Nutrition Practice Care Guidelines for Preterm Infants in the Community

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Revised 2016

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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 defined by Weight (U.S. Classification):

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

Preterm Infant defined by Age (WHO Classifcation):

- Moderate to Late Preterm: 32 to <37 weeks
- Very Preterm: 28 to 32 weeks
- Extremely Preterm: <28 weeks

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 10^{th} and 90^{th} 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.

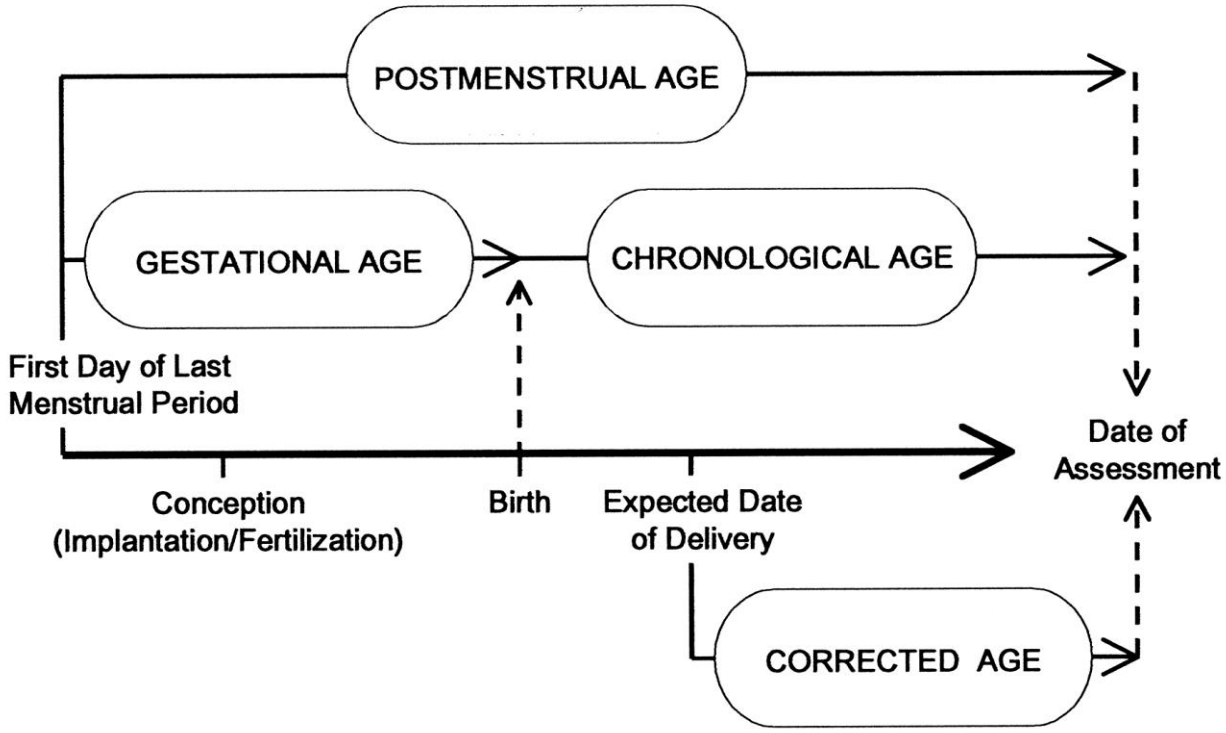
Symmetric SGA: Infants born with small body (weight and length) and head growth; often indicates that the intrauterine growth restriction was prolonged.

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
- Slow feeding and low feeding endurance
- Reflux and gagging
- Oral aversions
- 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
- Cost of feedings: supplies, tubing, special nipples
- Daycare 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/or neurodevelopmental clinics are located and how to contact them; including referrals to a developmental pediatrician, occupational therapist, speech and language pathologist, physical therapist
- How to contact a pediatric dietitian
- How to contact a lactation consultant
- How to contact Early Intervention
- How to access rental breast pumps

Feeding concerns for high-risk newborns at discharge

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

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 < 6oz/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 years	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:

