and weight in kilograms.

**Based on the recent DRI updates in 2023, with EER equations for each sex
Dietary Reference Intakes for Energy. Published online March 28, 2023. doi:https://doi.org/10.17226/26818

Vitamin and mineral supplementation

Definitions

Standard Infant Multivitamin: Liquid supplement containing vitamins A, D, C, B1, B2, B3, and B6; may also contain B12. Available with or without iron.
Example: *Poly-Vi-Sol*

Infant Tri-Vitamin: Liquid supplement containing vitamins A, D, and C. Available with or without iron.
Example: *Tri-Vi-Sol*

Vitamin D Supplement: Liquid supplement containing only vitamin D. Generally vitamin D3 (cholecalciferol) is used for routine supplementation.
Note: Liquid vitamin D is available in multiple concentrations.
Example: *D-Vi-Sol*

Iron Supplement: Liquid supplement containing only iron.
Note: Iron drops are available in two concentrations: 15 mg/ml and 25 mg/ml.

Iron

Most iron accumulation in the human fetus occurs during the last trimester of pregnancy (AAP Pediatric Nutrition, 9th edition, 2025). Preterm infants are born with lower iron stores than term infants. The AAP (2020) recommends an iron intake of 2-3 mg/kg/day starting at 2 weeks of age and continuing until 6-12 months of age. This can be achieved through iron-fortified infant formula and/or supplementation, with a maximum intake of 40 mg/day. Formula-fed infants consuming at least 150 ml/kg/day typically receive about 2 mg/kg/day from formula alone, though some may require additional supplementation. Monitoring ferritin levels is also recommended, but outpatient follow-up guidance should be clarified.

Vitamin D

The American Academy of Pediatrics (Misra et. al, 2008) recommends that fully or partially breastfed infants receive a supplement of 400 IU vitamin D daily for at least the first year of life. Non-breastfed infants should also be supplemented, until taking 32 fl. oz. (1000 ml) per day of vitamin D- fortified infant formula. For preterm infants, this 400 IU of vitamin D can be provided by: 1 ml daily of a standard infant multivitamin with/without iron; 1 ml daily of a tri-vitamin supplement with/without iron; or a vitamin D supplement such as D-Vi-Sol in combination with a separate iron supplement.

Table 3.3: Vitamin and Mineral Supplementation for Preterm Infants

If infant is primarily on:	What supplements are recommended?	When can the supplements be stopped?
Breast Milk (Unfortified or Fortified)	1 ml daily Infant Multivitamin with Iron or 1 ml daily Infant Multivitamin without Iron + separate Iron supplement	Continue until 12 months corrected age.
Iron-Fortified Formula	0.5 ml daily Infant Multivitamin without Iron	Stop when intake reaches about 32 oz/day (1000 ml).

Important biochemical parameters for post-discharge preterm infants

Osteopenia of prematurity

The condition of decreased bone density in the premature, low-birth-weight infant is osteopenia of prematurity, which may or may not be seen in conjunction with rickets. These two conditions

are characterized by low levels of calcium (Ca) and phosphorus (P) and high levels of serum alkaline phosphatase (ALP). During the last 3 months of pregnancy, large amounts of calcium and phosphorus are transferred from the mother to the baby for bone growth. When an infant is born prematurely, the infant may not receive the required amounts of calcium and phosphorus to form strong bones.

Risk factors for osteopenia of prematurity:
- Very-low-birth-weight infants (BW <1500 g).
- Any IUGR infant with a birthweight <1800 g regardless of gestational age.
- Infants with chronic lung disease/bronchopulmonary dysplasia.
- Infants requiring long-term TPN (> 4 weeks).
- Infants on certain medications, including diuretics & corticosteroids that affect mineral absorption.
- Infants starting feedings of unfortified breastmilk or standard formula too early, or soy formula.

In the absence of other disease conditions, ALP provides an indirect indicator of bone cell activity. High ALP along with low phosphorus and/or abnormal calcium level may indicate a need for further assessment and supplementation. These labs are usually checked prior to discharge and should be checked in the community until 3 months corrected age. Consider also checking parathyroid hormone.

Indications for reassessment of calcium, phosphorus and alkaline phosphatase status:
- 1-month post-discharge for all infants with birthweight (BW) < 1500 g and IUGR infants with BW < 1800 g.
- 1-month post-discharge if any of the labs at discharge (if known) were outside the reference range.
- If the premature infant is transitioning to exclusive breast or a term formula < 3 months corrected age. (Faienza, 2019)
- If the premature infant has had marginal intake and rate of growth falls in ‘red flag’ range (see Malnutrition, Chapter 3).

Anemia

Preterm infants are at higher risk for iron deficiency and anemia because 60% of total iron stores are accrued during the last trimester of pregnancy. The earlier the gestational age at birth, the higher the risk of anemia for the infant.

While in the NICU iron supplementation is a common practice with dosing ranging from 2 – 6 mg/kg (Pamela, 2020) depending on the weight and gestational age of the infant. Typically, at the time of discharge 2 mg Fe/kg is provided either through a multivitamin, iron supplement, or iron fortified formula. Per the AAP 9th edition: preterm infants should be provided 2-3 mg/kg/d enteral iron after hospital discharge until 6-12 months depending on diet. Formula fed preterm infants should be on iron fortified formula. In certain cases additional iron may need to be supplemented.

Table 3.4: Reference Table for Biochemical Parameters

Biochemical Marker	Reference Range*	Interpretation
Alkaline Phosphatase (ALP)	100 – 500 U/L	o Marker of bone formation. o Levels may be elevated during periods of bone growth. o Levels > 500 U/L in preterm infants may indicate a risk of osteopenia and need for further evaluation **if** there is also a low phosphorous or low/abnormal calcium level.
Calcium(Ca)	6.0 – 12.0 mg/dl	o Extracellular cation involved in skeletal development. o Elevated levels are a marker of bone formation. o Levels lower or higher than the reference range indicates a need for further assessment.
Phosphorus(P)	5 – 9 mg/dl	o Cellular anion involved in bone formation. o Elevated levels indicate skeletal disease, renal disease or excess phosphorus intake. o Low levels can indicate inadequate phosphorus intake. o Levels lower or higher than the reference range indicates a need for further assessment.
Vitamin D 25 (OH)	30 – 100 ng/ml	o Levels <30 ng/ml indicate insufficiency. o Levels <20 ng/ml indicate deficiency. o Levels < 5 ng/ml indicate severe deficiency. o *Reference ranges may vary depending on the source.
Hemoglobin (Hb)	10 – 15 g/dl	o Levels lower than the reference range may indicate iron deficiency.
Hematocrit (Hct)	30 – 40%	o Levels lower than the reference range may indicate iron deficiency.

*The normal range for these labs may change slightly depending on the reference range used by the individual laboratory.

Reference: Academy of Nutrition and Dietetics Pocket Guide to Neonatal Nutrition. AMERICAN DIETETIC ASSN; 2022.

Case Studies: Use of Tribasic for the breastfed preterm infant

Some very small premature infants gain weight & grow well while taking only breastmilk or fortified breastmilk, despite having abnormal bone labs. This puts them at risk of developing

osteopenia. Tribasic is a calcium (Ca) and phosphorus (Phos) supplement that can be given to infants to help improve their bone mineral status. The premature infants that benefit the most from supplementation with Tribasic are those that are exclusively breastfeeding well (evidenced by good weight gain), or are receiving only fortified breastmilk via bottle while showing readiness to start fully breastfeeding soon. Tribasic may be a good option for these infants to normalize the bone labs while promoting breastfeeding. While there may be no specific guidelines on how or when to use Tribasic, the general consensus for use is listed below.

Summary:

- Tribasic is a calcium/phosphorus supplement available for outpatient use.
- Tribasic contains 100 mg Ca and 50 mg Phos per 250 mg powder (1/8 of a tsp).
- The standard dose for Tribasic is 1/8 tsp twice a day (BID), but may be as high as 1/8 tsp three times a day (TID) with highly elevated Alkaline Phosphatase (Alk Phos).
- Bone labs should be monitored every 4-6 weeks while infant is taking Tribasic.
- Typically an infant needs to be on Tribasic for 2-3 months.

Dosing Decision:

Alk Phos goal is < 500 U/L. If above 500, consult with a pediatric RD & refer to the following:

- If Alk Phos is 500-700, suggest ways to increase Ca and Phos:
    - Increase volume
    - Increase fortification
- If Alk Phos is > 700, suggest changes to increase Ca and Phos:
    - Same as above; or
    - Recommend starting Tribasic
        - If infant is exclusively breastfeeding, start at 1/8 tsp BID. Recheck labs in 4 weeks.
        - If infant is taking fortified breastmilk or is partially breastfed, Ca/Phos levels must be calculated out before starting Tribasic. Do not exceed:
            - Goal Ca intake: 120-230 mg/kg/d
            - Goal Phos intake: 60-140 mg/kg/d
            - Goal ratio: 1.8-2:1
- If Alk Phos is > 800
    - Suggest all of the above; and/or
    - Recommend checking vitamin D levels: 25-hydroxy Vitamin D
- If Alk Phos is > 1000 and increasing despite nutritional intervention:
    - Recommend checking a fractionated Alk Phos level
    - Recommend an endocrine consult

Insurance/Costs:

- Most insurance companies will not cover the cost of Tribasic & the family would have to pay for it themselves.
- Tribasic costs about $25-$30. This would provide enough Tribasic for at least 3 months.

Pharmacy:

- Only available at compounding pharmacies.
- Tribasic comes in a powder form.
- Tribasic is now manufactured by Fairgone. It used to be made by Spectrum but was discontinued.
- It is preferable to have MD or provider with prescriptive rights call it into a compounding pharmacy.

Counseling:

- Tribasic does not come with a measuring tool, so the family would need to buy measuring teaspoons. Keep in mind that dosing typically starts with 1/8 tsp amounts & it can be very hard to find 1/8 tsp measuring spoons.
- The family will have to mix the 1/8 powder with about 5 ml breastmilk and give it via syringe (ask pharmacist for one) or via infant spoon.

Case Study #1

Jessica is a former 31-week premie. She had no major complications in the NICU. She was discharged home at 36 weeks GA. Her mom always had a great milk supply & was very dedicated to pumping while Jessica was in the NICU.

