

Nutrition Practice Care Guidelines for Preterm Infants in the Community



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Revised 2013

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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 premature 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 (3⅓ lbs)
- Extremely Low Birth Weight (ELBW): Birth weight < 1000 grams (2¼ lbs)

Late preterm: Infants born between 34-37 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.

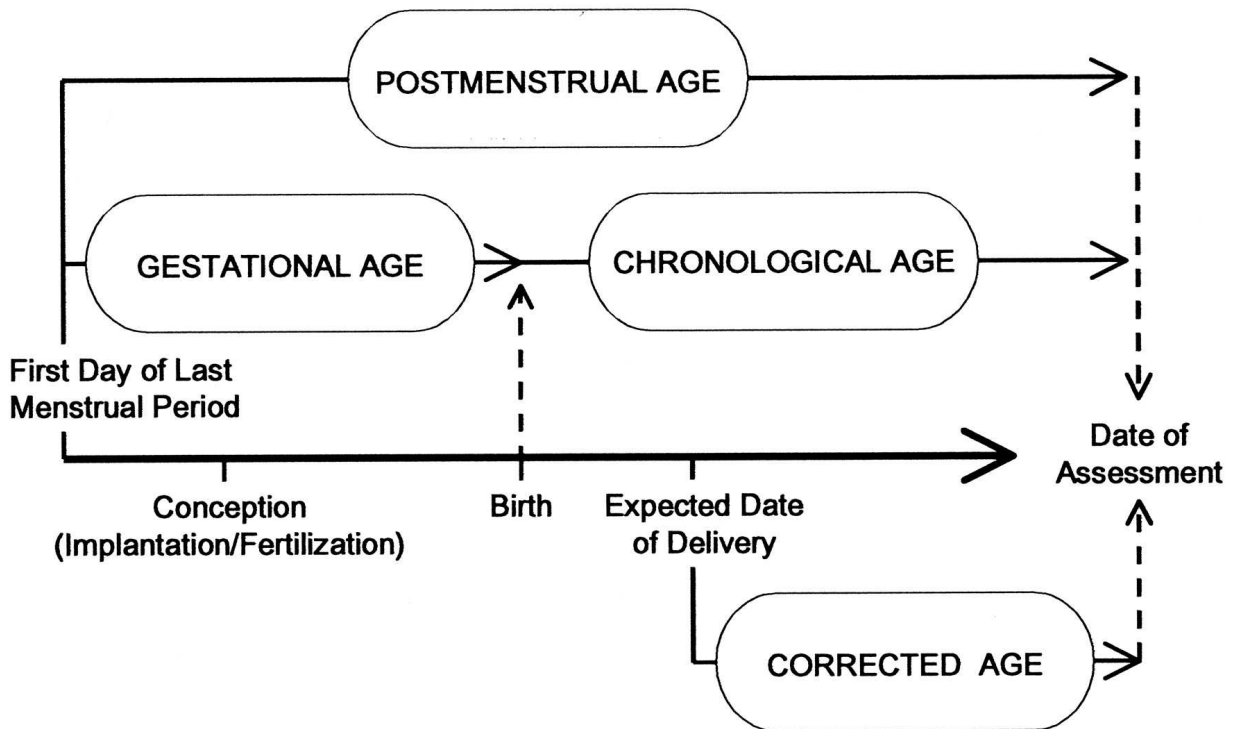
Symmetric SGA: Infants born with small body (weight and length) and head growth; often indicates that the intrauterine growth restriction was prolonged.

NICU: Neonatal Intensive Care Unit

Occipital frontal circumference (OFC): Head circumference

EMM: 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 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 his or her 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 a premature infant may be discharged earlier is to keep medical costs reduced allowing the NICU to target their resources toward the 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.

Transitioning home

Infants at highest risk post discharge:

- VLBW and 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 tracheotomies
- 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 track 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:

- 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 and gagging
- 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
- Day care and respite care

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 breastpump rental resources.

Feeding concerns for high-risk newborns at discharge

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

- State instability (e.g. difficulty transitioning from a sleep state to an awake state)
- Physiological instability (e.g. apnea)
- Limited endurance
- Poor suck/swallow/breathe coordination
- Impaired swallowing mechanism
- Poor oral motor control/coordination

See Table 1.1: Feeding Concerns for High Risk Preterm Infants on the following page.

Table 1.1: Feeding Concerns for High Risk Preterm Infants

Feeding Problem	Symptoms/Characteristics		Nutrition Counseling Guidelines	
State/Physiological Stability	<u>State Stability:</u> • 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	<u>Physiological Stability:</u> • Color changes • Stress signs • Sweating • Apnea/bradycardia • Falls asleep • Hiccoughs	<u>Calming Techniques:</u> • 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 (radio or TV, bright lights, etc.)	<u>Alerting Techniques:</u> • 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

Table 1.1: Feeding Concerns for High Risk Preterm Infants

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*, 3rd Edition; Groh-Wargo, S., Thompson, M., Cox, J. (Editors) pp 554-555. (2000). Precept Press, Chicago, IL

Referral criteria for further assessment and 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”

Growth expectations

- Weight loss or significant decline in percentile ranking (“falling away” from expected growth curve percentile).
- 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

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 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

Transitioning from a post discharge (transitional) formula to a standard term infant formula

The research is mixed in regards to how long a formula-fed preterm infant should continue on a transitional formula. A 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 study 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).

1. Low Risk – Low Birth Weight Infant

Category Definition:

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

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

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:
 - o Slow weight gain (<25 g/d)
 - o Poor intake (<150 ml/kg/day)

2. Moderate Risk – Low Birth Weight Infant

Category Definition:

- Infant birth weight between 1500 g (3 ½ lbs) – 2000 g (4 ½ lbs)
- Infant has had good growth and intake with no major medical complications
- Alkaline phosphatase and serum phosphorus are within normal limits before discharge

Breastfeeding Recommendations (see table 4.1):

- 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 multi-vitamin with iron

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 multi-vitamin without iron until infant is taking >32 oz (>1000 ml) per day

3. High Risk – Very Low Birth Weight Infant

Category Definition:

- Birth weight $\leq$ 1500 g (3 ½ 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)

Breastfeeding Recommendations (see table 4.1):

- 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 multi-vitamin with iron

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 multi-vitamin without iron until infant is taking >32 oz (>1000 ml) per day

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. The National Institute of Child Health and Human Development reports 83% to 100% of VLBW infants undergo significant growth failure between birth and discharge. The effect was greater in smaller preterm infants, almost 100% of infants weighing $\leq 1000\text{g}$ had weights less than the 10th percentile at 36 weeks corrected age (Griffin, I.J. & Cooke, R. J, 2007). 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. It is critical that premature infants are followed carefully in the community to ensure they are meeting their nutritional needs and experiencing catch-up growth post discharge.