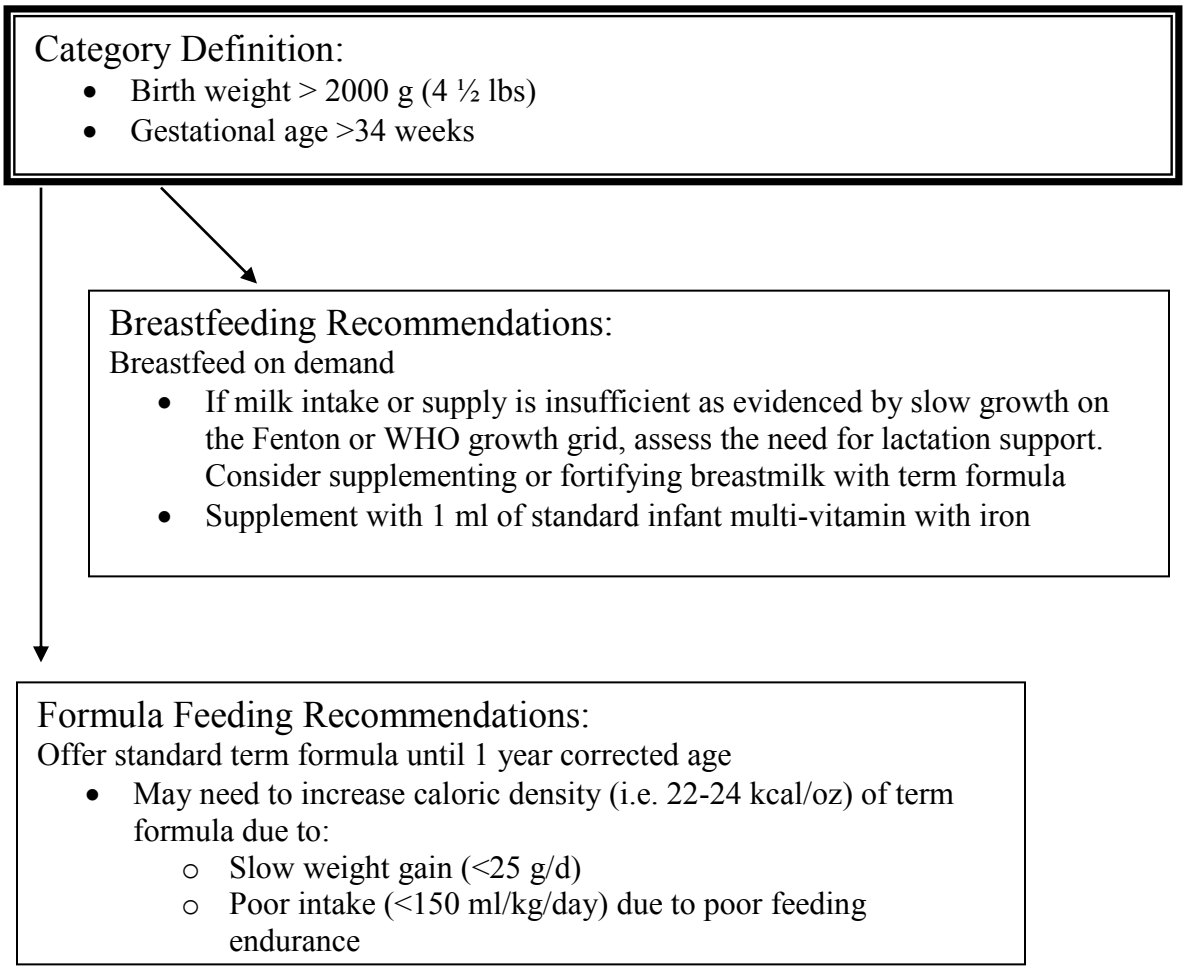
- Birthweight <1000 g
- TPN >1 month
- Weight at discharge is less than birthweight percentile on growth chart
- Abnormal markers of bone mineralization

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, higher percentage of lean 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's weight has been tracking at the same percentile as their percentile in length for 2-3 months after discharge, 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



2. Moderate Risk – Low Birth Weight Infant

Category Definition:

- Infant birth weight between 1500 g (3 ⅓ 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 (see Chapter 5)
- Check bone labs 1 month after discharge and/or or 1 month after infant starts exclusively breastfeeding (without fortification)
- 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 every 1-2 weeks for the first month 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 ≤ 1500 g (3 ⅓ lbs)
- Slow weight gain (<25 g/day)
- Poor intake (< 150 ml/kg/day)
- Elevated alkaline phosphatase (> 500 U/L) and/or low phosphorus (< 4 mg/dl)
- Complicated NICU course, which could include history of TPN >4 weeks & chronic lung disease
- Weight-for-corrected age or weight-for-length < 2nd-5th percentiles on the Fenton or 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 (see Chapter 5)
- 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 every 1-2 weeks for the first month 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 </= 1000g 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. These are the growth charts we recommend by age:

- From birth until discharge, use Olsen or revised Fenton growth charts
- From discharge (~36 weeks GA) until 10 weeks CA use Fenton growth chart
- From 10 weeks CA 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:

CDC recommends that clinicians in the United States use the 2006 WHO international growth charts for infants and children aged < 24 months. The 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. 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. 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, revised 2013:
The Fenton growth chart was updated in 2013. The new gender-specific growth grid represents an updated dataset of 4 million preterm infants from six developed countries born between 1991 and 2006. This growth grid starts at 22 weeks gestation and continues until 50 weeks gestation (10 weeks corrected age). The growth grid can be used to assign gestational age up to 36 weeks of age. Between 36 to 50 weeks gestation, the percentile lines have been slowly smoothed out to match the percentile lines of the World Health Organization growth chart starting at 10 weeks corrected age. There are growth percentiles lines for the 3rd, 10th, 50^{th,} 90th and 97th percentiles. This chart includes 100 gram graph increments and also reflects actual age instead of completed weeks. This growth grid may be ideal to use after NICU discharge due to the smoothing of the growth curves starting at 36 weeks which would give preterm infant about 15 weeks post-discharge growth before transitioning to a term growth chart.
This growth chart can be downloaded from: http://ucalgary.ca/fenton/2013chart

New Intrauterine Growth Curves, Irene Olsen University of Penn., 2010:
In 2010 Irene Olsen created gender specific intrauterine growth curves. This growth chart starts at 23 weeks gestation and continues until 41 weeks gestation. . These curves are based on a large, racially diverse United States sample size from using data from 1998-2006. These growth grids provide clinicians with an updated tool for growth assessment in neonatal intensive care units that may better represent the United States diverse population. There are 100 gram increments and also 3rd, 10th, 50th, 90th and 97th percentile lines for easy monitoring. Small-for-gestational age (SGA) and large-for-gestational age (LGA) classifications using the Lubchenco curves differed significantly from the new curves for each gestational age. However, it is thought that the Lubchenco curves are not a current representative of the U.S. population. More research into SGA and LGA classifications is needed. These newer growth curves are gaining acceptance in various neonatal units throughout the country.

