Nutrition Practice Care Guidelines for Preterm Infants In the Community

Revised August 2006

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TABLE OF CONTENTS

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OVERVIEW

Goal/Purpose

These guidelines have been designed to assist WIC and community-based nutritionists 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 low birth weight.

Definitions

Preterm Infant: Infants born <37 weeks of gestational age.[1]

- 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)

Small for Gestational Age (SGA): Infants born with growth parameters below the 10th percentile.

Intrauterine Growth Retardation (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.

Corrected Age (CA): Based on the age the infant would be if the pregnancy had actually gone to term.

Chronological age (CH) or "actual age": Indicates the age from the actual day the child was born.

NICU: Neonatal Intensive Care Unit.

Occipital frontal circumference (OFC): Head circumference.

Infants at highest risk post discharge:

- VLBW and ELBW
- Small for gestational age (SGA) and Intrauterine Growth Retardation (IUGR)
- Primarily breastfeeding with no fortification
- 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 less than 15 gm/kg/day)
- Infants with any of the following complications of prematurity:
  - Bronchopulmonary dysplasia/chronic lung disease
  - 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

Conditions of prematurity that predispose infants to nutritional deficiencies include:[3]

- Increased growth rate and high metabolic needs
- Inadequate nutrient stores
- Immature physiological systems
- Illnesses

ASSESSMENT

The growth patterns of preterm, VLBW infants are known to be considerably different from those of higher birth weight term infants. Despite these differences, the growth of preterm infants is still measured using weight, length and head circumference.

Growth Charts

Standard curves can be used for most preterm infants who are past term by corrected age.[4] All parameters (height, weight, head circumference) should be corrected for gestational age until 2 years of age when plotting on the Centers for Disease Control and Prevention (CDC) 2000 growth charts. As a rule of thumb, correct for gestational age when plotting measurements for the infant on the birth-36 month chart while using recumbent length. When standing height is used, then plot on the 2-20 year chart and no longer correct for gestational age.

There are several growth charts available to monitor growth of the preterm infant (see Appendix A). Since the revised CDC growth charts exclude LBW infants, the CDC suggests practitioners use charts for LBW infants in combination with the revised CDC charts to obtain a more accurate identification of growth problems in preterm LBW infants. The CDC recommends the Infant Health and Development Program (IHDP) chart for growth assessment of LBW infants because they are derived from US infants, the sample is larger, the data more recent, and they represent a diverse demographic and geographic population.[5]

The Oregon WIC Program and many but not all hospitals in the Portland metro area use the Fenton growth chart. It is considered an updated Babson and Benda chart. Growth data from the National Institute of Child Health and Human Development Neonatal Research Network (NICHD) have been superimposed onto this chart. Infants' growth can be plotted from 22-50 weeks postconceptual age.

Weight Gain Goals and Expected Growth:

In full-term healthy infants, the rate of weight gain slows during the first months of life. It is not clear what to expect as reasonable for incremental growth and weight gain for preterm infants. It is not unusual to see a growth spurt or increased rates of weight gain between 38 and 48 weeks postconceptual age. The head circumference will often show catch-up growth first, then weight, and finally length.

An expected rate of weight gain should be at least 20- 40 gm/day (~1 - 1 ½ oz.) A weight gain of greater than 40 gm/day, however, may be of concern and could indicate fluid retention or excessive feeding. [Cox, 49-50][6]

Catch-up Growth

The definition or interpretation of catch-up growth may vary. A classic definition is when growth improves after a period of growth failure. Most premature infants experience a period of slow growth after birth, followed by a period of catch-up growth. Their catch-up growth can be achieved by providing calories in excess of the RDA. Potentially as much as 20-30 % more energy may be required. Calculations using ideal weight for length have also been used to determine energy needs for catch-up growth. If the child is severely undernourished, energy intake should be increased gradually to avoid refeeding syndrome. Protein intake will also need to be increased.

Although catch-up growth may occur later during the first year, it is more ideal for the infant to catch up in nutritional status sooner rather than later. IUGR and SGA infants usually experience catch-up growth first in head circumference, then weight and finally length. Catch-up growth in head circumference usually occurs in the first 3-8 months. Infants may continue to plot less than the 3rd percentile for growth, but will actually be exhibiting catch-up growth.

If infants continue to plot below the growth curve, their growth pattern should at least parallel the growth curve. If this does not happen, factors such as growth potential, general health and presence of disease or disability should be considered in addition to nutrition status.[6, 7, 8, 9, 10, 11]

See Appendix D for information on calculating catch-up growth requirements.

FEEDING THE PRETERM INFANT

Feeding Concerns for High-Risk Newborns at Discharge

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

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

For more detailed descriptions of these feeding problems and nutrition counseling strategies, see Appendix K. (Groh-Wargo, 554-5)[2]

Selection of Feeding

Breastfeeding after premature birth is recommended and encouraged whenever possible. Lactation consultation is encouraged to promote successful breastfeeding and use of a breast pump if needed.