Once she started breastfeeding, her mom continued to pump after she breastfeed to maintain her milk supply. At 4 weeks of age, Jessica's mom stopped adding Neosure to her breastmilk because mom thought it made Jessica "too gassy and constipated."

At 6 weeks corrected age, Jessica was not gaining weight as expected, likely due to discontinuing Neosure supplementation. ALP was also elevated. Jessica's mother was reassured that some gassiness and decreased frequency of stooling is normal with premature babies. The high content of iron in Neosure can also decrease the frequency of stooling. Jessica's mother agreed to add Neosure into 4 bottles per day and breastfeed the other feeds. After six weeks weight gain was improved and Neosure supplementation was decreased. After another six weeks weight gain continued to improve and ALP levels normalized and Neosure supplementation was removed.

Date	Adjusted Age	Weight	Alk Phos	Phos	Ca	Feeding Method & Recommendations
12/10	31 wks GA	3#9oz				NICU: HMF + EMM x 5 weeks
12/18	32 wks GA		412	6.4	10.6	HMF + EMM
1/18	36 weeks GA	5#12oz				Discharge: EMM + Neosure 24 kcal/oz

2/2	38 weeks GA	7#oz	720	4,6	9.1	EMM
3/29	6 weeks CA	9#4oz	669	5.4	10	EMM + Neosure 24 kcal 4 bottles/day
5/5	12 weeks CA	12#10oz	403	5.6	10.2	EBF or EMM + Neosure 24 kcal 2 bottles/day
6/15	18 weeks CA	13#12 oz	372	5.8	10.6	EBF

Fluid requirements

Fluid restriction may be needed for VLBW infants with:
- Chronic lung disease/Bronchopulmonary dysplasia
- Cardiac complications requiring diuretics
- Renal disease

Fluid needs are increased with:
- Fever
- Diarrhea
- Vomiting
- Prolonged hot weather

As with full-term infants, caregivers should be asked if urine color is pale and if the infant is producing at least 6-8 wet diapers per day. Because of increased risk of dehydration, however, consider assessing actual fluid intake.

Table 3.5: Daily Maintenance Fluid Requirements Based on Weight

Body Weight	Fluid Requirements
1-10 kg	100 ml/kg
11-20 kg	1000 ml + 50 ml/kg for each kg above 10 kg
>20 kg	1500 ml + 20 ml/kg for each kg above 20 kg

Reference: Meyers RS. Pediatric fluid and electrolyte therapy. The journal of pediatric pharmacology and therapeutics : JPPT : the official journal of PPAG. 2009;14(4):204-211. doi:https://doi.org/10.5863/1551-6776-14.4.204

Example: An infant weighing 6 kg (13.2 lbs) would need 600 ml or 20oz per day. This would typically come from the breast milk or infant formula. (Supplementation with water is not routinely needed.)

Table 3.6: Dietary Reference Intake (DRI) for Fluid

Age of Infant	Fluid Requirements
0 – 6 months	700 mls/day
7 – 12 months	800 mls/day

Reference: Dietary Reference Intakes for Energy. 2023. doi:https://doi.org/10.17226/26818

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CHAPTER 4

Breastfeeding considerations

The American Academy of Pediatrics (9th edition) recommends the use of human milk for premature and other high-risk infants either by direct breastfeeding and/or using the mother's own expressed milk.

> *"Fortified human milk from the infant's own mother is the ideal enteral feeding for the preterm infant. Human milk contains living cells including stem cells and many bioactive factors that contribute positively to the infant's health and development*."

Often significant progress in breastfeeding is made as premature babies reach 0-8 weeks Corrected Age (CA). The ability to breastfeed is multifactorial and includes milk supply, birth weight / gestational age, complexity of NICU course, and infant maturity. It is important to work with and support a mom to realize her own goals around breastfeeding and pumping. Providing any breastmilk can be considered a success for a mom of a premature baby and sometimes "exclusive" breastfeeding may need to be re-defined for this dyad.

In most cases, infants born < 2000 g have additional nutritional needs that last longer than infants born weighing > 2000 g. In general, the smaller the infant at birth, the higher their nutritional needs and the longer they may need fortification. More research needs to be done in this area before definitive guidelines can be given for post-discharge premature nutrition for the breastfed infant. The use of fortified mother's milk varies infant to infant and all infants need to be evaluated individually. It is important to note that exclusively breastfed babies who are gaining weight well, may or may not be consuming adequate calcium and phosphorus with unfortified breastmilk, therefore it may be important to check bone labs and monitor growth closely (refer to chapter 3).

Benefits of human milk for the preterm infant

- Whey-predominant protein
- Improved nutrient absorption, especially of fat, zinc, and iron
- Low renal solute load
- Increased omega-3 fatty acids (DHA & EPA)
- Presence of anti-infective factors
- Promotion of maternal-infant attachment

Barriers to breastfeeding

- Establishing and maintaining a milk supply
- Transition from bottle to breastfeeding
- Breastmilk fortification
- Psycho-social issues for the family

Benefits of fortification of human milk for preterm infants

- Improved weight gain
- Increased linear growth
- Normalization of serum calcium, phosphorus, and alkaline phosphatase
- Improved protein status
- Increased bone mineralization

Nutritional concerns of feeding unfortified human milk to preterm infants

- Slower growth rates
- Decreased bone mineralization and risk of osteopenia
- Nutrient deficits (can include protein, calcium, phosphorus, magnesium, sodium, copper, zinc, and vitamins B2, B6, C, D, E, K, and folic acid)

Guidelines for use of fortified human milk for preterm infants

- Infants born < 34 weeks gestation
- Infants < 2000 g at birth
- Infants on total parenteral nutrition (TPN) for > 4 weeks
- Infants who are at high risk for nutrition problems after discharge from a NICU (See pg. 3 for a list of risk factors)

Fortification of human milk

Fortification of human milk should be in the form of a multi-nutrient supplement, such as a powdered infant formula. Single-nutrient supplements (e.g. Beneprotein) do not meet the needs of premature infants and are not recommended. Examples of powdered formula used for fortification of breastmilk are EnfaCare or Neosure. If nutrient supplementation is indicated, powdered supplement can be added to breastmilk or formula bottles can be given in addition to breastfeeding.

Options for fortification of breastmilk

Breastfeeding or use of expressed maternal milk (EMM) is recommended when it is consistent with the family's goals and infant's ability. Maternal milk may need additional fortification depending upon on the infant's nutritional and biochemical status.

If the infant has limited breastfeeding ability:

- Fortify EMM offered by bottle at times when the baby is not directly breastfeeding.
- Decrease the use of fortified bottles as breastfeeding supply increases.

If the infant is breastfeeding well and mother has a good milk supply:

- Minimize fortification of EMM
- Concentration of EMM may be increased in order to maximize nutrition in a limited number of bottles. Bottles of EMM can be fortified to 22, 24, 27 and 30 kcal/oz.

Storage guidelines for pumped breastmilk

Preparation for breastmilk storage

- Wash hands before handling breast pump or breastmilk supplies.
- Breastmilk can be stored in glass or BPA-free plastic bottles, or special breastmilk storage bags.
- Use containers that have been washed in hot, soapy water, rinsed and air-dried.
- Storing milk in 2-4 ounce amounts may reduce waste.
- All milk containers should be dated before storing in the refrigerator or freezer.

Storing breastmilk in the refrigerator or freezer

- Breastmilk contains live cells which have anti-infective properties to prevent illness. Storing breastmilk alters these properties slightly with refrigerated milk having more anti-infective properties than frozen milk.
- Store milk in the back of the refrigerator or freezer, not on the shelves of the door.
- When freezing milk, leave some room (about 1 inch) on top of container to allow for expansion.
- Freshly pumped milk should be chilled before adding it to a bottle of refrigerated milk.

Tips for thawing and warming milk

- Thaw frozen milk in the refrigerator overnight.
- Warm up refrigerated milk under warm running water or by setting it in a container of warm water.
- Never put breastmilk in the microwave since it may lose some of the beneficial properties of human milk and may cause hot spots.
- Use thawed breastmilk within 24 hours. Never refreeze thawed breastmilk.
- Stored milk will separate into layers. Swirl a warmed bottle to mix the layers.
- It is normal for pumped milk to vary in color, consistency & scent depending on the mother's diet.
- Rarely, previously frozen milk that has been thawed may smell or taste soapy and/or smell rancid. This milk is safe and most babies will continue to drink it. Some women have milk high in an enzyme called lipase which causes the breakdown of the milk fats (lipolysis). To prevent this, before freezing lots of milk, freeze a batch or two and then thaw it. If the milk smells or if a baby refuses it, future batches can be heated to scalding (~180 degrees F) after expression, then quickly cooled and frozen which deactivates the lipase enzyme.

Food safety

- Expressed breastmilk can be kept in a common refrigerator at the workplace or in a day care center. The US Centers for Disease Control (CDC) and the US Occupational Safety and Health Administration (OSHA) agree that human milk is not among the body fluids that require special handling or storage in a separate refrigerator.
- It is not known whether breastmilk that is left in the bottle after a feeding can be safely kept until the next feeding or if it should be discarded. It is generally recommended to discard one to two hours after the feeding.

Table 4.1: Breastmilk Storage Guidelines (without fortification added)

Breastmilk Storage Guidelines (without fortification added)					
	Room Temperature	**Cooler with Ice Packs**	**Refrigerator**	**Freezer compartment of a refrigerator**	**Freezer**
Storage Temperature Ranges	68-77° F (20-25° C)	59° F (15° C)	≤39° F (≤4° C)	<0° F (-18° C)	≤-4° F (-20° C)
Freshly expressed breastmilk	≤4 hours*	24 hours	48 days*	3-6 months	6-12 months
Thawed breastmilk (previously frozen)	Do not store	Do not store	24 hours	Never refreeze thawed milk	Never refreeze thawed milk

* The longer storage guidelines may be used with clean expressed breastmilk that has been pumped under strict handling guidelines.

References: Steele C, Collins EA, American Dietetic Association. Pediatric Nutrition Practice Group. *Infant and Pediatric Feedings : Guidelines for Preparation of Human Milk and Formula in Health Care Facilities*. Academy Of Nutrition And Dietetics; 2019.

Table 4.2: Fortified Breastmilk Storage Guidelines

Refrigeration	Store at ≤39° F (≤4° C) no longer than 24 hours
Room temperature	Do not store
After feeding begins	Feed within 1 hour or discard immediately. Do not re-refrigerate left over milk for later.