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	○ 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 ○ 100% of reference population breastfed for 12 months and were predominately breastfed for at least 4 months. ○ Exclusion criteria included maternal smoking, birth <37wks or >42 weeks, multiple birth, substantial morbidity, low socioeconomic status, and unwillingness of mother to follow feeding criteria ○ Separate chart for boys and girls	○ Worldwide standard birth to 5 years ○ Healthy breastfed infant is standard against which all other infants are compared	○ Graph starts at term corrected age ○ It is recommended to change to CDC growth charts at 24 months; switch may create disjunction in growth classification ○ 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	○ Data from NHANES I, II, & III ○ Represents racial/ethnic diversity of US ○ Includes both formula-fed and breastfed infants ○ Does not include growth data from preterm & very low birth weight infants (<1500 gm) ○ Separate charts for boys and girls	○ Includes weight for length for birth to 24 months and BMI for children over 24 months ○ U.S. data birth to 20 years	○ Does not include VLBW infants, and age is chronological age, not adjusted gestational age ○ Difficult to interpret when catch-up growth has not occurred ○ 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, Revised 2013	○ Meta-analysis of published reference studies from 1997-2007 ○ Based on data from six developed countries: Germany, Italy, United States, Australia, Scotland, & Canada ○ 4 million preterm infants in sample size ○ Gender Specific, 22 to 50 weeks gestation ○ Close agreement with data from 22 to 36 weeks & at 50 weeks, smoothing of curve from 36 weeks to 50 weeks to align with WHO growth grid.	○ Starts at 22 weeks gestation ○ Can be used to assign gestational age up to 36 weeks ○ Percentile curves at 3rd, 10th, 50th, 90th & 97th ○ 100 gram increments ○ Chart designed to enable plotting as infant measured, not as completed weeks ○ Equal to WHO chart at 50 weeks- smoothing of the percentile lines between 36 to 50 weeks gestational age may make it easier to transition to WHO chart if following preterm infant after discharge.	○ Validity of this growth chart is limited by heterogeneity of the data sources
New Intrauterine Growth Curves Irene Olsen, 2010	○ Based on contemporary, large, racially diverse U.S. dataset from 1998-2006 ○ 257,000 preterm infants from 248U.S.NICUs across 33. states ○ Gender Specific, 23 to 42 weeks	○ Racially diverse sample from across the U.S. ○ Starts at 23 weeks gestational age ○ Percentile curves at 3rd, 10th, 50th, 90th and 97th ○ 100 gm graph increments ○ May decrease misclassification of SGA and LGA high risk infants	○ May be difficult to assess growth when abruptly switch to WHO growth grid at 40 weeks gestation ○ More research needed on the ability of the new SGA and LGA cutoffs to identify high-risk infants appropriately

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

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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 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 post-discharge 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).

Current research demonstrates the need to optimize the woman's diet before, during and between pregnancies. Nutritional deficiencies in a mother's diet and her weight status at the time of conception have been shown to cause persistent and systemic changes in her offspring's DNA. (Dominguez-Sala, et al, 2014). High maternal blood glucose is associated with fetal morbidity, macrosomia and subsequent complications in the neonatal period. 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 maintaining 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:

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

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.

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

Calculation for protein requirements:

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

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

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

Table 2.2: DRI/AI*s for Energy and Protein

Category	Age	Energy (Kcal/kg)	Protein (g/kg)	Protein (g/d)
Infant	0-6 mos	108	1.5	9.1*
Infant	6-12 mos	98	1.5	11.0
Child	1-3 yrs	102	1.1	13

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.

Corrected age = Chronological age – (40 weeks – 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 weeks – 30 weeks = 10 weeks (2 ½ months) premature
Step 2: Chronological age – number of weeks premature
4 months – 2 ½ months = 1 ½ months CA

Example 2: Calculation using a calendar

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

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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 – 130 kcal/kg	See Estimated Energy Requirement (EER) below	See EER equation
Protein	3.5-4.5 g/kg	1.5 g/kg/day OR 9.1 g/day	1.2 g/kg/day OR 11 g/day
Vitamin A	400-1100 mcg/kg/d	400 mcg/day or 1330 IU/day DRI	500 mcg/day or 1665 IU/day DRI
Vitamin D	400 –1000 IU/day (from milk + supplement)	10 mcg/day or 400 IU/day	10 mcg/day or 400 IU/day
Vitamin E	2.2-11 mg/kg	4 mg/day or 6 IU/day	5 mg/day or 7.5 IU/day
Calcium	120-200 mg/kg	200 mg/day	260 mg/day
Phosphorous	60 - 140 mg/kg	100 mg/day	275 mg/day
Iron	2-3 mg/kg	0.27 mg/day	11 mg/day
Zinc	1.4-2.5 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. (Koletzko, 2014)

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

Age of Infant	Estimated Energy Requirement
0 – 3 months	(89 X weight [kg]) – 100 + 175
4 – 6 months	(89 X weight [kg]) – 100 + 56
7 – 12 months	(89 X 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 (in the U.S.): 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 without Iron + separate Iron supplement	Continue until 12 months corrected age.
Iron-Fortified Formula	0.5 ml daily Infant Multivitamin without Iron	Stop when intake reaches about 32 oz/day (1000 ml).

Important biochemical parameters for post-discharge preterm infants

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.

Osteopenia of prematurity

Osteopenia of prematurity is a condition of decreased bone density, more common in premature, very low birth weight infants. Osteopenia, like rickets, may cause bone fractures and may negatively impact long term bone development and growth.