Measurements most commonly used to assess nutritional status are weight, length and head circumference. 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

Growth charts commonly used to monitor preterm infants

WHO International Growth Charts < 24 months, 2006:

In 2006, the Centers for Disease Control (CDC), the National Institutes of Health (NIH), and the American Academy of Pediatrics (AAP) convened an expert panel to review scientific evidence and discuss the potential use of the new WHO growth charts in clinical settings in the United States. On the basis of input from this expert panel, CDC now recommends that clinicians in the United States use the 2006 WHO international growth charts, rather than the CDC growth charts, for infants and children aged < 24 months. The WHO growth charts can be used to monitor growth of preterm infants <37 weeks gestation at birth with age correction as well as very low birth weight infants. The 2006 WHO growth curves for children are based on data from the WHO Multicentre Growth Reference Study (MGRS), a worldwide study conducted during 1997-2003. These charts are growth standards that describe how healthy children should grow under optimal environmental and health conditions. In the WHO charts, the healthy breastfed infant is intended to be the standard against which all other infants are compared; 100% of the reference population of infants were breastfed for 12 months and were predominately breastfed for at least

4 months. When using the WHO growth charts to screen for possible abnormal or unhealthy growth, use of the 2.3rd and 97.7th percentiles are recommended, rather than the 5th and 95th percentiles. Clinicians should be aware that fewer U.S. children will be identified as underweight using the WHO charts, slower growth among breast fed infants during ages 3-18 months is normal, and gaining weight more rapidly than is indicated on the WHO charts might signal signs of overweight. WHO growth charts can be downloaded from:

http://www.cdc.gov/growthcharts/who_charts.htm

CDC Growth Charts, 2000:

CDC recommends using the CDC 2000 growth charts to examine growth and nutritional status from age 2-19 years. CDC growth charts measure stature as a standing height, while the WHO charts length measurements are based on recumbent measurements. It is important to note that the CDC growth charts are based on *growth reference* data (how growth looks at a point in time, in a particular population) vs. the WHO charts are based on a *growth standard* (how growth *should* look today if women adhered to prenatal recommendations and receive optimal prenatal care). The reference data for the CDC charts was based on a sample from the United States, in which 50% of the infants were ever breastfed and only 33% were breastfeeding at 3 months of age. VLBW infants were not included in the data to develop these charts. The CDC growth charts can be downloaded from: http://www.cdc.gov/growthcharts/clinical_charts.htm

Fenton Growth Chart, 2003:

The Fenton fetal-infant growth chart includes data from a compilation of studies from 1980 to 2002, in an effort to complete the pre and post term sections of the 1976 Babson and Benda fetal-infant growth chart. This frequently used chart supports growth monitoring of preterm infants from as early as 22 weeks gestation up to the term infant at 50 weeks post-conceptual age. Data from several population studies with large sample sizes are included. To validate the chart, the growth data from NICHD were superimposed on the new chart. The data for both genders were averaged together for the 3rd, 10th, 50th, 90th, and 97th to create one growth chart. One advantage of this chart includes the 100-gram graph increments. This growth chart can be downloaded from: <http://members.shaw.ca/growthchart/>

New Intrauterine Growth Curves, Irene Olsen University of Penn., 2010:

In 2010 Irene Olsen created new gender specific intrauterine growth curves for birth through 41 weeks. These curves are based on a large, racially diverse United States sample (1998-2006) and may provide clinicians with an updated tool for growth assessment in neonatal intensive care units. These curves are just now gaining acceptance in various neonatal units throughout the country. Growth curves can be downloaded from:

<http://www.nursing.upenn.edu/media/infantgrowthcurves/Pages/default.aspx>

Table 2.1: Growth Charts Commonly Used to Monitor Preterm Infants

Growth Chart	Description of Data Included	Advantages	Disadvantages
World Health Organization for infants and children < 24 months, 2006	- o MGRS cross-sectional component conducted during 1997-2003 with sites in the following locations: Pelotas Brazil, Accra Ghana, Delhi India, Oslo Norway, Muscat Oman, Davis, CA - o 100% of reference population breastfed for 12 months and were predominately breastfed for at least 4 months. - o Exclusion criteria included maternal smoking, birth <37wks or >42 weeks, multiple birth, substantial morbidity, low socioeconomic status, and unwillingness of mother to follow feeding criteria - o Separate chart for boys and girls	- o Worldwide standard birth to 5 years - o Healthy breastfed infant is standard against which all other infants are compared	- o Graph starts at term corrected age - o It is recommended to change to CDC growth charts at 24 months; switch may create disjunction in growth classification - o Will require training of health care providers and others who measure and assess child growth; tools are currently being developed on how to interpret growth on the charts
CDC 2000 Growth Charts	- o Data from NHANES I, II, & III - o Represents racial/ethnic diversity of US - o Includes both formula-fed and breastfed infants - o Does not include growth data from preterm & very low birth weight infants (<1500 gm) - o Separate charts for boys and girls	- o Includes weight for length for birth to 24 months and BMI for children over 24 months - o U.S. data birth to 20 years	- o Does not include VLBW infants, and age is chronological age, not adjusted gestational age - o Difficult to interpret when catch-up growth has not occurred - o Graphs start at term corrected age, does not include < 40 weeks gestation

Table 2.1: Growth Charts Commonly Used to Monitor Preterm Infants

Growth Chart	Description of Data Included	Advantages	Disadvantages
Fenton Intrauterine Growth Charts, 2003	- o Meta-analysis of published reference studies from 1980 to 2002 - o Non-Gender Specific, 22 to 50 weeks gestation	- o 100 gm graph increments - o Percentile curves (3,10, 50, 0- and 97th) rather than standard deviation - o Starts at 22 weeks gestation	- o Validity of this growth chart is limited by heterogeneity of the data sources - o Non-US data for < 40 weeks - o Data prior to 2002 - o Curve stops at 50 weeks
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 (23-41 weeks gestation age) - o Gender Specific, 23 to 41 weeks	- 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 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

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.
MWR Use of World Health Organization and CDC Growth Charts for Children Aged 0-59 months in the United States, September 10, 2010/Volume 59;
Olsen, I. E., Groveman, S. A., Lawson, M. L., Clark, R. H., & Zemel, B. S. New intrauterine growth curves based on United States data. *Pediatrics*, 125(2), e214-224, 2010.

Developmental origins of health and disease

Optimal nutrition in the neonatal period is critical for successful health outcomes after discharge. 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). Under nutrition during pregnancy, and low birth weight in general, are strongly associated with increased risk of hypertension, obesity, insulin resistance, and dyslipidemia later in life (Vickers, Sloboda, 2012).

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).

The current research demonstrates the need to optimize the woman’s diet before, during and between pregnancies. The infant of a woman with gestational diabetes (GDM) is at particular high risk for complications in the intermediate neonatal period resulting in metabolic alterations that can predispose the infant to obesity and diabetes in later life (Guilloteau, et al, 2009). Women with a history of GDM would benefit from reaching a healthy body weight prior to conception and to maintain a well balanced diet throughout future pregnancies.

Estimating catch-up growth

Critical thinking is vital when determining the range of calorie needs for catch-up growth in the community in light of research regarding the vulnerability of the preterm infant to developmental programming changes. Careful monitoring of the infant's growth velocity and biochemical parameters is recommended.