References: Steele C, Collins EA, American Dietetic Association. Pediatric Nutrition Practice Group. *Infant and Pediatric Feedings : Guidelines for Preparation of Human Milk and Formula in Health Care Facilities*. Academy Of Nutrition And Dietetics; 2019.

Pumping and maintaining milk supply for the preterm infant

Guidelines for initiating and maintaining milk supply with a preterm infant

- Use hand expression and compression along with pumping for at least the first 2 weeks post-partum. (see the Benefits of Hand Expression below).

- Pump with a double electric hospital grade pump for about 10-20 minutes per pumping and/or at least 2 minutes after last drop of breastmilk.
- Empty breasts at every pumping.
- For the first 2-3 weeks after birth, pump at least every 3 hours and one time per night (not to exceed 4-5 hours between pumpings).
- Pump ~7-10 times/day while establishing milk supply.
- If adequate milk supply after the first 2-3 weeks post-partum, time between pumping may be extended to every 4 hours and one time per night (not to exceed 5 hrs).
- Pump ~6-8 times/day after milk supply has been established.
- A mother of a premature infant should be able to pump 300 ml/day by the end of the first week and a minimum of 600 ml/day by the end of the second week. If these goals are not met, there could be issues with the mother's milk supply and she should talk with a lactation consultant.

Benefits of hand expression

Mothers of preterm infants are able to express twice as much breastmilk with hand expression and pumping combined compared to pumping alone. A mother's hands can compress her breast at the same time she is pumping or off and on during a pumping session rotating between manual compressions and using the electric pump. Colostrum is much more effectively expressed by hand than by pump. Most preterm infants start on very small volumes of colostrum to prime the gut and hand expression can meet this need effectively.

Videos demonstrating hand expression:

- Maximizing milk supply with hands on pumping
  https://med.stanford.edu/newborns/professional-education/breastfeeding/maximizing-milk-production.html

- Hand expression
  https://med.stanford.edu/newborns/professional-education/breastfeeding/hand-expressing-milk.html

Types of breast pumps

When a mother is dependent on a pump to establish or maintain her milk supply, it is important to assess which pump is most appropriate for the pumping mother's needs. Refer to the chart at the end of this chapter to differentiate between the most popular pumps on the market and what need they serve. There are small differences in each of the pumps in the categories listed, such as: 2-phase pumping, memory cards, battery packs or car adapters, multiple sizes of breast shields/flanges, hands-free, and some are silent.

Breast pumps range in price considerably. Manual pumps can cost around $20-$ 60 and personal double electric pumps can range from $200-$300. Most hospital grade pumps are rented at a rate of $45-$80 per month, in addition to a one-time kit fee which costs about $30- $50. Breast pumps are a big investment, but will pay off very quickly. For more information on locating retailers that sell and rent breast pumps and parts, visit https://breastfeedingsupply.com/en/ (Medela) or http://ameda.com/product_locator/ (Ameda).

Ways to increase milk supply

- Increase skin-to-skin contact.
- Ensure the most optimal pump and/or flange size is being used. (Flange size can vary throughout the breastfeeding process and may need to be re-evaluated).
- Increase frequency of pumping, up to 10 times per day.
- Use breast massage and/or breast compression in addition to pumping
- If the infant is transitioning to the breast, make sure the mother is continuing to pump after breastfeeding until the infant is able to empty the breast completely. Usually a mother will need to continue to pump after breastfeeding until the infant is 40-48 weeks gestational age.
- Try cluster pumping:
  - Pump, nurse, pump every half-hour to hour for several hours.
- Try power pumping:
  - Pump for 10 min, rest for 10 min and repeat for 60 minutes, 1-2 times /day.
  - Pump every 2 hours during waking hours for 1 full day.
- Ensure adequate fluid intake.
- Discuss the use of galactagogues with a lactation consultant.
- Discuss possible ways to deal with and decrease stress/tension while pumping (music, reading a book or magazine, watching TV).

Resources for maternal drugs and breastmilk

Most medications are safe while breastfeeding, while some are not. New research regarding medications and breastfeeding is published frequently and it is hard to keep up to date. Here is a list of the most current information regarding medications and breastfeeding:

- Dr. Hale's book, *Medication and Mother's Milk*. This book is considered by many people to be the most complete and authoritative resource. It includes some drugs not reviewed by the AAP. This book also lists the AAP's rating on each drug which AAP has reviewed.
- National Institute of Health, U.S. National Library of Medicine, Drugs and Lactation Database (LactMed). LactMed discusses medications and other chemicals in detail and discusses the research known about each drug. Drugs listed are mostly represented by their generic names. Where appropriate, the database also provides therapeutic alternatives to the drugs outlined.
  https://www.ncbi.nlm.nih.gov/books/NBK501922/
- AAP's publication discussing the transfer of drugs and other chemicals into human milk. The AAP list is extensive, but is not a complete list of every drug. If a drug is not listed, it does not mean it's not safe, only that it was not reviewed yet by AAP.
  https://publications.aap.org/pediatrics/article/132/3/e796/31630/The-Transfer-of-Drugs-and-Therapeutics-Into-Human
- Infant Risk Center at Texas Tech University Health Sciences Center. Call with questions Monday-Friday 8am-5pm CT (806)-352-2519 www.infantrisk.com

Table 4.3: Types of Breast Pumps

Type	Reasons for Use	Examples/Brands
Convenience	*For occasional separation from infant:* ● Missed Feeding ● Evening out ● Weekend away ● Very part-time work	*Manual Pumps:* ● Medela Harmony ● Medela Base ● Philips Avent Manual Pump ● Ameda One-Hand Manual Pump ● Hygeia Manual Pump *Single Electric Pumps:* ● Medela Mini Electric ● Medela Swing ● Zomee (provided by WA WIC, single/double) *Double Electric Pumps:* ● Medela Mini Electric ● Willow ● Momcozy ● Motif (single/double)
Work or School (Long-term use)	*For routine mother-infant separation:* ● Work ● School ● Preterm or Special Needs Infant (once milk supply is well established)	*Personal Use Double Electric Pumps:* ● Medela Pump In Style Advanced ● Medela Hands-Free Freestyle ● Philips Avent Twin Electric ● Ameda Purely Yours ● Hygeia EnJoye
Medical Need (Short or Long Term Use)	*For frequent use:* ● To establish or increase milk supply *Examples:* ● Premature infant ● Hospitalized ill infant ● Twins or multiples ● Severe recurrent engorgement ● Breast surgery	*Hospital-Grade Double Electric Pumps:* ● Medela Lactina ● Medela Symphony ● Ameda Elite ● Hygeia EnDeare

Banked human milk

Banked human milk vs. Donor human milk
Human milk is the gold standard food for infants, including premature and sick newborns. When a low birth weight premature infant's own mother's milk is not available or is insufficient in volume during hospitalization, banked (pasteurized) human milk is the next best option.

Banked human milk for low birth weight premature infants has been proven to reduce the incidence of necrotizing enterocolitis (NEC), sepsis, infection and feeding intolerances resulting in shorter hospital stays (Academy of Breastfeeding Medicine, 2010). Banked milk can provide many of the components and benefits of breastmilk while eliminating the risk of transmission of infectious agents from non-banked human milk. Pasteurization does affect some of the nutritional and immunologic components of breastmilk, but many immunoglobulins, enzymes, hormones, and growth factors are unchanged or minimally decreased (AAP & Committee on Drugs, 2001). Once out of the hospital, banked breastmilk is a costly option, at $5.00 per ounce (Northwest Milk Bank). In order to receive banked breastmilk after discharge, a family would need a **prescriptio**n from their pediatrician and would need to call a human milk bank to purchase it (See appendix for prescription form).

High cost and demand have caused some families to look to friends, family members, and the internet to find donated breastmilk. Although breastmilk is the perfect food for infants, human milk from unscreened donors can be contaminated with bacteria and viruses (such as HIV and HBV), chemical contaminants (such as illegal drugs), and a limited number of prescription drugs (AAP & the Section on Breastfeeding, 2005). If breastmilk is not handled and stored properly it could also become contaminated and would be unsafe to drink.

Human Milk Banking Association of North America (HMBANA) is a multidisciplinary group of health care providers that promote, protect, and support human milk banks. HMBANA, in advisement from the CDC and FDA, has developed guidelines for screening, processing, and dispensing human milk. Donated milk is tested for bacteria and levels of nutrients (calories, fat, protein, lactose), and is then pasteurized to kill any bacteria or viruses. Most milk banks may offer many varieties of pasteurized milk including colostrum, preterm milk, term milk and dairy-free milk.

More and more mothers are donating their milk to family, friends and people they have found on the internet thinking that they are helping another infant who would otherwise be fed formula. Although this is a valid stance, the national milk banks are not receiving the human milk donations from these healthy mothers that the milk bank could pasteurize to support the ever increasing demand for the most at risk infants, including premature infants. If a lactating mother has an overabundance of breastmilk, please recommend that she consider donating her breastmilk to a human milk bank.

See appendix for donor milk prescription form.

Human milk banks - Oregon

Northwest Mothers Milk Bank
417 SW 117th Ave. Suite 105
Portland, OR 97225
Phone: 503-469-0955
Fax:503-469-0962
Website: www.nwmmb.org (see website for listing of donor depot drop-off sites)

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CHAPTER 5
Breastmilk, formula and fortification

Human Milk Recommendation

The American Academy of Pediatrics (AAP) strongly recommends breastfeeding or breastmilk as the preferred method of feeding for all infants, including preterm infants. Breastmilk is the gold standard for infant nutrition due to the unique combination of nutrients, enzymes, hormones and immunological components. Breastmilk is recommended until 1 year corrected age and thereafter as long as mutually desired by mother and infant. If breastmilk is not available, iron-fortified infant formulas should be given until 1 year corrected age.