During fetal development, calcium and phosphorus are transferred from the mother to the infant reaching a peak accretion rate in the third trimester around 32-36 weeks gestation. As an infant's gestational age at birth decreases, the post-natal requirement for calcium and phosphorus increases. For VLBW infants, the need for additional calcium and phosphorus supplementation will likely last beyond the NICU stay.

Infants at high risk for osteopenia of prematurity:

- Born <27 weeks gestation
- Birthweight <1000 grams
- Severe chronic lung disease/bronchopulmonary dysplasia requiring diuretics and fluid restriction
- Long-term TPN (> 4 weeks) while in NICU
- Postnatal steroid use (as may affect mineral absorption)
- History of NEC
- Infants taking unfortified breastmilk or standard formula, including soy formula

The simplest way to assess bone development is to monitor serum levels of calcium, phosphorus and alkaline phosphatase. Osteopenia is characterized by low levels of calcium and phosphorus, and high levels of serum alkaline phosphatase. In the absence of other disease conditions, ALP provides an indirect indicator of bone cell activity. Significantly elevated alkaline phosphatase has been related to bone fractures and stunting of growth. These labs are 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 in the community:

- 1-month post-discharge for all infants:
    - With birthweight < 1500 g
    - At high-risk (listed above)
    - With labs prior to discharge outside the reference range
- If the premature infant is transitioning to breast or a term formula <3 mos corrected age
- If the premature infant has had marginal intake and slow weight gain

Table 3.4: Reference Table for Biochemical Parameters

Biochemical Marker	Reference Range*	Interpretation
Alkaline Phosphatase (ALP)	150 – 420 U/L	○ Marker of bone formation. ○ Levels may be elevated during periods of bone growth. ○ Levels > 600 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	○ Extracellular cation involved in skeletal development. ○ Elevated levels are a marker of bone formation. ○ 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)	○ Cellular anion involved in bone formation. ○ Elevated levels indicate skeletal disease, renal disease or excess phosphorus intake. ○ Low levels can indicate inadequate phosphorus intake. ○ Levels lower or higher than the reference range indicates a need for further assessment.
Vitamin D 25 (OH)	30-100 ng/ml	○ Levels <30 ng/ml indicate insufficiency. ○ Levels <20 ng/ml indicate deficiency. ○ Levels < 5 ng/ml indicate severe deficiency. ○ *Reference ranges may vary depending on the source.
Hemoglobin (Hb)	10.5 – 13.5 g/dl	○ Levels lower than the reference range may indicate iron deficiency.
Hematocrit (Hct)	33 – 39%	○ 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 of prematurity. While there are single forms calcium and phosphorus (i.e. Ca Glubionate, Ca Carbonate, PhosNa, PhosK) available at most pharmacies in liquid form, for ease of the preterm infant, Tribasic may be an effective supplement for this premature population. Tribasic is a calcium (Ca) and phosphate (P) supplement that can be given to infants to help improve their bone mineral status. Premature infants that would 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/phosphate supplement available for outpatient use.
- Tribasic contains 100 mg Ca and 50 mg P 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 (ALP).
- 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.

<u>Dosing Decision:</u>

ALP goal is < 600 U/L. If above 600, consult with a pediatric RD & refer to the following:

- If ALP is between 600-700 U/L, suggest ways to increase Ca and P:
  - Increase volume
  - Increase fortification
- If ALP is between 700-800 U/L, suggest changes to increase Ca and P:
  - 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/P levels must be calculated out before starting Tribasic. Do not exceed:
      - Goal Ca intake: 120-230 mg/kg/d
      - Goal P intake: 60-140 mg/kg/d
      - Goal ratio: 1.8-2:1
- If ALP is between 800-1000 U/L:
  - Suggest all of the above; and/or
  - Recommend checking vitamin D levels: 25-hydroxy Vitamin D
- If ALP is > 1000 U/L and increasing despite nutritional intervention:
  - Recommend checking a fractionated ALP 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:

- Tribasic is only available at compounding pharmacies.
- Tribasic comes in a powder form, and manufactured by Fairgone.
- It is preferable to have MD or provider with prescriptive rights call it into a compounding pharmacy since they may need to discuss it with the pharmacist since it is uncommon.

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 ALP was slightly elevated at 515 U/L. 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 post-discharge and his ALP, P 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**	**ALP** U/L	**P** mg/dl	**Ca** mg/dl	**Feeding Method & Recommendations**
9/11	27 weeks GA	2#4oz				NICU: TPN x 4 weeks HMF+EMM x 8 weeks EnfaCare x 1 week
11/28	39 weeks GA	5#13oz	515	5.3	9.2	Discharge: EnfaCare 24 kcal/oz
12/8	40 weeks GA	6#8oz				EnfaCare 24 kcal/oz
1/12	5 weeks 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 4 weeks corrected 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 6 weeks corrected age, her mom stopped pumping completely and she was successfully breastfeeding Jessica.

However, although Jessica was able to gain weight and grow well her ALP was elevated at 669 U/L. 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**	**ALP** U/L	**P** mg/dl	**Ca** mg/dl	**Feeding Method & Recommendations**
12/10	31 weeks GA	3#9oz				NICU: HMF + EMM x 5 weeks
12/18	32 weeks 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 milk supply. Her mom expressed that she wanted to exclusively breastfeed her baby once she was discharged. While in the NICU, Paola's ALP was slightly elevated at 482, 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 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 ALP was extremely elevated at 927 U/L 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	**Adjusted Age**	**Weight**	**ALP** U/L	**P** mg/dl	**Ca** mg/dl	**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	392			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 20 oz 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

Chapter 3 references

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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.