Using Corrected Age with Feeding

Feeding recommendations for infants born < 37 weeks gestation should be based on birth weight, discharge weight, nutritional status, and development stage, advancing through the normal progression using the corrected age.[3, 8, 9] Using corrected age, feeding progression for most preterm infants is the same as for infants born at term.

- Human milk or iron fortified infant formula is recommended until 1 year corrected age.
- Solid foods may be introduced at ~ 6 months corrected age, based on developmental stage and feeding skill.
- Cow's milk may be introduced at 12 months ***corrected*** age.

See Appendix C: Feeding Your Preterm Baby Step-by-Step[12]
See also Appendix E: Selection of Feeding at Discharge

Special Formula Use Recommendations

Preterm formula and Human Milk Fortifier: These are generally used for infants weighing less than 1,850 to 2,000 gm (about 4 to 4 ½ lbs). It is inappropriate for most infants who weigh more than 2.5 kg (5 ½ lbs) or are taking in over 500 ml daily to be fed premature formulas (Enfamil Premature Lipil or Similac Special Care) or Human Milk Fortifiers (Similac HMF, Similac Natural Care or Enfamil HMF) for all their feeds because of the higher vitamin A and vitamin D content of these formulas and the possible risk of hypervitaminosis.[13]

Transitional Formulas: (also called "post-discharge premature formulas") Formulas such as Enfamil EnfaCare Lipil and Similac Neosure Advance provide 22 kcal/oz and have higher levels of protein, calcium, phosphorus, vitamins and other minerals than standard infant formulas. Research has shown that premature infants fed these formulas have improved growth and bone mineralization compared to those fed standard infant formulas.[2] *See recommendation below for length of time an infant needs to remain on a transitional formula.

Specialized formulas: These include Pregestimil, Alimentum, Nutramigen, Neocate and Elecare, and may be indicated based on feeding intolerance. Enfamil AR is not indicated for preterm infants due to the risk of the formation of lactobezoars (hard clumps of undigested milk curds).[6] These are "term" formulas and thus have less calcium, phosphorus, and protein than transitional formulas. If preterm infants are given these formulas, they should be followed more closely by an RD 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) doesn't recommend soy formula for infants born < 1800 g since preterm infants 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 bone marker formation in the premature population which can lead to osteopenia.[14]

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. [15]

For more information see Appendix F: Human Milk and Formulas.

Transitioning to a Standard (20 kcal/oz) Infant Formula from a Transitional (22 kcal/oz) Infant Formula

As the preterm infant on transitional formula grows, he should be evaluated to see whether he can advance to a standard infant formula. The current recommendation for preterm infants is to use a transitional formula until the infant is 9 months corrected age. Some preterm infants, however, may benefit from continuing a transitional formula until 12 months corrected age. Each infant needs to be evaluated individually, considering the following:

1. **NICU course**: Did the infant have a difficult NICU course with multiple interventions and feeding difficulties, or was his NICU course relatively easy and short?
2. **Growth Velocity**: Is the infant gaining at least at the 50th percentile expected weight gain for corrected age, or staying on or exceeding his growth curve line?
3. **Tolerance**: Is the infant tolerating the transitional formula? If not, and intake is decreased, then re-assess for appropriate formula and intake needed.

See Appendix E: Selection of Feeding at Discharge.

BREASTFEEDING THE PRETERM INFANT

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 is recommended by the American Academy of Pediatrics.[16]

> *"Feeding human milk to preterm infants provides nutritional, gastrointestinal, immunological, developmental, and psychological benefits that may impact their long term health and development. Human milk is advocated as the nutrition for preterm infants because it provides substances not supplied in formula."* [17]

Benefits of Human Milk for the Preterm Infant[2]

- 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
- Possible protection against necrotizing enterocolitis (NEC) and late-onset sepsis
- Promotion of maternal-infant attachment

Barriers to Breastfeeding[17]

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

Benefits of Fortification of Human Milk for Preterm Infants[2]

- 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[2]

- 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[2]

- Infants born < 34 weeks gestation
- Infants < 1500 grams at birth
- Infants on total parenteral nutrition (TPN) for > 2 weeks
- Infants who are at high nutritional risk for nutrition problems after discharge from a NICU. *See p. 2 for a list of risk factors.

How to Fortify Human Milk[18]

- Human milk fortification should be in the form of a multi-nutrient supplement, such as a powdered infant formula, since single-nutrient supplements do not meet the needs of premature infants
- If nutrient supplementation is indicated:
  - Powdered supplement should be added to breastmilk
  - Formula bottles can be given in addition to breastfeeding

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. The recommendation for the use of a transitional formula is until 9 months corrected age. There is no recommendation for the use of fortified breastmilk for breastfed infants based on the current data. More research needs to be done in this area before definite guidelines can be given for post-discharge premature nutrition for the breastfed infant. The use of fortified mother's milk varies infant to infant. All infants need to be evaluated individually.

Options for Fortification of Breastmilk

Breastfeed or feed expressed maternal milk (EMM) as much as possible per the family's goals and infant's ability. Fortify maternal milk as necessary depending on nutritional status.