Formula Information and Descriptions

Additional feeding considerations for premature infants

- *Standard Term & Specialized Term Formulas:* Commercially prepared formulas are always the safest option for premature infants. These formulas are designed for babies born at term and thus have **less calcium, phosphorus, and protein t**han premature transitional formulas.. If preterm infants are given these formulas, they should be followed more closely by a dietitian and the appropriate labs should be checked.
- *Soy-based formulas* are **NOT** recommended for preterm infants. Preterm infants receiving soy formula have suboptimal carbohydrate and mineral absorption and utilization than cow's milk-based formula. The American Academy of Pediatrics (AAP) does not recommend soy formula for infants born < 1800 g (4 lbs.) since preterm infants fed soy-based formula showed significantly less weight gain, less linear growth, and lower serum albumin levels than those infants receiving cow's milk-based formulas. Studies also have shown lower levels of markers for bone formation in the premature population which can lead to osteopenia.
- *Goat's milk* is **NOT** recommended for preterm infants. Goat's milk is deficient in folic acid and vitamin B6. It is also higher in protein than human milk and infant formula which puts the premature infant at risk for dehydration due to the higher renal solute load.

Table 5.1: Human Milk

Human Milk	
Breastmilk is considered the gold standard for infant nutrition due to the unique combination of nutrients, enzymes, hormones and immunological components. Preterm milk is higher in calories and protein than term milk for the first two to four weeks, however, it is usually not sufficient enough in protein and other nutrients to support the intrauterine growth rates in very low and extremely low birth weight preterm infants without fortification in the first 3-6 months of life.	
● Human breastmilk	~ 20 calories per ounce
Donor Human Milk	
Donor human milk is used in many NICUs when a baby's own mother's milk is not available. Pasteurized donor milk for premature and high risk infants has been shown to reduce the	

incidence of necrotizing enterocolitis (NEC), sepsis and infection resulting in shorter hospital stays. Donor milk is prioritized for the smallest and most critically ill infants.	
● Donor human milk	~ 20 calories per ounce

Table 5.2: Human Milk Fortifiers and Preterm Formulas

Human Milk Fortifiers		
Indication: Commercial Human milk fortifiers (HMF) and preterm formulas are designed for rapidly growing preterm infants born less than 2000 grams (4 1/2 lbs) needing increased protein, vitamins, minerals and calories. *Contraindication:* Preterm infants taking >500ml/day, or full term and failure to thrive infants due to hypervitaminosis & hypercalcemia. *Note:* Infants are rarely discharged home on HMF. Prolonged use is associated with vitamin D & vitamin A toxicity & may exceed renal solute load if intake > 500 ml per day. Liver function test should be monitored for impairment along with copper deficiency.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Human Milk Fortifier (liquid)	Mead Johnson	
Enfamil Human Milk Fortifier (powder)	Mead Johnson	
Similac Human Milk Fortifier (powder)	Abbott	
Similac Special Care Advance 30, liquid	Abbott	Preterm formula also approved for use as a human milk fortifier
Prolact+ H2MF, liquid	Prolacta Bio-science	Made from 100% concentrated human milk with added minerals
Preterm Formulas for In-Hospital Use		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Premature 20, 24, & 30	Mead Johnson	
Enfamil Premature 20, 24 Low Iron	Mead Johnson	
Enfamil Premature 24 High Protein	Mead Johnson	
Good Start Premature 20, 24	Gerber	100% whey, partially hydrolyzed proteins
Good Start Premature 24 High Protein	Gerber	100% whey, partially hydrolyzed proteins
Similac Special Care Advance 20, 24 & 30	Abbott	
Similac Special Care High Protein 24	Abbott	

Post-Discharge Premature Formula (or Transitional Formula)		
Designed to provide additional protein, minerals and vitamins needed by the preterm infant after discharge from the NICU. Provides 22 calories/oz with standard preparation. *Indications:* Birthweight <2000g and/or <34 weeks gestational age at birth. May be used to fortify or supplement breastmilk feedings. May be used until 1 year corrected age. *Contraindications:* Full term or failure to thrive infants due to hypervitaminosis and hypercalcemia.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Enfacare, powder	Mead Johnson	20% MCT oil, 65% lactose
Enfamil Enfacare, RTU	Mead Johnson	20% MCT oil, 40% lactose
Good Start Nourish	Gerber	100% whey, partially hydrolyzed proteins, 20% MCT, 60% lactose
Similac Expert Care Neosure	Abbott	25% MCT oil, 50% lactose, added lutein

Table 5.3: Term Formulas

Standard Milk-Based Formula		
Indications: Infants >34 weeks and >2000 grams with no special nutritional needs. *Protein source:* Intact cow's milk proteins casein and whey modeled after human milk to aid in absorption. *Note:* Higher levels of nutrients are included in infant formulas because they are less well absorbed than those in breastmilk. Most have added DHA and ARA. Some have added prebiotics. Provides 20 kcal/oz with standard preparation.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Premium Infant	Mead Johnson	Added prebiotic Galactooligosaccharides (GOS), Polydextrose (PDX)
Good Start Gentle	Gerber	100% whey, partially hydrolyzed proteins, 70% lactose added prebiotic GOS
Good Start Protect	Gerber	100% whey, partially hydrolyzed proteins, added probiotic Bifidobacterium lactis (B. Lactis)
Similac Advance	Abbott	Added prebiotic GOS, lutein
Various store brands of infant formulas	Wyeth	Varies

Reduced or No Lactose Formula		
Indications: Lactose sensitivity, GI upset or constipation. *Contraindications:* galactosemia *Protein Source:* cow's milk proteins: casein and whey Provides 20 kcal/oz with standard preparation.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Gentlease	Mead Johnson	Partially hydrolyzed proteins, 20% lactose
Good Start Soothe	Gerber	100% whey, partially hydrolyzed proteins, 30% lactose, added probiotic: L. Reuteri
Similac Sensitive for Fussiness and Gas	Abbott	Trace amount of lactose (2%) derived from added prebiotic GOS
Similac Total Comfort	Abbott	Trace amount of lactose (2%) derived from added prebiotic GOS, 100% whey, partially hydrolyzed proteins.

Partially Hydrolyzed Protein Formulas		
These are not true hypoallergenic formulas, but are more available and less expensive than fully hydrolyzed formulas. *Indications:* GI upset, constipation. *Contraindication:* Known cow's milk protein allergy. *Protein source*: Cow's milk proteins, casein & whey, are partially hydrolyzed to small peptides. Provides 20 kcal/oz with standard preparation.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Gentlease	Mead Johnson	20% lactose
Good Start Gentle	Gerber	100% whey, 70% lactose, added prebiotic: GOS
Good Start Protect	Gerber	100% whey, added probiotic (B. Lactis)
Similac Total Comfort	Abbott	Trace amount of lactose (2%) derived from added prebiotic GOS, 100% whey, partially hydrolyzed proteins.

Extensively Hydrolyzed Protein Formulas		
Hypoallergenic; lactose, sucrose free. *Indications*: Intact cow's milk protein and soy protein allergy, intractable diarrhea, multiple food allergies, lactose and sucrose intolerance. *Protein source*: Cow's milk protein hydrolyzed to small peptides and supplemented with amino acids Provides 20 kcal/oz with standard preparation.		
Product Name	**Manufacturer**	**Product characteristics**
Nutramigen with Enflora LGG (powder only)	Mead Johnson	With added probiotic: Lactobacillus rhamnosus GG (LGG) Use level, **packed** scoops. Use cool water & do not warm *Additional indications:* galactosemia
Nutramigen RTU	Mead Johnson	Not indicated for galactosemia
Pregestimil, powder	Mead Johnson	Use level, **packed** scoops. 55% MCT oil. *Additional indications*: carbohydrate/fat malabsorption, cystic fibrosis, pancreatic insufficiency, short gut, GI immaturity, celiac disease and cholestasis, galactosemia
Pregestimil, RTU	Mead Johnson	Not indicated for galactosemia
Similac Expert Care Alimentum	Abbott	33% MCT oil. *Additional indications:* carbohydrate/fat malabsorption, cystic fibrosis, pancreatic insufficiency, short gut & GI immaturity.
Similac Expert Care Alimentum, RTU	Abbott	Corn free

Free Amino Acid Elemental Formulas

Hypoallergenic; lactose & galactose free.
Indications: Cow and soy milk protein allergy, multiple food protein intolerance, GERD, short bowel syndrome, malabsorption, eosinophilic esophagitis, and galactosemia.
Protein source: Synthetic free amino acids
Note: Formulas have limited retail availability and are expensive.
Provides 20 kcal/oz with standard preparation.

Product Name	Manufacturer	Product characteristics
Elecare	Abbott	33% MCT oil
Neocate Infant	Nutricia	33% MCT oil Mixing ratio differs from standard infant formula; refer to manufacturer's instructions
PurAmino (formerly Nutramigen AA)	Mead Johnson	33% MCT oil Mixing ratio differs from standard infant formula; refer to manufacturer's instructions.
Alfamino	Nestle	43% MCT oil Mixing ratio differs from standard infant formula; refer to manufacturer's instructions

Low Mineral Feeding Options

Human Milk is the ideal option when an infant is renal compromised since breastmilk is naturally low in minerals due to its higher absorption rate.
Indications: Lower minerals for impaired renal function, neonatal hypocalcemia.
Precaution: Additional iron may be needed.

Product Name	Manufacturer	Product characteristics
Similac PM 60/40	Abbott	Lower in Calcium, Phosphorus, Potassium to support renal function

Thickened Formulas

Contain rice starch which thickens upon entering the stomach. Viscosity in the bottle is 10 times that of routine formula, yet flows freely through a standard nipple. These formulas are nutritionally balanced compared to adding infant cereal to formula. Provides 20 kcal/oz with standard preparation.

Indications: Uncomplicated GERD
Contraindications: **Premature infants <38 weeks gestational age** due to the risk of the formation of lactobezoars (hard clumps of undigested milk curds).
Protein source: Intact cow's milk proteins.