> " Human milk from the preterm infant's mother is the enteral feeding of choice.…In addition to its nutritional value, human milk provides immunologic and antimicrobial components, hormones, and enzymes that may contribute positively to the infant's health and development."
>
> *AAP, 2014, p. 103*

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. 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 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 fortification 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:

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

If mom does not have a full milk supply:

- 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: <u>Based on 100% feeds as Mother's milk</u>**

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**	**<u>Phase 2:</u>** **Once per day BF without bottle or gavage afterwards**	**Phase 3:** **Twice per day BF without bottle afterwards**	**<u>Phase 4:</u>** **3–4 times per day BF without bottle afterwards**	**Phase 5:** **5–6 times per day BF without bottle afterwards**	**<u>Phase 6:</u>** **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 nippling:
- 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.

	Room Temperature	Refrigerator	Freezer*
Storage Temperature Ranges	60-85° F (16-29° C)	<39° F (<4° C)	0° F (-20° C)
Freshly expressed breastmilk	4-6 hours	4-8 days	up to 12 months**
Thawed breastmilk (previously frozen)	Refrigerate if not used immediately	24 hours	Never refreeze thawed milk

* Freezer refers to a standalone freezer, also known as a deep freezer. For a freezer compartment of a refrigerator, milk storage should be limited to 3 months.

** Milk stored for longer durations in the range listed is safe, but some of the lipids in the milk undergo degradation resulting in lower quality milk.
References: ADA Infant Feedings: Guidelines for Preparation of Formula and Breastmilk in Health Care Facilities (2011) & HMBANA, 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 by Stanford University:

- Maximizing milk supply with hands on pumping http://med.stanford.edu/newborns/professional-education/breastfeeding/maximizing-milk-production.html
- Hand expression http://med.stanford.edu/newborns/professional-education/breastfeeding/hand-expressing-milk.html

Types of breast pumps

When a mother is dependent on a pump to establish or maintain her milk supply, it is important to assess which pump is most appropriate for the pumping mother's needs. 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. However, most insurance companies will cover the cost of a rental pump if there is a documented medical need with the infant and/or the mother. 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	*For occasional separation from infant:* • Missed Feeding • Evening out • Weekend away • Very part-time work	*Manual Pumps:* • Medela Harmony • Hygeia EnHand Manual Pump • Hygeia Two-Hand Manual Pump *Single Electric Pumps:* • Medela Swing • Philips Avent Single Electric
Work or School (Long-term use)	*For routine mother-infant separation:* • Work • School • Preterm or Special Needs Infant (once milk supply is well established)	*Personal Use Double Electric Pumps:* • Medela Pump In Style Advanced • Medela Freestyle • Philips Avent Double Electric • Ameda Purely Yours • Hygeia Enjoye
Medical Need (Short or Long Term Use)	*For frequent use:* • To establish or increase milk supply *Examples:* • Premature infant • Hospitalized ill infant • Twins or multiples • Severe recurrent engorgement • Breast surgery	*Hospital-Grade Double Electric Pumps:* • Medela Lactina • Medela Symphony • Ameda Platinum • Hygeia EnDeare

Banked human milk

Banked human milk vs. Donor breastmilk

"Human milk is the gold standard for feeding and nutrition of preterm and term newborns…infants, including premature and sick newborns. When a mother's own milk is unavailable or in short supply (a common occurrence in Neonatal Intensive Care Units), the World Health Organization and the American Academy of Pediatrics recommend the use of donor milk as the best alternative"

Peila, The Effect of Holder Pasteurization on Nutrients and Biologically-Active Components in Donor Human Milk: A Review, 2016

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. Holder pasteurization affects several human milk components to variable degrees, even though it is rather difficult to quantify the degradation level…clinical practices demonstrate that many beneficial properties of human milk remain, even after pasteurization. (Peila, The Effect of Holder Pasteurization on Nutrients and Biologically-Active Components in Donor Human Milk: A Review, 2016).Once out of the hospital, banked breastmilk is a costly option, ranging from $3.50-$4.50 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

Alabama
Mothers Milk Bank of Alabama
107 Walter Davis Drive
Birmingham, AL 35209
Phone: (205) 942-8911
Website: **www.mmbal.org**

California
Mothers' Milk Bank
751 South Bascom Ave
San Jose, CA 95128
Phone: (408) 998-4550
Website: www.mothersmilk.org

Colorado
Mothers' Milk Bank Rocky Mountain Children's Health Foundation
5394 Marshall Street, Suite 400
Arvada, CO 80002
Phone: (303) 869-1888
Website: http://rmchildren.org/mothers-milk-bank

Florida
Mothers' Milk Bank of Florida
8669 Commodity Circle, Suite 490
Orlando, FL 32819
Phone: (407) 248-5050
Website: www.milkbankofflorida.org

Illinois
Mothers' Milk Bank of the Western Great Lakes
1691 Elmhurst Road
Elk Grove Village, IL 60007
Phone: (847) 262-5134
Website: www.milkbankwgl.org

Indiana
The Milk Bank
5060 E. 62nd Street, Suite 128
Indianapolis, IN 46220
Phone: (317) 536-1670
Website: www.themilkbank.org

Iowa
Mother's Milk Bank of Iowa
University of Iowa Hospitals and Clinics119 2nd Street, Suite 400
Coralville, IA 52241
Phone: (319) 386-9929
Website: https://www.uichildrens.org/mothers-milk-bank/