1. *Plot* the child's measured length or height and weight on the sex-appropriate WHO growth chart (recommended for < 2 years) or CDC growth chart (recommended for > 2 years).
2. *Height Age:* Determine the age at which the child's current length (lt) or height (ht) would be at the 50th percentile on the growth chart.
3. *Ideal weight for height:* Using the height age, determine the expected weight in kg at the 50th percentile for the height age, as calculated in step 2. This is the ideal weight for height or length.
4. *Use height age and RDA table* below to determine the expected caloric and protein needs category.
5. *Multiply* expected calorie and protein needs per kilogram by ideal body weight.
6. *Divide* this value by the child's actual weight.

Calculation for catch-up growth requirements for calories:

$$\frac{\text{RDA calories for height age} \times \text{ideal weight for height (kg)}}{\text{Actual weight (kg)}}$$

Example 1: Jane is a 7 month old infant who is 62 cm long and weighs 5.8 kg. Using the WHO growth chart, Jane's current length would be at the 50th percentile at 4 months. This is her height age. A 4 month old infant's weight at the 50th percentile would be 6.4 kg. This is Jane's ideal weight for height age.

$$\frac{\text{RDA calories for ht age (108)} \times \text{ideal weight for ht age (6.4 kg)}}{\text{Actual weight (5.8 kg)}} = 119 \text{ cal/kg}$$

Calculation for protein requirements:

$$\frac{\text{RDA for protein for height age} \times \text{ideal weight for height (kg)}}{\text{Actual weight (kg)}}$$

Example 2: Jane's protein needs would be calculated as:

$$\frac{\text{RDA pro for ht age (1.52 gm/kg)} \times \text{ideal weight for ht (6.4 kg)}}{\text{Actual wt (5.8 kg)}} = 1.6 \text{ gm pro/kg}$$

Table 2.2: RDAs for Energy and Protein

Category	Age	Energy (Kcal/kg)	Protein (gm/kg)
Infant	0-6 mos	108	1.52
Infant	6-12 mos	98	1.2
Child	1-3 yrs	102	1.05

Age correction for preterm infants

Premature infants and toddlers up to 24 months should be corrected for gestational age when assessing for growth, nutritional needs, feeding and developmental milestones. Practitioners sometimes prefer to use age correction up to 36 months with some of the extremely low birth weight (ELBW) infants and/or premature infants with significant medical issues. Growth data should be plotted according to the infant's age corrected for prematurity.

There are a number of ways to calculate corrected age (also known as adjusted age). The most common way to calculate corrected age is by subtracting the number of weeks premature from the chronological or actual age.

$$\text{Corrected age} = \text{Chronological age} - (40 \text{ weeks} - \text{weeks gestational age at birth})$$

Here is an example using the basic formula above, shown 2 different ways (monthly method and calendar method):

*An infant was born at 30 weeks gestation and is now 4 months old.
Date of birth was January 1, 2011
Estimated due date was March 12, 2011
Today's date is May 7, 2011*

Example 1: Calculation using months

- Step 1: Full-term gestation – gestational age at birth
 $40 \text{ weeks} - 30 \text{ weeks} = 10 \text{ weeks (2 } \frac{1}{2} \text{ months) premature}$
- Step 2: Chronological age – number of weeks premature
 $4 \text{ months} - 2 \frac{1}{2} \text{ months} = 1 \frac{1}{2} \text{ months CA}$

Example 2: Calculation using a calendar

- Step 1: Full-term gestation – gestational age at birth
 $40 \text{ weeks} - 30 \text{ weeks} = 10 \text{ weeks premature}$
 $\text{March 12, 2011-January 1, 2011} = 10 \text{ weeks premature}$
- Step 2: Calculate chronological age by counting # of weeks from
Infant's birth date thru today's date
 $\text{January 1, 2011 thru May 7, 2011} = 18 \text{ weeks}$
- Step 3: Chronological age – # of weeks premature
 $18 \text{ weeks} - 10 \text{ weeks} = 8 \text{ weeks old CA}$

Note: Calculating corrected age by using a calendar method is more precise.

Growth velocity

Both the WHO International and CDC Growth Charts show similar growth velocity data for healthy infants from birth to age 2. 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 growth in a VLBW preterm infant it is important to use a consistent growth chart.

Table 2.3: Growth Parameters for Preterm Infants

Growth Parameter	Term - 3 month CA	3-6 months CA
Weight Gain	~6 to 8 oz/week	~ 4 oz/week
Length Gain	~ 1 cm/week	~ 0.5 cm/week
HC Gain	~0.5 cm/week	~0.2 cm/week

Chapter 2 references

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CHAPTER 3

Energy, nutrient and biochemical recommendations

There are a variety of conditions of prematurity that predispose infants to nutritional deficiencies. These conditions include accelerated growth rate and high metabolic needs, inadequate nutrient stores, immature physiological systems, and illnesses related to prematurity. If the infant is growing well and their lab values for bone mineralization are normal, they do not require additional fortification.

It is important to note for exclusively breastfed babies who are gaining weight well, they may or may not be consuming adequate calcium and phosphorus with unfortified breastmilk. Therefore, it is important to check bone labs and monitor weight gain closely (see table 3.4).

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	110 - 150 kcal/kg	See Estimated Energy Requirement (EER) below	See EER equation
Protein	3.4 - 4.4 g/kg	1.5 g/kg/day OR 9.1 g/day	1.2 g/kg/day OR 11 g/day
Vitamin A	210 - 450 mcg/kg or 700 - 1500 IU/kg	400 mcg/day or 1330 IU/day DRI	500 mcg/day or 1665 IU/day DRI
Vitamin D	3.75 - 10 mcg/kg or 150-400 IU/kg 400 – 800 IU/day	10 mcg/day or 400 IU/day	10 mcg/day or 400 IU/day
Vitamin E	4 - 8 mg/kg or 6 -12 IU/kg	4 mg/day or 6 IU/day	5 mg/day or 7.5 IU/day
Calcium	100 - 220 mg/kg	200 mg/day	260 mg/day
Phosphorous	60 - 140 mg/kg	100 mg/day	275 mg/day
Iron	2 - 4 mg/kg	0.27 mg/day	11 mg/day
Zinc	1 - 3 mg/kg	2 mg/day	3 mg/day

*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
0 – 3 months	$(89 \times \text{weight [kg]}) - 100 + 175$
4 – 6 months	$(89 \times \text{weight [kg]}) - 100 + 56$
7 – 12 months	$(89 \times \text{weight [kg]}) - 100 + 22$

**The EER equations were released in 2002. These are predictive equations to determine energy needs in normal healthy infants (as well as children and adults). These equations are meant to replace the RDA for energy from 1989. The EER equations have been found to be a more accurate energy need predictor than the RDA for energy. For a more detailed explanation for the use of EER over RDA for energy see: <http://www.nap.edu/books/0309085373/html/index.html>

Vitamin and mineral supplementation

Supplementation with a standard infant multivitamin with or without iron is generally needed initially after NICU discharge to meet the preterm infant's vitamin needs. Once the infant's intake reaches about 25-32 ounces daily feed intake, only iron and vitamin D supplements are required.