Note: Decreased efficacy when used with proton pump inhibitor medications (e.g.Prilosec, Prevacid, etc). *Special Instructions:* Allow theses formulas to sit 5 minutes before feeding and immediately discard unused formulas. Do not mix formula >24 kcal/oz due to increased viscosity.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil A.R.	Mead Johnson	Trace amount of lactose derived from added prebiotic GOS, Polydextrose (Pdx)
Similac for Spit-Up	Abbott	Trace amount of lactose (0.2%) derived from added prebiotic GOS, added lutein

Soy-Based Formulas		
Indications: Vegan diets. *Contraindications*: **Premature infants**, infants with cow's milk protein-induced enteropathy, or for the management of colic or constipation. *Protein source*: Soy protein isolates *Note*: Lactose-free. Provides 20 kcal/oz with standard preparation.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Prosobee	Mead Johnson	Additional indication: galactosemia (powder only, not liquid)
Good Start Soy	Gerber	
Similac Soy Isomil	Abbott	Added prebiotic, FOS Additional indication: galactosemia

Developing a formula recipe

The example below demonstrates a method for developing a recipe. It's important to take into consideration the displacement factor when adjusting recipes. The displacement factor is the amount of fluid which is displaced when a powder is added to a liquid. In this case the formula is Similac Advance. The displacement factor is 0.77 ml/gram, weight is 8.7 gm per scoop and 100 gm per cup, calories equal 5.12 calories per gram.

Formula companies frequently reformulate their products which can result in a change in calories per gram, displacement factor, etc. As new products become available, consult the manufacturer to obtain correct data to develop recipes in the concentration and volume appropriate for your patients. Formula information from the manufacturer of Similac Advance is current as of time of publication.

Example:
Goal: 6 oz of 22 cal/oz formula

	Calories	ml
3 scoops (26.1 gm)	133.6	20
5.5 oz water		165
Total volume		185 (6.1 oz)

This recipe provides 21.9 calories per ounce

To calculate this recipe, use the following steps:

1. Assume the amount of water in the recipe will be less than the final volume due to the displacement factor of the powdered formula.
2. At 8.7 gm/scoop, 3 scoops of Similac Advance = 26.1 gm
3. Multiply grams of formula x calories per gram (26.1 gm x 5.12 = 133.6 calories)
4. Multiply grams of formula x displacement factor to get volume created by the powdered formula (26.1 gm x 0.77 ml/gm = 20 ml)
5. Add ml from powdered formula plus the water to get total volume (185 ml)
6. Divide total volume by 30 to convert volume to ounces (185 divided by 30 = 6.1 oz)
7. Divide total calories by ounces to get cal/oz (133.6 divided by 6.1 = 21.9 cal/oz)

Note: Although recipes may be the same for 2 brands of formula at 20 or 22 calories per ounce in a small volume, the recipes differ at more concentrated levels and at greater volumes due to variances in displacement factor, etc.

Updated information regarding calories per gram, displacement factor, etc can be obtained from the formula manufacturers:
http://www.abbottnutrition.com
http://www.enfamilprofessional.com
http://www.medical.gerber.com
HYPERLINK "http://www.nutricia.com/"
http://www.nutricia.com

Formula preparation and storage guidelines

1. **Cleaning and sterilization of feeding and preparation equipment (WHO guidelines)**
    - Hands should always be washed thoroughly with soap and water before cleaning and sterilizing feeding and preparation equipment (as described below).
    - Cleaning: wash feeding and preparation equipment (e.g. cups, bottles, teats and spoons) thoroughly in hot soapy water. Where feeding bottles are used, clean bottle and teat brushes should be used to scrub inside and outside of bottles and teats to ensure that all remaining feed is removed.
    - After washing the feeding and preparation equipment, rinse thoroughly in safe water.
    - Sterilizing:
        i. Fill a large pan with water and completely submerge all washed feeding and preparation equipment, ensuring that there are no trapped air bubbles
        ii. Cover the pan with a lid and bring to a rolling boil, making sure the pan does not boil dry; and keep pan covered until the feeding
        iii. Hands should be washed thoroughly with soap and water before removing feeding and preparation equipment from a sterilizer or pan
2. **Preparing a formula feed**
    - Clean and disinfect a surface on which to prepare the feed.
    - Wash hands with soap and water, and dry using a clean cloth or a single-use napkin.
    - Boil a sufficient volume of safe water. If using an automatic kettle, wait until the kettle switches off; otherwise make sure that the water comes to a rolling boil. Note: bottled water is not sterile and must be boiled before use. Microwave ovens should never be used in the preparation of infant formula as uneven heating may result in 'hot spots' that can scald the infant's mouth.
    - Taking care to avoid scalds, pour the appropriate amount of boiled water, which has been allowed to cool slightly, but not below 70 °C (158 °F), into a cleaned and sterilized feeding cup or bottle. The temperature of the water should be checked using a sterile thermometer.
        i. If making a batch in a larger container: the container should have been cleaned and sterilized. It should be no larger than 1 liter, be made from food-grade material and be suitable for pouring hot liquids.
    - To the water, add the exact amount of formula as instructed on the label. Adding more or less powder than instructed could make infants ill.
        i. If using feeding bottles: assemble the cleaned and sterilized parts of the bottle according to the manufacturer's instructions. Shake or swirl gently until the contents are mixed thoroughly, taking care to avoid scalds.
        ii. If using feeding cups: mix thoroughly by stirring with a cleaned and sterilized spoon, taking care to avoid scalds.

iii. If preparing a batch in a larger container: stir formula using a cleaned and sterilized spoon to ensure even mixing. Immediately pour into individual feeding cups or bottles, taking care to avoid scalds.

- Cool feeds quickly to feeding temperature by holding under a running tap, or placing in a container of cold water or iced water. Ensure that the level of the cooling water is below the top of the feeding cup or the lid of the bottle.
- Dry the outside of the feeding cup or bottle with a clean or disposable cloth and label with appropriate information, such as type of formula, infant's name, time and date prepared, and preparer's name.
- Because very hot water has been used to prepare the feed, it is essential that the feeding temperature is checked before feeding in order to avoid scalding the infant's mouth. If necessary, continue cooling as outlined above.
- Discard any feed that has not been consumed within two hours.

Use a Safe Drinking Water Source

- City water is considered safe.
- If using well water, it is best to boil the water or purchase bottled water.
- When boiling water, bring water to a boil for one minute and allow to cool before use. Boiling water for more than one minute will concentrate minerals in the water.
- If there are concerns with lead in the water, run cold water for 1-2 minutes before filling up bottle to decrease the amount of lead in the water.
- When buying bottled water, use fluoride-free water until 6 months of age.
- Although formula itself has low amounts of fluoride, when infant formula is mixed with fluoridated water and used as the primary source of nutrition, it may introduce fluoride at levels above the amount recommended which may lead to fluorosis. Proportional to body weight, fluoride intake from liquids is generally higher for younger, smaller infants.
- Well water: It is not recommended to use well water for mixing infant formula as it is not regulated for safety by federal or state governments. Well water can be polluted by many substances, such as nitrates, which can cause severe poisoning in infants and cannot be removed by boiling the water beforehand.
- Discuss best source of water with your healthcare professional.

Table 5.4: Storage Instructions for Fortified Breastmilk and Prepared Formula

Refrigeration	Prepared from powder: Store at 35 – 40° F (2 – 4° C) no longer than 24 hours
	Prepared from concentrate or ready-to-use: Store at 35 – 40° F (2 – 4° C) no longer than 48 hours
Room Temperature	Prepared from powder, ready-to-use, or concentrate: Keep no longer than a total of 2-4 hours*; If bottle is warmed, discard after 1 hour
After feeding begins	Prepared from powder, ready-to-use, or concentrate: Feed within 1 hour or discard immediately; do not refrigerate for later.
Thawed, Previously Frozen Human Milk	1–2 Hours at room temperature, up to 1 Day (24 hours) in refrigerator. NEVER refreeze human milk after it has been thawed
Leftover from a Feeding (baby didn't finish bottle	Use within 2 hours after the baby is finished feeding

*Editors recommend limiting the length of time formula is kept at room temperature to 2 hours or per manufacturer's instructions

Source: ADA Infant Feedings: Guidelines for Preparation of Formula and Breastmilk in Health Care Facilities 2011, Mead Johnson Nutritionals "Instructions for Safe Infant Formula Preparation, Storage and Use" 2010.

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CHAPTER 6

Nutritional interventions for preterm infants post-discharge

Nutritional interventions for preterm infants post-discharge involve careful management to support growth while addressing common challenges. For constipation, ensuring adequate fluid intake and considering the impact of vitamin/ mineral supplementation-can help. Formula selection is critical, with options like hydrolyzed or partially hydrolyzed formulas potentially beneficial for infants with digestive sensitivities. Managing reflux may involve using thickened formulas or feeding smaller, more frequent meals. Additionally, monitoring and adjusting caloric intake is essential to prevent growth faltering while also avoiding excessive growth, which can lead to future health complications. These tailored interventions aim to balance nutrition while mitigating common post-discharge complications in preterm infants.In this chapter you will find some common barriers or complications in feeding preterm infants post-discharge with recommendations for addressing these concerns.

Constipation in the preterm infant

Constipation is defined as stools that are dry, hard and are difficult to pass independent of frequency.

Reasons causing increased rate of constipation with premature infants:

- Immature gastrointestinal motility.
- Medications (calcium, iron, diuretics)
- Inadequate fluid intake due to fluid restriction or poor fluid intake.
- Increased use of nutrient/caloric-dense formulas (22-30 kcal/oz).
- Improper formula preparations.
- Using packed or heaping scoops instead of unpacked and level scoops.
- Incorrectly using a measuring device to add supplemental formula to expressed breastmilk.
- Transitioning from breastmilk to formula.
- Early introduction of cereals in bottle or by spoon.
- Certain metabolic, endocrine & muscular disorders.

Possible ways to treat constipation:

1. Maximize the amount of breastmilk the infant is receiving by assisting the mom with lactation support.
2. Always make sure the formula is prepared properly.
3. Try a warm bath, infant massage, or recumbent bicycle movement with infant's legs which may stimulate peristalsis.
4. Iron supplements:

- Many believe that constipation may be a side effect of iron supplements; however, there have been studies to prove that iron-fortified formulas do not cause constipation.
- Iron is very important for growth and development of the preterm infant. Most preterm infants are discharged on a multivitamin with iron or an iron supplement since their volume of formula doesn't support their iron needs.
- If the family feels strongly about iron supplements causing constipation, it may be beneficial to check a hematocrit on a preterm infant with constipation. If the hematocrit level is normal & the infant is meeting their iron needs through formula, may consider discontinuing iron supplementation or switching to a multivitamin without iron. There's also evidence that intermittent supplementation, i.e. every other day, may improve absorption and decrease side effects. Would also suggest trying different formulations of iron, such as polysaccharide-iron, which evidence suggests may have less GI side effects.