Massachusetts
Mothers' Milk Bank Northeast
377 Elliot Street
Newton Upper Fall, MA 02464

Phone: (617) 527-6263
Website: www.milkbankne.org

Michigan
Bronson Mothers' Milk Bank
601 John Street, Suite N1300
Kalamazoo, MI 49007
Phone: (269) 341-8849
Website: www.bronsonhealth.com/MedicalServices/Obstetrics/page928

Mississippi
Mothers' Milk Bank of Mississippi
2001 Airport Road, Suite 204
Flowood, MS 39232
Phone: 601-613-0531
Website: www.msmilkbank.org

Missouri
Heart of America Mother's Milk Bank
St. Luke's Hospital
4401 Wornail Rd.
Kansas City, MO 64111
Phone: (816) 932-4888.
Website: http://www.saintlukeshealthsystem.org/services/saint-luke%E2%80%99s-heart-america-mothers%E2%80%99-milk-bank

Montana
Mother's Milk Bank of Montana
734 Kensington Ave.
Missoula, MT 59801
Phone: (406) 721-5440
http://mothersmilkbankofmt.org/

North Carolina
WakeMed Mothers' Milk Bank and Lactation Center
1900 Kildaire Farm Rd.
Cary, NC 27518
Phone: (919) 350-8599
Website: www.wakemed.org/landing.cfm?id=135

Ohio
Ohio Health Mothers' Milk Bank
4850 E. Main St.
Columbus, OH 43213
Phone: 614-566-0630
Website: www.ohiohealth.com/mothersmilkbank

Oklahoma
Oklahoma Mother's Milk Bank Inc.
901 N Lincoln Blvd. Suite #330
Oklahoma City, OK 73104
Phone: (405) 297-LOVE
Website: www.okmilkbank.org

Oregon
Pacific Northwest Northwest Mothers Milk Bank
417 SW 117th Ave, Ste 105
Portland, OR 97225
Phone: (503) 469-0955
Website: www.nwmmb.org
* Refer to Oregon appendix or website for a listing of donor depot drop-off sites.

Pennsylvania
CHOP Mothers' Milk Bank
34th and Civic Center Drive
Philadelphia, PA 19104
Phone: (267) 425-1662
Website: www.chop.edu/services/chop-mothers-milk-bank#.Vwz9U6QUW00

Mid-Atlantic Mother's Milk Bank/Three Rivers Mothers' Milk Bank
3127 Penn Avenue
Pittsburgh, PA 15201
Phone: (412) 281-4400
Email: info@threeriversmilkbank.org

South Carolina
Mothers' Milk Bank of South Carolina
Phone: (843) 792-5415
Website: www.scmilkbank.org

Texas
Mothers' Milk Bank at Austin
2911 Medical Arts St. Suite 12
Austin, TX 78705
Phone: (512) 494-0800
Website: https://www.milkbank.org/

Mothers' Milk Bank of North Texas
600 W Magnolia Ave.
Ft. Worth, TX 76104
Phone: (817) 810-0071
Website: www.texasmilkbank.org

Virginia
The Children's Hospital of The King's Daughters
400 Gresham Drive, Suite 410,
Norfolk VA 23507
Phone: (757) 668-MILK
Website: www.chkd.org/milk

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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 of prematurity.
- *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		
Indication: Commercial Human milk fortifiers (HMF) and preterm formulas are designed for rapidly growing preterm infants born less than 2000 grams (4 1/2 lbs) needing increased protein, vitamins, minerals and calories. HMF is to be ONLY mixed with breastmilk. *Contraindications:* Full term and failure to thrive infants due to hypervitaminosis & hypercalcemia. *Contraindications for HMF:* Preterm infants taking >500ml/day and/or >3600g (8 pounds). *Contraindications for Preterm Formula:* Preterm infants taking >12 oz/day *Note:* Infants are rarely discharged home on HMF. Prolonged use is associated with vitamin D & vitamin A toxicity & may exceed renal solute load. Liver function test should be monitored for impairment along with copper deficiency. *Calories:* Various calorie levels available, 24-30 kcal/oz		
Human Milk Fortifiers		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Human Milk Fortifier (acidified liquid & powder)	Mead Johnson	
Similac Human Milk Fortifier (liquid & powder)	Abbott	
Similac Human Milk Fortifier Hydrolyzed Protein (liquid)	Abbott	100% extensively hydrolyzed protein
Similac Special Care *30* with iron (liquid)	Abbott	Preterm formula also approved for use as a human milk fortifier
Prolact+ H^2MF *24, 26, 28, 30* (liquid)	Prolacta Bio-science	Made from 100% concentrated human milk with added minerals *Indications:* for preterm infants weighing < 1250g at birth.
Preterm Formulas for In-Hospital Use		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Premature 20, 24, 30 & 24 High Protein	Mead Johnson	40% MCT oil
Similac Special Care 20, 24, 30 & 24 High Protein	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. *Indications:* Birthweight <1800-2000g at birth. May be used to fortify or supplement breastmilk feedings. May be used until 1 year corrected age. *Contraindications:* Full term or failure to thrive infants due to hypervitaminosis and hypercalcemia. *Calories:* Provides 22 kcal/oz with standard preparation.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil EnfaCare, powder	Mead Johnson	65% lactose 20% MCT oil
Enfamil EnfaCare, RTU	Mead Johnson	40% lactose 20% MCT oil
Similac Neosure, powder and RTU	Abbott	50% lactose 25% MCT oil
Standard Milk-Based Formula		
Indications: Infants >34 weeks and >2000 grams with no special nutritional needs. *Protein source:* Intact cow's milk proteins casein and whey modeled after human milk to aid in absorption. *Note:* Higher levels of nutrients are included in infant formulas because they are less well absorbed than those in breastmilk. Most have added DHA and ARA. *Calories:* Provides 20 kcal/oz with standard preparation, unless otherwise noted.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Enspire	Mead Johnson	60% whey 100% lactose Added Milk Fat Globule Membrane (MFGM), and Lactoferrin Added prebiotics Galactooligosaccharides (GOS), Polydextrose (PDX) Non-GMO
Enfamil Infant *20 & 24 kcal/oz*	Mead Johnson	60% whey 100% lactose Added prebiotics GOS & PDX
Enfamil Newborn	Mead Johnson	80% whey 100% lactose Added prebiotics GOS & PDX Additional vitamin D added (400 IU at 27 oz)
Enfamil for Supplementing	Mead Johnson	60% whey 20% lactose Additional vitamin D added (400 IU at 27 oz)