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

Preterm infants have lower iron stores than term infants. By 1 month post birth (Note: not 1 month corrected age), 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. Formula-fed infants taking at least 150 ml/kg/day will receive about 2 mg iron/kg/day from feeds. However, 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.

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.

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 <u>without</u> Iron + separate Iron supplement	Continue until 12 months corrected age.
Iron-Fortified Formula	0.5 ml daily Infant Multivitamin <u>without</u> 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 called 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). Significantly elevated alkaline phosphatase has been related to bone fractures and stunting of growth.

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 lower Ca and P levels 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.

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 the breast or a term formula < 3 months corrected age.
- If the premature infant has had marginal intake and rate of growth falls in 'red flag' range (see 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 – 5 mg/kg 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 with iron supplement if breastfeeding, iron fortified formula or iron supplements. The American Academy of Pediatrics has recommended that breastfed preterm infants be given 2mg Fe/kg no later than 1 month of age until 12 months of age. Formula fed preterm infants should be on iron fortified formula. In certain cases additional iron may need to be supplemented.

Monitoring the hemoglobin and/or hematocrit values after discharge from the NICU is recommended for infants thought to be at risk for iron deficiency or anemia. Normal ranges for these labs can be found in Table 3.4.

Table 3.4: Reference Table for Biochemical Parameters

Biochemical Marker	Reference Range*	Interpretation
Alkaline Phosphatase (ALP)	150 – 420 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 calcium level.
Calcium(Ca)	9.0 - 11.0 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)	4.5-9 mg/dl (< 40 wks GA) 4.5-6.7 mg/dl (> 40 wks GA)	- 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)	10.5 – 13.5 g/dl	o Levels lower than the reference range may indicate iron deficiency.
Hematocrit (Hct)	33 – 39%	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.

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, 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

Kyle is a former 27-week premie. He had a 3 ½ -month NICU stay which was complicated by chronic lung disease, patent ductus arteriosus, gastroesophageal reflux, and cholestasis. His mom pumped for 2 months while he was in the NICU and at discharge Kyle was fully formula fed.

At discharge, Kyle's Alk Phos was slightly elevated. After calculating his calcium and phosphorus needs, it was decided to continue his current feeding plan of a post-discharge formula since it should provide all of his nutrient needs.

His labs were re-checked at six weeks postdischarge and his Alk Phos, Phos and Ca were all found to be within normal limits. He continued to grow well and was on a post-discharge formula until one year corrected age.

Date	Adjusted Age	Weight	Alk Phos	Phos	Ca	Feeding Method & Recommendations
9/11	27 wks GA	2#4oz				NICU: TPN x 4 weeks HMF+EMM x 8 weeks EnfaCare x 1 week
11/28	39 wks GA	5#13oz	515	5.3	9.2	Discharge: EnfaCare 24 kcal/oz
12/8	40 wks GA	6#8oz				EnfaCare 24 kcal/oz
1/12	5 wks CA	9#12oz	321	6.1	10.1	EnfaCare 22 kcal/oz

Case Study #2

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 38 weeks gestational age, Jessica's mom stopped pumping after breastfeeding at night, but continued to pump after breastfeeding during the day to maintain her milk supply. At 40 weeks gestational age, her mom stopped pumping completely and she was successfully breastfeeding Jessica.

However, although Jessica was able to gain weight and grow well her Alk Phos was elevated. Tribasic was started at 1/8 tsp BID while she continued to exclusively breastfeed. After six weeks, labs were rechecked and had normalized so Tribasic was discontinued. Jessica continued to exclusively breastfeed well after one year of age. (see Chapter 4 for Breastfeeding Considerations)

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	498	6.0	9.3	EBF @ night EMM + Neosure 24 kcal/oz @ day
3/29	6 weeks CA	10#4oz	669	5.4	10	EBF + 1/8 tsp Tribasic BID
5/5	12 weeks CA	13#2oz	403	5.6	10.2	Discontinue Tribasic & continue EBF
6/15	18 weeks CA	14#	372	5.8	10.6	EBF

Case Study #3

Paola is former 31-week, IUGR premature infant. She had no major medical complications in the NICU. Her mom pumped while Paola was in the NICU and had a great supply. Her mom expressed that she wanted to exclusively breastfeed her baby once she was discharged. While in the NICU, Paola's Alk Phos was slightly elevated, but was trending downwards with the current feeding regimen of EMM fortified with EnfaCare.

After Paola was discharged, her mom stopped pumping and started breastfeeding Paola with the exception of 2, 2-oz bottles of 22 kcal/oz EnfaCare formula per day. Her mom expressed concern with her milk supply. Her mom had stopped pumping after breastfeeding & also wasn't pumping when she was offering a bottle, which had dramatically decreased her milk supply.

Labs were checked and Paola's Alk Phos was extremely elevated even though Paola was gaining weight and growing well. It was recommended that mom continue to breastfeed on demand and

supplement with 1-2 oz of formula afterwards as needed until her milk supply had increased. It was also recommended to pump after breastfeeding to help increase breastmilk supply.

Tribasic was started at 1/8 tsp BID & labs were re-checked in 6 weeks. Slowly, with additional supplementation, Paola's Alk Phos started to trend downward and mom's milk supply increased with pumping. Although Paola's mom was never able to regain her full milk supply, she was able to continue to breastfeed until Paola was 6 months while supplementing with a small amount of formula. (see Chapter 4 for Breastfeeding Considerations)

Date	Adj. Age	Weight	Alk Phos	Phos	Ca	Feeding Method & Recommendations
5/8	31 wks GA	2#9oz	502	5.8	9.6	NICU: TPN x 11 days, HMF + EMM x 29 days
6/20	37 wks GA	5#	482	5.9	9.3	Discharge: EMM+EnfaCare 24 kcal/oz
7/5	39 wks GA	5#12oz				Breastmilk + 4 oz of EnfaCare QD
7/19	1 wk CA	6#15oz	927	5.4	10.4	Breastmilk + 4-6 oz formula Start Tribasic 1/8 tsp BID
8/24	5 wks CA	9#	505			Breastmilk + 6 oz formula + Tribasic 1/8 tsp QD
10/19	13 wks CA	12#8oz				Breastmilk + 8 oz formula discontinued Tribasic

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

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

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CHAPTER 4

Breastfeeding considerations

The American Academy of Pediatrics 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.

"Feeding human milk to preterm infants provides nutritional, gastrointestinal, immunological, developmental, and psychological benefits that may impact their long term health and development. Human milk is advocated as the nutrition for preterm infants because it provides substances not supplied in formula."(Callen & Pinelli, 2005, p. 73)

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 for exclusively breastfed babies who are gaining weight well, they may or may not be consuming adequate calcium and phosphorus with unfortified breastmilk therefore it is important to check bone labs and monitor weight gain 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
- Protection against necrotizing enterocolitis (NEC) and late-onset sepsis
- 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 (Refer to the next section, "Options for decreasing breastmilk fortification").
- Concentration of EMM may be increased in order to maximize nutrition in a limited number of bottles. Bottles of EMM can be fortified to 24, 27, or 30 kcal/oz.