5. Initiation of prune or pear juice:

- If the infant is greater than 40 weeks (term age), may start small amounts of diluted juice.
    - Mix ½ oz prune, pear or white grape juice with ½ oz of water.
    - Start by giving 1 oz of diluted juice every other day. Increase to 1 oz per day of diluted juice if needed. If still constipated, may increase to a maximum of 2-3 oz full-strength juice every day.
- Although juice is not recommended by the AAP until 6 months of age, juice may be an effective and inexpensive alternative used to treat constipation in smaller premature infants who would benefit from long-term use of a transitional formula. Always consult with a healthcare professional prior to starting juice.

6. If infant is taking a transitional formula prepared to >24 kcal/oz:
   - Decrease from 27 kcal/oz to 24 kcal/oz.
   - Decrease from 24 kcal/oz to 22 kcal/oz.
   - Always check weight gain/intake frequently after making a feeding plan change.
7. If infant's birth weight was >3 ½ pounds (1500g) and if baby is: 1) gaining weight well, 2) consuming a good volume, and 3) nutritional needs are met; consider:
   - Discontinue fortifier in breastmilk & offer 100% breastmilk or as much breastmilk as possible.
   - If there is not enough breastmilk, and the infant is on a post-discharge formula, consider transitioning from a post-discharge formula to a standard term or partially hydrolyzed formula. Partially hydrolyzed or lactose reduced formulas may work better to decrease constipation, along with concentrate or ready-to-feed formulas.
   - Always check weight gain/intake frequently (once a week for 2-4 weeks) after making a change to the feeding plan.
8. If infant's birth weight was < 3 ½ pounds (1500g) and is currently < 3 months corrected age
   - Consider talking with a pediatric dietitian who is familiar with premature infants before making any changes with the infant's feeding plan.
   - Check bone labs to determine bone mineralization status (see chapter 3).
     - If labs are within the normal range AND infant has good growth, may consider discontinuing the fortifier and offer 100% breastmilk or switching to a term formula. (Similac Sensitive and Enfamil Gentlease have the highest amounts of calcium & phosphorus which would be beneficial to the preterm infant). Check weight in 2 weeks AND recheck bone labs in 4-6 weeks; adjust plan if necessary.
     - If labs are outside of reference range, continue with the transitional formula and consider using another method to treat the infant's constipation.
9. If none of the above options are helping to prevent constipation, discuss the use of stool softeners with the infant's healthcare provider or refer to peds GI

Potentially harmful ways to treat constipation:

- Corn syrup
  - It may cause a rare but serious form of food poisoning known as infant botulism.
  - Today's commercially prepared dark corn syrup may not contain the type of chemical structure that draws fluid into the intestine and softens the stool making it ineffective for infant constipation.
- Mineral oil
  - It is a tasteless, indigestible liquid that is poorly absorbed from the GI tract. It softens the stool by decreasing the reabsorption of water from the intestines.
  - It is not appropriate for infants since an infant may not produce a protective cough reflex due to immature swallowing skills which may lead to mineral oil aspiration or lipoid pneumonia and/or gastroesophageal reflux.
- Excess Water/Overdiluting the formula
  - Overdiluting the formula may cause under nutrition.
  - Too much water dilutes infants' normal sodium levels and can lead to seizures, coma, brain damage and death.
- Excessive or early introduction of juice

- Juice may be associated with malnutrition (over/undernutrition) and may be associated with diarrhea, flatulence, abdominal distention, and tooth decay.
- The American Academy of Pediatrics (AAP) does not recommend juice until 6 months of age.

- Frequent suppository use
  - Overuse of suppositories or anything that induces a bowel movement can weaken the smooth muscle tissue of the infant's bowels and disrupt the normal rhythm.
  - By overusing suppositories the infant may not learn how to relax the anal sphincter which is important to produce an effective bowel movement.

Reflux in the preterm infant

In preterm infants, gastroesophageal reflux (GER) primarily occurs due to transient lower esophageal sphincter relaxation where the lower esophageal sphincter briefly loses pressure, allowing stomach contents to flow back into the esophagus. This is a common and normal phenomenon in preterm infants, often worsened by their liquid diet and certain body positions. The presence of a gastric tube can further increase reflux episodes by interfering with lower esophageal sphincter closure. While delayed gastric emptying does not contribute to reflux in these infants, reflux is more frequent after feeding due to stomach distension. Body position also plays a role, with reflux being more likely when infants are placed on their right side after feeding. The esophagus and airway are generally protected from GER by reflex actions, but if refluxed material reaches the upper esophagus, it can lead to spitting up or vomiting, which is commonly observed in these infants.

Possible Interventions and Considerations for Treating Reflux

- Smaller Feeds
  - Smaller volume, more frequent (q 2-3 hrs) feeds have been shown to reduce overall reflux episodes. Feeds given over a longer duration and slower milk flow rates are also associated with less episodes.
- Partially hydrolyzed/Extensively hydrolyzed /Amino Acid based formulas
  - Broken down formulas have been shown decrease observed regurgitation but not the number of reflux episodes
  - Extensively hydrolyzed and amino acid based formulas have been shown to reduce reflux episodes in infants allergic to cows milk protein
- Breastfeeding
  - Removing immunogenic foods, like cow's milk, soy, and eggs, may improve reflux symptoms
- Thickened Feeds
  - Feeds thickened with rice cereal or starch were once thought to reduce reflux, but commercially available formulas that thicken through acidification are not suitable for preterm infants.
  - A systematic review of randomized controlled trials of thickened formulas in term infants with GERD revealed that although these agents reduced episodes of regurgitation, though there isn't enough evidence to support the improvement of

other reflux symptoms

- Prokinetic Agents
    - Typically used in older infants to treat symptoms of reflux. However pharmacological treatment has shown to not be indicated for preterm infants as they all carry the risk of serious side effects: infantile pyloric stenosis and cardiac arrhythmia with erythromycin, as well as neurological side effects with domperidone and metoclopramide. Due to the lack of evidence supporting their effectiveness and their concerning safety profiles, these drugs should not be used in preterm infants solely for treating GERD due to limited research.
- Positioning
    - Changing the infant's body position while awake can be effective in reducing reflux. The flat prone and left-side down positions are linked to fewer reflux episodes, but they should only be recommended for awake, supervised infants during the postprandial period.

Monitoring excessive growth

Preterm infants are at risk for excessive growth and increased adiposity as they catch up in weight and length after birth. Rapid postnatal weight gain, especially weight gain out of proportion of linear growth can lead to increased adiposity. This raises concerns about long-term metabolic health, including the risk of obesity, insulin resistance, and cardiovascular disease later in life. Careful nutritional management is crucial to support healthy growth patterns in preterm infants while minimizing the risk of excessive weight gain and its associated health complications.

Excessive growth concerns

- Long-term and unnecessary fortification of “empty calories” through the use of calorie modulators such as MCT oils, and dextrin maltose can lead to greater net lipogenesis and more adiposity resulting in disproportionate fat mass gains.
- Monitor proportionate growth: weight for length should be continually evaluated in addition to weight and height velocity. Fortification should be adjusted or discontinued if weight gain velocity exceeds proportionate height gains.

Feeding progression for the preterm infant

Using corrected age with feeding

- Feeding recommendations for infants born < 37 weeks gestation should be based on corrected age. Recommendations for feeding need to take into consideration an infant’s current level of development, their birth weight, discharge weight and nutritional status. Advancement of feeding may vary from the typical developmental progression due to the

premature infant's increased risk of developmental delay. Feeding progression for most preterm infants is the same as for infants born at term when corrected age is used.

Feeding progression

- Breastmilk/breastfeeding or infant formula is the primary source of nutrition for at least the first 6 months corrected age. Furthermore, the AAP supports continued breastfeeding, along with appropriate complementary foods introduced at about 6 months, as long as mutually desired by mother and child for 2 years or beyond. These recommendations are consistent with those of WHO.

For full feeding progression recommendations, please see Chapter 8

Supplementation

See Ch. 3 for lab monitoring and supplementation

Update on Probiotics Usage in Preterm Infants

The FDA issued a warning in 2023 that preterm infants in hospital settings who are given probiotics are at risk of invasive, potentially fatal disease caused by the bacteria or fungi contained in probiotics. In addition, there are currently no probiotic products for infants that have been approved by the FDA.

Table 6.1: Probiotic and Prebiotic Use in Preterm Infants

	Probiotics	Prebiotics
Definition and Function	Live microorganisms (mostly "good" bacteria) that have a beneficial effect on health. Prevent colonization of pathogenic microorganisms, increase immunity to infectious disease of the intestinal tract, and stimulate anti-inflammatory agents.	Non-digestible carbohydrate that selectively stimulates the growth and/or activity of beneficial bacteria in the colon and improve health. Serves as a food for probiotics in the large intestine.
Common Types	Lactobacillus & Bifidobacterium; yeast	Oligosaccharides, Galacto-oligosaccharide (GOS), fructo-oligosaccharide (FOS)

Table 6.1: Probiotic and Prebiotic Use in Preterm Infants

Sources	● fermented dairy products (yogurt, kefir & cheese) ● sourdough bread ● some infant formulas ● supplements	● breast milk ● legumes ● unrefined whole grains ● raw bananas, onions, jicama, chicory root, leek, garlic, asparagus ● some infant formulas
Breastmilk	Breast fed infants have increased amounts of bifidobacteria and lactobacilli than formula fed infants due to the probiotics and prebiotics found in breast milk. Breastmilk fosters the growth of certain specifics of bacteria, such as bifidobacteria.	Breastmilk contains over 100 oligosaccharides that are undigested by newborns. This fuels beneficial bifidobacteria found in the newborn's gut which stimulates the gut's lining to grow thicker and to provide more protection against harmful pathogens and allergenic substances.
Possible Benefits in Infants	● Improve immune function ● Treat infant diarrhea ● Treat antibiotic associated diarrhea ● Treat infant colic ● Reduce intestinal inflammation ● May prevent decreased morbidity and mortality related to NEC in preterm infants ● Improve digestion and gastric emptying ● Treat Helicobacter Pylori ● Prevent and reduce allergic diseases	● Prevent attachment of enteropathogens (anti-infective properties). ● Stimulate growth of beneficial bacteria in a newborn infant's sterile gut ● Softer stools
Concerns for Use in Infants	● May cause bacterial translocation in infants with short gut syndrome. ● Sepsis, endocarditis. No data on long term benefits or safety. *Immuno-compromised infants most at risk for the above mentioned concerns.	● Gas and/or bloating if getting too much. ● No data on long term benefits or safety.
Recommendations	Currently there are no evidence based guidelines regarding dosing for infants.	Currently there are no evidence based guidelines regarding dosing for infants.