Good Start Gentle	Gerber	100% whey, partially hydrolyzed proteins 70% lactose Added prebiotic GOS Non-GMO
Good Start Gentle for Supplementing	Gerber	100% whey, partially hydrolyzed proteins 70% lactose Added probiotic B. lactis Non-GMO
Similac Advance *19, 20 & 24 kcal/oz*	Abbott	Added prebiotics GOS Available in non-GMO
Similac for Supplementing *19 kcal/oz*	Abbott	Added prebiotics GOS, 10% more than Advance Non-GMO
Similac Pro-Advance *19 kcal/oz*	Abbott	Added prebiotic human milk oligosaccharide (HMO) Non-GMO
Various store brands of infant formulas	Wyeth	Varies
Reduced or No Lactose Formula		
Indications: Lactose sensitivity, GI upset or constipation. *Contraindications:* galactosemia *Protein Source:* cow's milk proteins: casein and whey *Calories:* Provides 20 kcal/oz with standard preparation, unless otherwise noted.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Gentlease	Mead Johnson	60% whey, partially hydrolyzed proteins 20% lactose
Good Start Soothe	Gerber	100% whey, partially hydrolyzed proteins 30% lactose Added probiotic L. Reuteri Non-GMO
Similac Sensitive *19 kcal/oz*	Abbott	18% whey Trace amount of lactose (2%) derived from added prebiotic GOS Available in non-GMO
Similac Pro-Sensitive	Abbott	Added prebiotic HMO Non-GMO
Similac Total Comfort *19 kcal/oz*	Abbott	100% whey, partially hydrolyzed proteins Trace amount of lactose (2%) derived from added prebiotic GOS Available in non-GMO

Partially Hydrolyzed Protein Formulas		
These are not true hypoallergenic formulas, but are more available and less expensive than fully hydrolyzed formulas. *Indications:* GI upset, constipation. *Contraindication:* Known cow's milk protein allergy. *Protein source*: Cow's milk proteins, casein & whey, are partially hydrolyzed to small peptides. *Calories:* Provides 20 kcal/oz at standard preparation, unless otherwise noted.		
Product Name	**Manufacturer**	**Product characteristics**
Enfamil Gentlease	Mead Johnson	60% whey, partially hydrolyzed proteins 20% lactose
Enfamil Reguline	Mead Johnson	60% whey, partially hydrolyzed protein 50% lactose Added prebiotics GOS & PDX
Good Start Gentle	Gerber	100% whey, partially hydrolyzed protein 70% lactose Added prebiotic GOS Added probiotic B. Lactis Non-GMO
Good Start Soothe	Gerber	100% whey, partially hydrolyzed protein 30% lactose Added probiotic B. Lactis
Similac Total Comfort *19 kcal/oz*	Abbott	100% whey, partially hydrolyzed protein Trace amount of lactose (2%) derived from added prebiotic GOS Available in non-GMO
Extensively Hydrolyzed Protein Formulas		
Hypoallergenic; lactose & sucrose-free. *Indications*: Intact cow's milk protein and soy protein allergy, intractable diarrhea, multiple food allergies, lactose and sucrose intolerance. *Protein source*: Cow's milk protein hydrolyzed to small peptides and supplemented with amino acids *Calories:* Provides 20 kcal/oz with standard preparation.		
Product Name	**Manufacturer**	**Product characteristics**
Nutramigen with Enflora LGG (powder only)	Mead Johnson	Use level, **packed** scoops. Use cool water & do not warm Added probiotic: Lactobacillus rhamnosus GG (LGG) *Additional indications:* galactosemia
Nutramigen (RTU)	Mead Johnson	Not indicated for galactosemia
Pregestimil (powder)	Mead Johnson	55% MCT oil *Additional indications*: carbohydrate/fat malabsorption, cystic fibrosis, pancreatic

		insufficiency, short gut, GI immaturity, celiac disease, cholestasis, galactosemia, & severe protein calorie malnutrition
Pregestimil (RTU)	Mead Johnson	55% MCT oil RTU is isotonic Not indicated for galactosemia
Similac Alimentum (powder)	Abbott	33% MCT oil *Additional indications:* carbohydrate/fat malabsorption, cystic fibrosis, pancreatic insufficiency, short gut & GI immaturity.