If the family is opposed to the use of bottles for feeding:

- o Consider the use of a supplemental nursing system (SNS) or alternative feeding method.

If mom does not have a full milk supply:

- o May feed a transitional formula (EnfaCare or Neosure) in addition to breastfeeding.

Options for decreasing breastmilk fortification

Evaluation of readiness to reduce fortification:

In order to decrease breastmilk fortification a breastfeeding infant must demonstrate:

- Ability to sustain adequate growth
- Ability to sustain an appropriate ad lib milk intake
- Lab values are within normal limits

If the breastfed infant is not able to demonstrate these abilities, it is recommended to continue to fortify breastmilk. The timeline for needing fortified breastmilk varies from infant to infant. For example, a baby born at 24 weeks gestation with a birthweight <1000 g may need to be on breastmilk fortification for the entire first year of life in an extreme circumstance, while another infant with the same gestational age may only need fortification for 1-2 months post-discharge while working towards full breastfeeding.

Methods for reducing fortification:

If the breastfed infant is able to demonstrate the ability to sustain adequate growth, to sustain an appropriate ad lib milk intake, and maintain lab values that are within normal limits:

- Decrease fortification of breastmilk bottles can be done incrementally while monitoring weight gain to ensure intake and weight gain goals are met. For example, if an infant is taking 8 bottles of fortified breastmilk per day, decrease to 6 bottles of fortified breastmilk with two breastfeedings and a weight check in one week. Continue process weekly until off fortification. Continue support from a dietitian and lactation consultant during this transition to ensure nutritional needs are met.

It cannot be stressed enough that all preemies are different and need to be evaluated individually especially when being fed breastmilk. The key components to making this assessment are intake, growth, and lab values. Close follow-up is vital to ensure nutritional needs are being met.

Table 4.1: Breastfeeding Progression for the Preterm Infant

Breastfeeding (BF) Progression for Preterm Infants: Based on 100% feeds as Mother's milk**

If the baby's doctor recommends a breastmilk fortifier (a nutrient powder or liquid), add the fortifier to all mother's milk given by bottle or gavage.

← Usually started in the hospital → At home →						
	Phase 1: Always follow BF with bottle or gavage	Phase 2: Once per day BF without bottle or gavage afterwards	Phase 3: Twice per day BF without bottle afterwards	Phase 4: 3–4 times per day BF without bottle afterwards	Phase 5: 5–6 times per day BF without bottle afterwards	Phase 6: Exclusive Breastfeeding
Daily Feeding Plan (x/d = times per day)	To Breast: 1-4x/d Gavage/Bottle**: 8x/d Pump: 8-10x/d	To Breast: 2-4x/d Gavage/Bottle**: 7x/d Pump: 7-8x/d	To Breast: 3-5x/d Bottle**: 6x/d Pump: 6-8x/d Once a day, okay to go 5-6 hours without pumping	To Breast: 4-8x/d Bottle**: 3-5x/d Pump: 6-8x/d	To Breast: 6-8x/d Bottle**: 2x/d Note: Earlier, sicker babies may need to continue these fortified bottles for a longer time, for the extra nutrients.	To Breast: On demand. Bottle**: None Pump: As needed
Criteria to Trial this Phase Baby should meet all criteria listed before moving into the phase. Continue to check mom's milk supply & pump as needed.	- Follow baby's cues - Typically preemies ready for nutritive nursing by 32 weeks PMA (PMA = Post-Menstrual Age; is referred to as "Corrected Age" in the post discharge period.)	- Nippling ≥ 50% total daily volume - One time recently per scale took ≥ 40% of feed volume at breast - If < 36wks PMA, min. weight (wt) gain: 15 g/kg/d - If > 36 wks PMA, min. wt gain: 25 g/d If growth drops below goal for >3 days: - Return to Phase 1	- Baby ready for more breastfeeding, per cues - Nippling 100% total daily volume - Per scale, usually takes ≥ 60% goal feed volume when checked - Wt, Length (L), Head (HC) growth good If growth drops below goal for >3 days, either: - Return to Phase 2, - Or consider higher kcal/oz fortification	- Baby ready for more breastfeeding, per cues - Ca, Phos, Alk Phos labs WNL at NICU discharge or last outpt check ‡ - Per scale, volumes at breast are increasing - Good growth continues - Total fluid intake appears appropriate Reassess wt gain after 1 wk into Phase 4; reassess wt, L, HC after 2-4 wks - Reassess labs after 1 mo. in phase 4 ‡	- Baby ready for more breastfeeding, per cues - Wakes predictably to feed - Takes bottles well - Good growth If growth slows at this phase: - Check Mom's supply and pump more if needed - Consider higher kcal/oz fortification of bottles	- Baby ready for more breastfeeding and seems satisfied without bottle afterwards - Good growth - Ca, Phos, Alk Phos WNL at last check ‡ - Reassess wt gain after 1 wk into Phase 6; wt, L, HC at 1 month - Reassess labs after 1 month‡
Comments	- Goal is to pump at least: Day 6: 12-16 oz/ day Day 10: 20 oz/ day - Kangaroo care as often as able	- Learn to use the breastfeeding scale - Talk with nurse or lactation consultant about whether to offer one or both breasts when nursing	- Help baby change from NICU schedule to "on demand" feeds, usually every 2½-3 hrs - Using scale with every BF may be best now	Offer breast every 2-4 hours, per cues	- Nurse on demand, at least once every 3 hours - Continue to check pre- and post- breastfeeding weights, as pumping decreases	- Typically preemies could be ready for Phase 6 by 42-44 weeks PMA - For several months, feeding cues may be more subtle than a full term baby

****Based on 8 feeds/day of breastmilk; adjust number of bottles for other schedules and/or lower milk supply. ‡ If <34 wks GA & <1500g at birth, or history of osteopenia.**

Baby's Cues for Feeding

When baby is hungry and ready to eat, you may see:

- Baby is rooting and/or bringing hands to mouth
- When you touch baby's lips, s/he opens mouth with tongue down and forward
- Baby takes nipple in mouth when offered

Some general signs that baby is developmentally mature enough to be offered breastfeeding and nipple:

- Baby manages milk flow without double swallow, gurgly sounds, or splashing of milk from mouth
- Baby stays quiet and alert through most of feeding
- Baby paces well with feeding without much help. (Burst of sucks, swallow, breathe. Some pausing between bursts is normal)
- When feeding, baby's breathing and heart rate stays about same as usual

Keep in mind that even as preterm infants get older, their cues may not be as obvious as a full term baby's. For example, it is not typical for a preemie to cry loudly when hungry.