	Studies have indicated benefits for use in infants with infectious diarrhea, prevention of antibiotic associated diarrhea and prevention of NEC.	

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CHAPTER 7

Special considerations for the late preterm infant

Medical risks for the late preterm infants

Definition: Infants born between 34 0/7 – 36 6/7 weeks gestational age.

- Late preterm infants account for the largest portion of preterm births in the United States, representing more than 70% of all preterm births in 2005 (Martin et. al, 2019). With birth weights typically ranging from 2000 to 3000g (4 ½- 6 ½ pounds), these infants appear more mature and stable than infants born at earlier gestations. They are frequently cared for in the maternity ward.

- During the birth hospitalization, late preterm infants are at higher risk of:
  - Feeding difficulties
  - Hypoglycemia
  - Jaundice
  - Apnea
  - Temperature instability
  - Excessive weight loss

- In the first month of life, late preterm infants are more likely than term infants to be readmitted to the hospital for:
  - Feeding difficulties, including breastfeeding failure
  - Dehydration
  - Jaundice
  - Poor weight gain

- Risk factors for post-discharge morbidities and re-hospitalization include:
  - First born child
  - Breastfed
  - Mother with labor and delivery complications
  - Low socio-economic status at time of delivery
  - Asian-Pacific Islander descent

Feeding the late preterm infant

Late preterm infants are at risk of inadequate nutrient intake for several reasons, including immature gastrointestinal function, underdeveloped nervous system, lower stamina and lower oral-motor tone in comparison to term infants. For example, they may be sleepier than a term infant, have more subtle hunger cues, and may not wake independently for feedings. Both breastfed and bottle-fed late preterm infants are at elevated risk for feeding problems and should have weekly weight checks until 40 weeks of post-conceptual age (i.e due date) or until they are thriving.

Late preterm infants generally have higher calorie and nutrient needs compared to term infants, but specific guidelines are lacking due to insufficient research of the benefits of enriched formula or fortifiers. Current practice is to feed late preterm infants unfortified mother's milk or term infant formula. However, many late preterms struggle to consume enough calories with standard term formula or plain breastmilk to support weight gain of at least 23-34 grams/day until 4 months corrected age (WHO, 2009). If the infant has suboptimal weight gain, the term formula or breastmilk can be concentrated or fortified to 22 or 24 kcal/oz, allowing the infant to consume more calories in smaller volumes. Typically, they don't need fortified feedings for an extended period of time.
For additional fortification monitoring and weaning, refer to Chapter 6.

Breastfeeding Considerations:

Unlike younger, smaller preterm infants, most late preterm infants are discharged home before their mother has established her milk supply. Late preterm infants may initially be unable to provide enough breast stimulation to bring in an adequate maternal milk supply. Providing good support to mother and baby is critical to breastfeeding success in this population. Referral to a lactation consultant is recommended for all breastmilk-fed preterm infants immediately following initial hospital discharge

Here are a few strategies to support these breastfeeding dyads long-term.

- Initiate expressing breastmilk while hospitalized and continue until at least 40 weeks post-conceptual age (i.e due date)
    - A combo of hand expression initially and transitioning to a hospital grade pump are most-effective.
    - Expressing at least 6 times per day, with a goal of 8 times a day or more to maximize milk removal and to establish a long-term supply.
- Increase the frequency of breastfeeding.
- Set a time limit for breast feeding to prevent fatigue with feeding
- Start supplementing, preferably with expressed breastmilk or donor milk, after breastfeeding.
- Try the triple feeding method (breastfeeding, followed by supplementation and then expressing) with every feeding. This is very effective, but may not be sustainable with limited support at home.

**See Chapter 5 for additional breastfeeding resources.*

The Academy of Breastfeeding Medicine suggests the following as signs that a late preterm infant is getting enough milk at the breast:

- Has lost no more than 7% - 8% from birth weight
- At least 6 -8 voids daily
- Four sizable yellow seedy stools by day 4 of life
- Satisfied after 20- 30 minutes of nursing
- Average weight gain of >23-34 grams/ day, after first week of life

Special Nutrient Considerations

Iron:
Preterm infants have lower iron stores than term infants. By 1 month post birth, preterm infants should have an intake of at least 2 mg iron/kg/day (up to a maximum of 40 mg/day) from an iron-fortified infant formula and/or supplement. This iron dose should be continued for the first year of life. Some exclusively formula-fed infants will need an iron supplement in addition to their infant formula. The American Academy of Pediatrics Committee on Nutrition (2010) notes that approximately 14% of formula-fed preterm infants develop iron deficiency between 4 and 8 months of age.
The PCP should closely monitor iron status post-discharge as the preterm infant's iron dosage will frequently need to be adjusted as their formula volumes change

Vitamin D:
The American Academy of Pediatrics (AAP) recommends that fully or partially breastfed infants receive a supplement of 400 IU vitamin D daily for at least the first year of life. Non-breastfed infants should also be supplemented until taking 32 fl. oz. (1000 ml) per day of vitamin D-fortified infant formula. For preterm infants, this 400 IU of vitamin D can be provided by: 1 ml daily of a standard infant multivitamin with/without iron; 1 ml daily of a tri-vitamin supplement with/without iron; or a vitamin D supplement such as D-Vi-Sol in combination with a separate iron supplement.

Corrected Age

- Corrected age should be used for all late preterm infants to account for their early birth and to ensure accurate growth and developmental assessments as it pertains to feeding readiness. For example, late preterm infants will start solids and transition to cow's milk later than their term counterparts.

Follow-Up and Monitoring

- Post-discharge growth and feeding management is typically managed by the PCP if no other complications. It is recommended to refer to a pediatric dietitian if ongoing concerns about growth.

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CHAPTER 8

Feeding - Transitioning to Solids

Introduction of Solids

The American Academy of Pediatrics (AAP) recommends breast milk or formula feeding as the primary source of nutrition for the first six months before introducing complementary foods. Preterm infants follow the same general guideline, using corrected age and assessing their developmental readiness for solid foods. Some smaller or medically complex preemies may not be ready for solids until after 6 months corrected age.

Developmental Readiness for Solids:

- Sitting: Infant is able to sit with minimal support
- Head Control: Infant is able to hold head upright and steady in a supported seated position for the duration of the meal (about 15 minutes)
- Reach & Grab: Infant is able to pick up objects while seated and easily bring them to the mouth
- Interest: Infant is intently watching you eat, mouths for food, or leans forward for it

Highchairs:

Infants need full support when they are introduced to complementary foods so that their body does not have to work hard to stabilize. Choose a high chair with a full back and an upright position. Towel rolls added next to the torso/hips will help the infant feel more secure and prevent slouching to one side. Towels can also be added under their bottom to ensure they can reach their tray. For older infants and toddlers, it is important that highchairs provide foot support with a 90 degree bend at both their hips and knees.

Introduction to Solids:

Families can start with any pureed food that they prefer - iron-fortified cereals, pureed vegetables, fruits, or meats. It is recommended to start with 1 new single ingredient food every 3-5 days and monitor for signs of any allergies or intolerances. It is important to offer and expose infants to a variety of new foods to support healthy growth and development. If an infant is fed predominantly breast milk, it is important to provide a good source of iron and zinc at 6 months of age, such as fortified infant cereals or pureed meats.

Introduction of Cups:

It is best to introduce open cup drinking practice a few months after spoon feeding has been established. Infants are ready for open cup drinking when they can sit fairly well independently and show interest in handling utensils and putting them in the mouth. Open cup drinking practice is important because the infant has to learn how to stabilize their jaw, while containing the liquid in their mouth and independently using their tongue to initiate the swallow. It may be helpful to encourage starting with thicker liquids, like a smoothie or thinned yogurt, to slow the flow and

give the baby more control while they learn to manage the liquid in their mouth. As an infant transitions to more table foods, start practicing drinking from a straw cup.

Allergens:

- Major food allergens: Milk, eggs, fish, shellfish, tree nuts, peanuts, wheat, soybeans, sesame
- Evidence supports early introduction of peanuts between 4-6 months to help prevent IgE-mediated allergies.
- Early introduction of egg may be beneficial, though more research is needed. (Abrams, Yakaboski). There is limited evidence to support early introduction of other top food allergens
- Special Considerations: If a baby has severe eczema or an egg allergy, these conditions can increase the risk of an allergic reaction and a referral to an allergist should be considered.

Vitamins:

All preemies should continue to take 1 ml of an infant vitamin with iron for the first year of life, or beyond 1 year if there are concerns about inadequate intake of solid foods.

Transitioning off infant formula

When transitioning an infant off formula, it is recommended to evaluate the following:

- at least 12 months corrected age
- current weight and growth trends
- monitor reliance of formula or breastmilk as a percentage of calorie intake
- assess their current intake of table foods and oral motor skills

Some infants, especially preemies, may have delayed feeding skills and may continue to heavily rely on infant formula as their primary source of nutrition, and therefore may not be ready to switch to cow's milk or a milk alternative at 12 months corrected age. Transitioning to cow's milk before the infant is taking an adequate volume of solid foods, will lead to excess intake of cow's milk which may cause nutritional deficiencies. If an infant has poor growth or is not taking enough solid food, they may need to continue infant formula until growth and feeding concerns have resolved. In some cases, preemies with significantly delayed feeding skills may need to transition to a pediatric formula to meet their nutritional needs.

Once an infant is eating a variety of age appropriate table foods, they are ready to transition to whole fat cow's milk. Some parents choose alternative milks and beverages such as almond beverage, oat beverage, or rice beverage. These alternative milks are not appropriate for a toddler due to low calorie, protein and fat levels, inadequate vitamin fortification, and differing absorption rates. If a toddler cannot tolerate cow's milk or a parent desires to provide an alternate milk, then fortified pea beverages or fortified soy beverages are recommended due to their calorie, protein, and vitamin and mineral content.