Free Amino Acid Elemental Formulas

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

Product Name	Manufacturer	Product characteristics
Elecare	Abbott	33% MCT oil
Gerber Extensive HA	Gerber	100% whey protein extensively hydrolyzed 49% MCT oil Added probiotic B. lactis
Neocate Infant	Nutricia	33% MCT oil **Mixing ratio differs from standard infant formula**; refer to manufacturer's instructions
PurAmino	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.
Indications: Lower minerals for impaired renal function, neonatal hypocalcemia.
Precaution: Additional iron may be needed.
Calories: 20 kcal/oz with standard preparation

Product Name	Manufacturer	Product characteristics
Similac PM 60/40	Abbott	60% whey Low iron

Thickened Formulas

These formulas contain rice starch which increases the viscosity 10 times that of a routine formula. The formula flows freely through a standard nipple and continues to thicken upon reaching acidic environment of the stomach. These formulas are nutritionally balanced compared to adding infant cereal to formula Adding infant cereal to formula is not recommended as it alters the caloric density and changes the nutrition composition by increasing the carbohydrate load and potentially leading to excessive iron.

Indications: Uncomplicated GERD
Contraindications: **Premature infants <38 weeks gestational age** due to the risk of the formation of lacto bezoars (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 any unused formula. Do not mix formula >24 kcal/oz due to increased viscosity.
Calories: Provides 20 kcal/oz with standard dilution, unless otherwise noted.

Product Name	Manufacturer	Product characteristics
Enfamil A.R.	Mead Johnson	20% whey Trace amount of lactose derived from added prebiotics GOS & PDX.
Similac for Spit-Up *19 kcal/oz*	Abbott	Trace amount of lactose (0.2%) derived from added prebiotic GOS Available in non-GMO

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
Calories: Provides 20 kcal/oz at standard preparation, unless otherwise noted.

Product Name	Manufacturer	Product characteristics
Enfamil Prosobee	Mead Johnson	*Additional indication:* galactosemia (powder only, not liquid)
Good Start Soy	Gerber	100% soy protein partially hydrolyzed Non-GMO, Kosher & Halal
Similac Soy Isomil *19 & 20 kcal/oz*	Abbott	Added prebiotic fructooligosaccharides (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 Enfamil Advance. The displacement factor is 0.77 ml/gram, weight is 8.8 gm per scoop and 111 gm per cup, and calories equal 5.1 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 Enfamil Advance is current as of time of publication.

Example:
Goal: 6 oz of 24 cal/oz formula

	Calories	ml
3 scoops (26.4 gm)	134.6	20
5oz water		150
Total volume		170 (5.6 oz)

This recipe provides 24 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 8.8 gm/scoop, 3 scoops of Enfamil Advance = 26.4 gm
3. Multiply grams of formula x calories per gram (26.4 gm x 5.1 = 134.6calories)
4. Multiply grams of formula x displacement factor to get volume created by the powdered formula (26.4 gm x 0.77 ml/gm = 20 ml)
5. Add ml from powdered formula plus the water to get total volume (170 ml)
6. Divide total volume by 30 to convert volume to ounces (170 divided by 30 = 5.6 oz)
7. Divide total calories by ounces to get cal/oz (134.6 divided by 5.6 = 24 cal/oz)

Note: Although recipes may be the same for 2 brands of formula at 20 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. When creating a recipe, it is generally accepted to be within ½ calorie of desired calorie level.

Updated information regarding calories per gram, displacement factor, etc can be obtained from the formula manufacturers:

- http://abbottnutrition.com/categories/infant-and-new-mother/term-infant-nutrition/home
- http://www.meadjohnson.com/pediatrics/us-en/
- 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, however, it is recommended to sanitize the water for at least the first 3 months of life. Sanitize all types of water including tap water, bottled drinking water and distilled water.
     - Run cold tap water for one to two minutes to before collecting to boil. Running the cold water can decrease the lead in the water if older pipes contain lead. Never use hot water when preparing infant formula.
     - Bring the water to a rolling boil and boil for one minute. Allow water to cool before use. Boiling the water for longer than one minute will concentrate the minerals.
     - For healthy infants 3 months and older, it is not necessary to sanitize the water unless a health care provider recommends it. If the water quality is poor or questionable, as in the case of well water, continue to boil the water or use bottled 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	Nurse on demand, at least 6-8 times per day to keep up your milk supply 2-5 oz., 6-8 times per day 3-6 oz., 5-7 times per day 4-7 oz, 4-7 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	5-6 months	**When your baby shows these signs of readiness, your baby may be ready for solids** ▪ Sits with support ▪ 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. ▪ Social readiness (watching you eat, opening mouth, etc.)	Breast milk and/or Formula Iron-fortified baby cereal	On demand 6-8 oz, 4-6 times per day 1-2 tablespoons 2 times per day.	▪ Breast milk or formulas have all the nutrition your baby needs. If your baby doesn't seem interested in solids, wait a week and offer again. ▪ Feed iron-fortified baby cereal from a spoon. ▪ Feed only one new cereal each week.

Date	Actual Age	Corrected Age	Developmental Stages and Feeding Skills	Foods	Daily Amounts	Feeding Tips
_____ to _____	___ to___ Months	7-8 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, 3-5 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 or toast 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. ▪ 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	9-12 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, toast	On demand 6-8 oz, 3-4 times per day Offer daily 3-4 tablespoons per day, 2 times per day. 3-4 tablespoons, 2 times per day. 3-4 tablespoons, 2 times per day. 2 crackers, ¼ slice bread or toast 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 use 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, 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. If needed, increase to 1 oz per day of diluted juice. 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 compared to medicines 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 lipoid pneumonia and/or gastroesophageal reflux.
- Excess Water/Over dilution of formula
  - Over dilution of 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	Breastfed 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 term or pre-term 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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