Baby's Cues to Pause Feeding

Baby will give cues if s/he needs a pause from feeding. If baby shows the signs listed below, pause feeding for baby to rest briefly:

- Repeatedly pushing nipple out of mouth or turning head away
- Does not open mouth, does not bring tongue forward
- Falls asleep and is difficult to arouse
- Color changes, hiccups, gags, sneezes, or yawns repeatedly
- Arching back, fingers spread wide, flailing movements, squirming
- Weak cry, irritable, fussy
- Suck is weak or without rhythm
- Jaw is slack and not closing around nipple
- Compresses nipple instead of sucking
- Starts losing more and more fluid out of corner of mouth
- If on monitor: desaturates repeatedly

If baby continues to show these signs, stop feeding for now and try again later in the day following baby's cues.

Considerations for Fortification of Breastmilk

- Fortifying mother's milk (adding nutrient powders or liquids) helps preterm babies in many ways. Preterm infants who are on fortifier supplement show improved weight gain, growth protein status, bone growth and lab values. These preterm infants are often discharged from the NICU earlier than preterm infants receiving formula only.
- Fortifiers have the most lasting benefits for infants less than 34 weeks gestational age and/or less than 2000 grams (4.5 pounds) at birth.
- Generally, a preterm baby is ready to try stopping fortifiers when s/he: is growing well, has normal nutrition lab values, and takes at least 2.25 fl.oz. per day for every pound of weight (Ex: a 4.5 pound baby consuming at least 10 fl.oz. daily).
- Fortifiers may be needed longer for babies who have: been on TPN more than 4 weeks, demonstrating slow growth, poor bone growth, on diuretic medications, and/or poor nutrition lab values in the NICU.
- Each preterm baby is unique and their feeding, nutrition, and growth should be evaluated individually. Work with the family and their baby's doctor to increase nursing at breast and decrease the use of fortifiers. This handout can be a guide to help with that discussion.
- Families may also find it helpful to work with a dietitian, feeding specialist, community health nurse, and/or lactation consultant experienced with preterm infants.

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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 4.2: 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 (not "frost free")	Freezer ("frost-free")
Storage Temperature Ranges	60-77° F (<25° C)	59° F (15° C)	<32-40° F (<4° C)	5° F (-15° C)	0° F (-19° C)	0° F -19° C
Freshly expressed breastmilk	4-8 hours*	24 hours	3-8 days*	2 weeks	6 – 12** months	6 – 12** months
Thawed breastmilk (previously frozen)	1-4 hours	Do not store	24 hours	Never refreeze thawed milk	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.

** Milk stored for longer durations in the ranges listed is safe, but some of the lipids in the milk undergo degradation resulting in lower quality milk.

References: Medela, Inc, La Leche League International,; U.S. Department of Health and Human Services Office of Women's Health (2010), Academy of Breastfeeding Medicine (2010), American Dietetic Association (ADA) Infant Feedings: Guidelines for Preparation of Formula and Breastmilk in Health Care Facilities (2011).

Table 4.3: Fortified Breastmilk Storage Guidelines

Refrigeration	Store at 35 – 40° F (2 – 4° C) no longer than 24 hours
Room temperature	Store at 60-78° F (16-29° C) for no longer than 2-4 hours***; If bottle is warmed, discard after 1 hour
After feeding begins	Feed within 1 hour or discard immediately. Do not re-refrigerate left over milk for later.

***Editors recommend limiting to 2 hours or per manufacturer's instructions

Reference: ADA Infant Feedings: Guidelines for Preparation of Formula and Breastmilk in Health Care Facilities (2011)

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
<http://newborns.stanford.edu/Breastfeeding/MaxProduction.html>
- Hand expression
<http://newborns.stanford.edu/Breastfeeding/HandExpression.html>

Types of breastpumps

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. The chart in this section will help 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 <http://medela/findlocation.com> or <http://ameda.com/gmap.php>

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 in detail and discusses the research known about each drug. While some drugs are listed by both their brand names and generic names, many are only listed by their generic names. It includes only drugs, not other substances or environmental agents.
<http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?LACT>
- 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.
<http://pediatrics.aappublications.org/content/108/3/776.full?eaf>
- 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 4.4: Types of Breast Pumps

Type	Reasons for Use	Examples/Brands
Convenience	<i>For occasional separation from infant:</i> • Missed Feeding • Evening out • Weekend away • Very part-time work	<i>Manual Pumps:</i> • Medela Harmony • Medela Base • Philips Avent Manual Pump • Ameda One-Hand Manual Pump • Hygeia Manual Pump <i>Single Electric Pumps:</i> • Medela Mini Electric • Medela Swing
Work or School (Long-term use)	<i>For routine mother-infant separation:</i> • Work • School • Preterm or Special Needs Infant (once milk supply is well established)	<i>Personal Use Double Electric Pumps:</i> • 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)	<i>For frequent use:</i> • To establish or increase milk supply <i>Examples:</i> • Premature infant • Hospitalized ill infant • Twins or multiples • Severe recurrent engorgement • Breast surgery	<i>Hospital-Grade Double Electric Pumps:</i> • Medela Lactina • Medela Symphony • Ameda Elite • Hygeia EnDeare

Banked human milk

Banked human milk vs. Donor breastmilk

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, ranging from \$3.50-\$4.00 per ounce. In order to receive banked breastmilk after discharge, a family would need a prescription from their pediatrician and would need to call a human milk bank to purchase it.

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 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.

Human milk banks

California

Mothers' Milk Bank

751 South Bascom Ave

San Jose, CA 95128

Phone: (408) 998-4550

Website: www.sanjosemilkbank.com

Colorado

Mothers' Milk Bank Presbyterian

St. Luke's Medical Center and Rocky Mountain Hospital for Children

1719 E 19th Ave

Denver, CO 80218

Phone: (303) 869-1888

Website: www.milkbankcolorado.org

Indiana

Indiana Mothers' Milk Bank, Inc.

4755 Kingsway Drive, Suite 120

Indianapolis, IN 46205

Phone: (317) 536-1670

Toll-free: 1 (877) 829-7470

Website: www.immilkbank.org

Iowa

Mother's Milk Bank of Iowa

University of Iowa Hospitals and Clinics

119 2nd Street, Suite 400

Coralville, IA 52241

Phone: (319) 356-2652

Website: <http://www.uihealthcare.org/MilkBank/>

Michigan

Bronson Mothers' Milk Bank

601 John Street, Suite N1300

Kalamazoo, MI 49007

Phone: (269) 341-8849

Website: www.bronsonhealth.com/MedicalServices/Obstetrics/page928

North Carolina

WakeMed Mothers' Milk Bank and Lactation Center

3000 New Bern Ave

Raleigh, NC 27610

Phone: (919) 350-8599

Website: www.wakemed.com/body.cfm?id=135

Ohio

Mothers' Milk Bank of Ohio

Grant Medical Center @ Victorian Village Health Center

1087 Dennison Avenue

Columbus, OH 43201

Phone: (614) 544-0810

Website: www.ohiohealth.com/mothersmilkbank

Texas

Mothers' Milk Bank at Austin

2911 Medical Arts St. Suite 12

Austin, TX 78705

Phone: (512) 494-0800

Toll-free: 1 (877) 813-MILK (6455)

Website: www.texasmilkbank.org

Mothers' Milk Bank of North Texas

1300 W. Lancaster Suite 108

Ft. Worth, TX 76102

Phone: (817) 810-0071

Toll-free: 1 (866) 810-0071

Website: www.milkbank.org

Developing mother's milk banks

Florida

Mothers' Milk Bank of Florida

2520 N. Orange Ave. Suite 103

Orlando, FL 32804

Email: milkbankofflorida@gmail.com

Massachusetts

Mothers' Milk Bank of New England

225 Nevada Street, Room 201

Newtonville, MA 02460

Phone: (781) 535-7594

Website: www.milkbankne.org

Mississippi

Mothers' Milk Bank of Mississippi

PO Box 1538

Madison, MS 39130-1538

Website: www.msmilkbank.org

Missouri

Kansas City Regional Human Milk Bank

St. Luke's Hospital

Phone: (816) 932-4888.