Key Micronutrients for Infants 1-3 years of age:

- Calcium: 700 mg/day

- Iron: 7 mg/day
- Vitamin D : 600 IU/day

Choking Hazards:

Infants up to 24 months of age are at a high risk for choking due to their small airways and developing chewing skills. To reduce the risk of choking, avoid hard, round, sticky, or large pieces of food, such as whole grapes, nuts, popcorn, chunks of meat or cheese, and spoonfuls of nut butter. All food should be given while securely seated and supervised to reduce the risk of choking.

Feeding concerns

As preterm infants grow and begin exploring solid foods, caregivers may encounter common feeding concerns, such as difficulties with chewing or swallowing, persistent gagging or coughing during meals, refusing solids, delayed self-feeding skills, or strong oral sensitivities that make eating challenging. While some infants may take longer to adjust to new textures, ongoing struggles with feeding can impact growth, nutrition, and overall development and may require additional support from other healthcare disciplines. If an infant is struggling with feeding, a referral to a feeding specialist should be considered. These specialists can assess oral motor skills, sensory sensitivities, and overall feeding development to provide tailored strategies for a successful feeding experience.

When to Seek Additional Support:

- Frequent coughing, choking, or difficulty swallowing during meals
- Persistent gagging or vomiting with food introduction
- Difficulty progressing to appropriate food textures
- Prolonged dependence on pureed foods (>8-12 weeks)
- Limited interest in eating or refusal of most foods
- Poor weight gain or signs of nutritional deficiencies
- Sensory sensitivities that make mealtime stressful or challenging

Infant and Child Feeding Questionnaire Screening Tool

The Feeding Matters Feeding Questionnaire is a screening tool designed to help identify potential feeding challenges in infants and young children. By answering a series of questions, caregivers can assess their child's feeding behaviors and determine if further evaluation by a feeding specialist is needed. This tool can provide early insights into feeding difficulties, support timely intervention, improve feeding outcomes and may indicate a need to refer to appropriate providers as necessary.

6-QUESTION SUBSET

Does your baby/child let you know when he is hungry?	YES	NO	
Do you think your baby/child eats enough?	YES	NO	
How many minutes does it usually take to feed your baby/child?	<5	5-30	>30
Do you have to do anything special to help your baby/child eat?	YES	NO	
Does your baby/child let you know when he is full?	YES	NO	
Based on the questions above, do you have concerns about your baby/child's feeding?	YES	NO	

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Appendix

Table 1.1 - Feeding Concerns for High Risk Preterm Infants

Feeding Problem	Symptoms/Characteristics		Nutrition Counseling Guidelines	
State/ Physiological Stability	State Stability: - Sleepy baby - Poor waking cues, may sleep poorly - Cries frequently - Fussy with feedings - Difficulty achieving quiet alert state - Difficulty initiating sucking - Difficulty focusing on feeding	Physiological Stability: - Color changes - Stress signs - Sweating - Apnea/bradycardia - Falls asleep - Hiccoughs	Calming Techniques: - Swaddle - Watch for subtle/early hunger cues - Provide pacifier - Begin feeding during quiet alert state - Provide slow rhythmic movement - Speak in a quiet voice or stay quiet - Check out environment for sources of excessive stimulation or TV, bright lights, etc.)	Alerting Techniques: - Vary pitch of voice - Change diaper - Frequent burping - Keep unswaddled - Wipe baby's face with cool cloth
Endurance	- Sleepy baby, doesn't wake for feedings - Slow, "pokey" eater - Feeding lasts longer than 30-45 minutes - Increased liquid loss as feeding progresses - Sucking becomes disorganized as feeding progresses - Baby takes long pauses to breathe - Baby has very short sucking bursts - Indicates fullness or falls asleep early in feeding		- Consider a faster flow nipple if coordination is not a problem - Offer chin and cheek support - Limit feeding to 20-30 minutes, stop feeding when baby is fatigued - Consider feeding supplements or concentrated feedings - Look closely at environment for sources of excessive stimulation - Support flexed position with head aligned with body	

Feeding Problem	Symptoms/Characteristics	Nutrition Counseling Guidelines

Suck/ Swallow/ Breathe Coordination	- Gulping - Takes 1-2 sucks then pulls away - Coughing/choking - Excessive liquid loss with feeding - Apnea with or without brachycardia - Gasping for breath	- Begin nursing after initial let down/ejection reflex - Adjust flow of milk from nipple (e.g. use slow flow nipple) - Reduce distractions in the environment - Swaddle or hold baby in flexed position with head aligned with body - Help baby pace feeding by allowing breaks for breathing - Baby may need a feeding/swallow evaluation by a Feeding Team
Swallowing Mechanism	- Takes pacifier but not breast/bottle - Holds liquid in mouth before swallowing - Excessive liquid loss with feeding - Audible hard swallows - Frequent coughing/choking - Recurrent aspiration pneumonia	- Begin nursing after initial let down/ejection reflex - Adjust flow of milk from nipple (e.g. use slow flow nipple) - Feeding evaluation and/or videofluoroscopic swallow study to rule out delayed or dysfunctional swallow
Oral Motor Control/ Coordination	- Weak or noisy suck - Frequent gagging Tongue retraction or abnormal movement - Arching backward, altered trunk tone - Nipple biting/munching instead of sucking - Excessive liquid loss or frequent coughing/choking even with reduced milk flow - Aversive or defensive behaviors - Hypertonia or hypotonia - Recurrent aspiration pneumonia - Lack of feeding skill progression at appropriate corrected age intervals	- Feeding evaluation by speech or occupational therapist - Assess nutrient intake and provide recommendations to optimize nutrient intake and support growth and development potential

Table reprinted with permission from: Nutritional Care for High-Risk Newborns, 3 rd Edition; Groh-Wargo, S., Thompson, M., Cox, J. (Editors) pp 554-555. (2000). Precept Press, Chicago, IL

northwest
MOTHERS MILK BANK
address 15875 SW 74th Ave, Tigard, OR 97224 • **hours** Mon-Thu 8:30-4:30, Fri 9:00-3:00
phone 503.469.0955 • **toll free** 800.204.4444 • **fax** 503.469.0962 • **website** donatemilk.org

MILK TO GO

Prescription Forms

Instructions

1. **Choose** the *Milk to Go* program that fits your patient best.
2. **Fill out** the form for that program, attached.
3. **Fax** the form to 503.469.0962 or **upload** at donatemilk.org/milk-to-go-providers

Programs

Milk to Go
For babies up to 4 weeks old, one time only.

Milk to Go Plus
For babies up to 8 weeks old with specific medical needs, one time only.

Milk to Go Critical *(2 pages)*
For babies with serious medical conditions.

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MILK TO GO
CRITICAL

For babies with serious medical conditions

❸ CLINICIAN AUTHORIZATION

☑ *CHECK EACH BOX TO ACKNOWLEDGE*

☐ Donor milk is a limited resource intended to support lactation or transition to a permanent feeding plan.

☐ A *Statement of Medical Necessity* (below) and chart notes are required; notes should support an ongoing medical need for donor milk.

☐ The maximum volume and age limit for this program is determined on a case-by-case basis.

☐ The patient's family will sign an agreement acknowledging the amount of milk and general timeline for receiving it, which provides time to develop a permanent feeding plan.

☐ *Milk to Go Critical* ends after the agreed-upon amount has been dispensed with the opportunity to re-apply based on eligibility (more info at donatemilk.org/milk-to-go-providers).

Clinician Signature _____ Clinician Print _____

Clinic or Hospital _____ Phone _____

❹ CLINICIAN STATEMENT OF MEDICAL NECESSITY

I am requesting pasteurized donor human milk for my patient in support of treatment they are receiving for a medical condition. I certify that this nutritional therapy is medically necessary and that the information provided is accurate to the best of my knowledge. Approval for this request for donor milk will make a significant impact on the health of this infant. I have obtained the legal guardian's authorization to release my patient's medical information.

Clinician Signature _____ Date _____

❺ REQUIRED DOCUMENTATION

FAX TO 503.469.0962 OR SECURELY UPLOAD AT DONATEMILK.ORG/MILK-TO-GO

☐ **Milk to Go Critical Request** (this form, page 1)
☐ **Statement of Medical Necessity** (this form, page 2)
☐ **Chart notes** (attach to this form)

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MILK TO GO
CRITICAL

For babies with serious medical conditions

PROCESSING FEE: $5.00 PER OUNCE This covers the services provided by Northwest Mothers Milk Bank that make donor milk safe.
SHIPPING DEADLINE: 12PM, MON-THU We do not ship within the Portland metro area or on weekends to avoid milk spoiling in transit.

❶ PATIENT INFO *YOU MUST CALL AHEAD TO RESERVE YOUR MILK*

Infant Name(s) _____ Infant DOB _____

Parent/Guardian Name(s) _____

Phone 1 _____ Phone 2 _____

Address _____ City _____

State _____ Zip _____ Email _____

INSURANCE *IF APPLICABLE; CHECK COVERAGE WITH YOUR PROVIDER*

Insurance Provider _____

Member ID # _____ Group # _____

❷ MEDICAL NEED FOR DONOR MILK *CHECK ALL THAT APPLY*

Medical needs not listed here will be considered on a case-by-case basis. Learn more about eligibility criteria at donatemilk.org/milk-to-go or call us at 503.469.0955 to discuss specific needs.

- ☐ Awaiting organ transplant Z76.82
- ☐ Congenital digestive system anomaly Q45.9
- ☐ Congenital heart disease or anomaly Q24.9
- ☐ Congenital renal disease or anomaly Q63.9
- ☐ Extreme prematurity, 28 weeks (or earlier) P07.31
- ☐ Growth faltering R62.51 (below 5th %ile at 8+ weeks)
- ☐ Formula intolerance***
- ☐ HIV-positive birthing parent
- ☐ Immunologial or metabolic deficiencies
- ☐ Malabsorption disorder K90.9
- ☐ Maternal cancer
- ☐ Maternal death
- ☐ Necrotizing enterocolitis (NEC) K55.3
- ☐ Neonatal abstinence syndrome P96.1
- ☐ Post-surgical nutritional needs
- ☐ Short gut syndrome K90.82

*** **Formula intolerance** is suboptimal growth or persistent symptoms after 3 or more documented trials of breastmilk substitutes, including hypoallergenic or amino acid-based preparations

DETAILS & CONTEXT *ADD ANY RELEVANT INFORMATION NOT INCLUDED IN CHART NOTES*