Email: mcross@saint-lukes.org

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

Refer to Oregon appendix for a listing of donor depot drop-off sites.

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CHAPTER 5

Breastmilk, formula and fortification

Human milk and formula descriptions

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.

Additional feeding considerations for premature infants

- *Standard Term & Specialized formulas:* These formulas are designed for babies born at term and thus have less calcium, phosphorus, and protein than 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 and Formulas

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 5.1: Human Milk and Formulas (continued)

Human Milk Fortifiers and Preterm Formulas for In-Hospital Use		
<i>Indication:</i> 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. <i>Contraindication:</i> Preterm infants taking >500ml/day, or full term and failure to thrive infants due to hypervitaminosis & hypercalcemia. <i>Note:</i> 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.		
Human Milk Fortifiers		
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	

Table 5.1: Human Milk and Formulas (continued)

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.		
<i>Indications:</i> 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. <i>Contraindications:</i> 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

Standard Milk-Based Formula		
<i>Indications:</i> Infants >34 weeks and >2000 grams with no special nutritional needs. <i>Protein source:</i> Intact cow's milk proteins casein and whey modeled after human milk to aid in absorption. <i>Note:</i> 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

Table 5.1: Human Milk and Formulas (continued)

Reduced or No Lactose Formula		
<i>Indications:</i> Lactose sensitivity, GI upset or constipation. <i>Contraindications:</i> galactosemia <i>Protein Source:</i> 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. <i>Indications:</i> GI upset, constipation. <i>Contraindication:</i> Known cow's milk protein allergy. <i>Protein source:</i> 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.

Table 5.1: Human Milk and Formulas (continued)

Extensively Hydrolyzed Protein Formulas		
Hypoallergenic; lactose, sucrose free. <i>Indications:</i> Intact cow's milk protein and soy protein allergy, intractable diarrhea, multiple food allergies, lactose and sucrose intolerance. <i>Protein source:</i> 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 <i>Additional indications:</i> galactosemia
Nutramigen RTU	Mead Johnson	Not indicated for galactosemia
Pregestimil, powder	Mead Johnson	Use level, packed scoops. 55% MCT oil. <i>Additional indications:</i> 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. <i>Additional indications:</i> 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. <i>Indications:</i> Cow and soy milk protein allergy, multiple food protein intolerance, GERD, short bowel syndrome, malabsorption, eosinophilic esophagitis, and galactosemia. <i>Protein source:</i> Synthetic free amino acids <i>Note:</i> 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	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. <i>Indications:</i> Lower minerals for impaired renal function, neonatal hypocalcemia. <i>Precaution:</i> Additional iron may be needed.		
Product Name	Manufacturer	Product characteristics
Similac PM 60/40	Abbott	

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 these 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
Similac Expert Care for Diarrhea	Abbott	Used for the diarrhea management in infants >6 months old

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

	<u>Calories</u>	<u>ml</u>
3 scoops (26.1 gm)	133.6	20
5.5 oz water		<u>165</u>
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>
- <http://www.nutricia.com>

Formula preparation and storage guidelines

1. Preparing the area

- Wash hands with hot, soapy water.
- Clean the area for preparing formula.
- Wash & scrub the nipples, bottles, caps, etc. with hot, soapy water. Rinse well & allow to air dry.

2. Checking the formula can

- Check the expiration date
- Make sure the can is not dented.
- Wipe off the lid of the formula with a clean cloth.

3. Adding the formula

Powder formula

- Measure water in bottle.
- Add formula on top of water.
- Always measure using level scoops; never mix less than full scoops. Refer to package directions if scoops are measured as unpacked or packed.
- Close bottle & shake for 10-20 seconds.
- Once formula can is opened, store in a cool, dry place.
- Discard opened can of formula within one month.

Liquid concentrate formula:

- Shake can of formula well before opening.
- Add equal amounts of water & formula to bottle.
- Once formula can is opened, store it covered in the refrigerator.
- Discard within 24-48 hours (refer to can).

4. 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.
- Discuss best source of water with your healthcare professional.

5. Heating formula

Ways to warm formula

- Hold bottle under warm running water & then swirl around.

- Place bottle in bowl of warm water (not boiling) & then swirl around.
- Always test temperature on back of wrist before giving to baby.

Do not microwave or boil formula

- Possible hot spots can burn the baby.
- Nutrients can break down.
- Can cause leaching of chemicals from plastic bottles into the liquid.

Table 5.2: 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.

*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

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 (see table 6.1)

- Breastmilk/breastfeeding or infant formula is the primary source of nutrition for at least the first 6 months corrected age and should continue until 1 year corrected age.
- Although the AAP supports exclusive breastfeeding/breastmilk with the exception of medicinal/nutrient supplements until 6 months, complementary or solid foods may be introduced between 4 and 6 months corrected age, based on developmental stage and feeding skill.
- Iron fortified cereals and pureed meats are good first foods as they provide ample protein, iron, and zinc.
- Introduce a variety of foods by the end of the first year.
- Withhold cow's milk until 12 months corrected age.

TABLE 6.1: Feeding Your Preterm Infant Step by Step

Name: _____ Date: _____ Date of Birth: _____ Actual Age: _____ Corrected Age: _____

It is important to discuss with your baby's doctor or dietitian when to start solid food. Every baby is different and your baby may be ready for solid food sooner or later than another baby depending on their readiness and feeding skills. Offer solids on a spoon; do not add solids to the bottle.

Date	Actual Age	Corrected Age	Developmental Stages and Feeding Skills	Foods	Daily Amounts	Feeding Tips
Birth To _____	0 to _____ months	0-4 months	• Mouth closed most of the time • Breastmilk or formula leaks from mouth • Pushes spoon out with tongue • Babies make sucking movements from their mouths, root toward one side or another, fuss or cry when they are hungry • Babies stop sucking, fall asleep, or turn away from the nipple when they are full	Breastmilk and/or Formula 0-1 month 1-2 months 2-3 months 3-4 months	Nurse on demand, at least 6-8 times per day to keep up your milk supply 2 oz., 8-12 times per day 2-4 oz., 8-12 times per day 3-5 oz, 6-8 times per day 4-6 oz, 6-8 times per day	• Feed your baby when he is alert and hungry • Nurse on demand • Six wet diapers per day is a good sign that your baby is eating enough • Putting your baby to bed with a bottle may cause choking • Heating formula or pumped breastmilk in the microwave is not recommended
_____ to _____	_____ to _____ months	4-6 months	When your baby shows these signs of readiness, your baby may be ready for solids • Sits with support • Interested in watching others eat • Opens mouth when food is offered • Able to move semi-solid food from the front of tongue to back • "Chews" by moving mouth up and down	Breast milk and/or Formula Iron-fortified baby cereal Pureed meats, beans and legumes	On demand 6-8 oz, 4-6 times per day 1-2 tablespoons 2 times per day 1-2 tablespoons per day	• Breast milk or formula has all the nutrition your baby needs, if your baby doesn't seem interested in solids, wait a week and offer again • Feed solids from a spoon; infant cereal is not to be added to the bottle • Feed only one new cereal each week • Pureed meats, beans and legumes can be started before cereal since they provide good sources of iron • Feed in a high chair, with supervision

Date	Actual Age	Corrected Age	Developmental Stages and Feeding Skills	Foods	Daily Amounts	Feeding Tips
____ to ____	____ to ____ months	6-8 months	• Sits with little or no support • Holds bottle by self. • Opens mouth when food is offered and takes food from spoon with lips • May gag on new food textures • Beginning to chew food	Breast milk and/or Formula Iron-fortified baby cereal Pureed meat, beans and legumes Pureed vegetables and fruit Crackers, bread, toast	On demand 6-8 oz, 4-6 times per day 1-2 tablespoons per day, increase to 2-4 tablespoons, 2 times per day 1-2 tablespoons per day 1-2 tablespoons per day, increase to 2-3 tablespoons, 2 times per day 2 crackers, ¼ slice bread per day	• Feed iron-fortified baby cereal from a spoon • Pureed meats, beans and legumes and certain vegetables (green beans, peas, sweet potatoes) can be started before cereal since they provide good sources of iron • Add one new food every 3-5 days • Encourage exploration and messiness to help increase food acceptance • Juice is not necessary; if offered, should be 100% fruit juice in a cup and limited to 2oz daily diluted with water <u>Textures:</u> Start with pureed foods first, and then add cooked or mashed foods and finely chopped foods later
____ to ____	____ to ____ months	8-12 months	• Less loss of liquid from cup • Tries to use spoon to feed self • Moves food with tongue from center to sides of mouth • Chews food • Picks up food with middle finger and thumb	Breast milk and/or Formula Cheese (1/2 ounce) Plain yogurt (1/2 cup) Cottage cheese (¼ cup) Iron-fortified baby cereal Meat, beans, eggs and legumes Fruit and vegetables Crackers, bread, pasta and rice	On demand 4-6 oz, 4-6 times per day Offer daily 3-4 tablespoons per day, 1-2 times per day 3-4 tablespoons, 1-2 times per day 3-4 tablespoons, 2 times per day 2 crackers, ¼ slice bread or 2-4 tbsp pasta/rice per day	• Offer fresh, soft fruit and cooked vegetables in bite size portions • Be patient. Babies are messy when they feed themselves • Offer baby extra water in a cup with solid feedings • Always taste heated foods before serving them to baby to make sure they are not too hot • Offer finger foods to encourage self feeding • Let baby hold a spoon for self-feeding. • Avoid foods with added salt and sugar The following foods should not be given to infants because of risk of choking: nuts/nut butters, raisins, whole grapes, hot dogs cut in rounds, uncut stringy meats, hard raw fruit or vegetables

*Cow's milk should not be given until after 1 year corrected age.

*Honey, including processed foods containing honey, should not be given to infants due to risk of botulism poisoning

Adapted from: Oregon Dairy Council; Nevin-Folino, N. L. (Ed.). (2008). Pediatric Manual of Clinical Dietetics, 2nd Edition. Chicago, IL: American Dietetic Assoc. American Dietetic Association on-line Nutrition Care Manual

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, anticholinergics).
- 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.
5. Initiation of 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 1 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.
 - Consider a referral to a practitioner trained in infant massage.
 - 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.

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 lipid 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.

Table 6.2: 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)
Sources	• breast milk • 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.

Table 6.2: Probiotic and Prebiotic Use in Preterm Infants continued

	Probiotics	Prebiotics
Benefits in Infants	• Improve immune function • Treat infant diarrhea • Treat antibiotic associated diarrhea • Treat infant colic • Reduce intestinal inflammation • 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. Studies have indicated benefits for use in infants with infectious diarrhea, prevention of antibiotic associated diarrhea and prevention of NEC.	Currently there are no evidence based guidelines regarding dosing for infants.

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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. 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 frequently are cared for in the normal maternity unit rather than the NICU. However, they are at substantially higher risk for morbidity and mortality than infants born at term.
- During the birth hospitalization, late preterm infants have elevated rates of:
 - Feeding difficulties
 - Hypoglycemia
 - Jaundice
 - Respiratory distress
 - Apnea
 - Temperature instability
- In the first month of life, late preterm infants are more likely than term infants to be readmitted to the hospital for:
 - Feeding difficulties
 - Dehydration
 - Jaundice
 - Suspected sepsis
- Risk factors for post-discharge morbidities and re-hospitalization include:
 - First born child
 - Breastfed
 - Mother with labor and delivery complications
 - Recipient of public insurance 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, immature neural function, lower stamina and lower oral-motor tone in comparison to term infants. For example, they may be sleepier than a term infant, failing to awaken for needed feedings. Both breastfed and bottle-fed late preterm infants are at elevated risk for feeding problems and should be monitored more closely for adequate intake and growth until they have at least reached 40 weeks postmenstrual age (i.e. due date).

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. If baby is unable to effectively latch on and transfer milk, it is recommended that mother express her breastmilk with a combination of hand expression and pumping using a hospital-grade electric pump. Mothers may need to express milk for several weeks following birth to bring in and sustain an adequate milk supply, until the infant is able to fully breastfeed with normal growth. 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 following initial hospital discharge.

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 birthweight
- 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 >20 grams/ day, after first week of life

Special nutrient considerations

It is likely that late preterm infants have additional needs beyond that of a term infant. However, no recommendations are currently available due to lack of research. The benefit of enriched formula/fortifiers is unclear even in infants born earlier than 34 weeks gestational age. Thus, current practice is to feed late preterm infants either unfortified mothers milk or a term infant formula. If the infant has difficulty taking adequate volumes for growth, a term infant formula can be used to fortify expressed mothers milk or the term formula can be mixed to 22 or 24 kcal/oz. This allows the infant to take in smaller total volumes but still meet nutrition needs. Typically late preterm infants do not require fortified/ concentrated feedings for an extended period of time.

Iron

Preterm infants have lower iron stores than term infants. By 1 month post birth (Note: not 1 month corrected age), 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. Formula-fed infants taking at least 150 ml/kg/day will receive about 2 mg iron/kg/day from feeds. However, 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.

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.

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