- If the infant has limited breastfeeding ability:
  - All maternal milk other than at breast given to baby should be fortified
  - Fortified bottles should decrease as breastfeeding ability increases

- If the infant has advanced breastfeeding ability:
  - Fortification of EMM should be kept to a minimum
  - Concentration of EMM (24, 27, 30 kcal/oz) may be increased in order to maximize nutrition in a limited number of bottles
  - May need to consider supplemental feeding system (SNS) or alternative feeding method if family is opposed to bottles

- 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

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 that are within normal limits[18]

If the breastfed infant is not able to demonstrate these abilities it is recommended to continue to fortify breastmilk. The smaller the infant at birth the longer the possibility of needing breastmilk fortification.

The timeline for needing fortified breastmilk is as varied as is the population of premature infants in the NICU.

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.

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:

- It is recommended to decrease or discontinue the fortification of breastmilk.
- Continued support with a dietitian and a lactation consultant will be important through this transition to ensure nutritional needs are being met.

If the infant's breastfeeding ability does not advance to full feeding at the breast, but the infant is able to demonstrate the ability to sustain adequate growth, sustain an appropriate ad lib milk intake, and maintain lab values that are within normal limits:

- Fortified bottles can transition to unfortified breastmilk bottles.

It cannot be stressed enough that all premies 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.

See Appendix H for more information on fortifying human milk.

VITAMIN-MINERAL SUPPLEMENTATION

Vitamins

Supplementation with a standard infant multivitamin (with vitamins A, D, B1, B2, B3, B6, B12, C, and iron) is generally needed initially after NICU discharge to meet the preterm infant's vitamin needs, until the infant is consuming larger volumes of feeds.[2, 10, 12, 18] **See Table below.**

Vitamin D: Per the American Academy of Pediatrics (AAP), all infants fed unfortified breast milk should continue to receive a supplement of 200 IU of Vitamin D for the first year. This 200 IU of Vitamin D can be provided by continuing the 0.5 ml daily of the standard infant multivitamin, or by changing to 0.5 ml daily of a tri-vitamin supplement (vitamins A, C, and D). Infants receiving 17 oz. (500 ml) or more of a vitamin D-fortified infant formula do not need any additional Vitamin D supplementation.[19]

Iron: Preterm infants have lower iron stores than term infants. By 2 months post birth (not 2 months corrected age), preterm infants should have an intake of 2-4 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.[16, 20]

If infant is primarily on:	What supplements are recommended?	When can the supplements be stopped?
Unfortified Breast Milk	0.5 ml daily Infant Multivitamin with Iron (vitamins A, D, B1, B2, B3, B6, B12, C, and Iron)	Continue until 12 months corrected age. If desired, can change to a Tri-vitamin with Iron (A, D, C and Iron) when intake reaches about 25 oz./day (750 ml)

If infant is primarily on:	What supplements are recommended?	When can the supplements be stopped?
Fortified Breast Milk	0.5 ml daily Infant Multivitamin with Iron	Continue until 12 months corrected age. If desired, can change to a Tri-vitamin with Iron (A, D, C and Iron) when intake reaches about 25 oz./day (750 ml).
Iron-Fortified Formula	0.5 ml daily Infant Multivitamin without Iron	Stop when intake reaches about 17-25 oz./day (500 - 750 ml).

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

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.

Daily maintenance of fluid requirements based on weight are as follows:[15, 21]

Body Weight	Fluid Requirements
1-10 kg	100 ml/kg
11-20 kg	1,000 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.)

DISCHARGE OF THE PRETERM INFANT TO THE COMMUNITY & COORDINATION OF CARE

Community nutritionists must be knowledgeable about and prepared to work with preterm infants and their families. The WIC nutritionist is not expected to provide primary care or care coordination for these infants. The WIC nutritionist should, however, know the referral resources available in the community, be in contact with the medical care provider, be able to recognize "red flags" that require further follow-up and referral, and follow the principles of family-centered care listed in Appendix L.

With improvements in medical and nutritional care, there has been an increase in survival rates along with an increase in morbidity for very low birth weight preterm infants. These infants are also being discharged earlier into the community. The reasons for this are several:

- To decrease the amount of time the infant is separated from his or her parents and reduce negative effects on parenting and bonding.
- To decrease the risk of the infant contracting infections in the hospital.
- To target NICU resources to higher risk infants requiring more intensive care.
- To reduce medical costs.[22] (Some of these early discharge infants are re-admitted, however, due to failure to thrive and feeding problems, partly as a result of a lack of or gaps in coordinated care and follow-up in the community.)

The community nutritionist should be aware of the common feeding concerns expressed by parents and caregivers for preterm infants. These concerns include:[12]

- Growth
- Obtaining special medical formulas and/or modules
- Cost of feedings: supplies, tubing, special nipples
- Oral aversions
- Slow feeding and low feeding endurance
- Reflux and gagging
- When to start solid foods
- Lack of interest in or enjoyment of food
- New feeding issues that surface once infant starts on solid foods
- Day care and respite care

For a more complete description of these concerns, see Appendix K.

The community nutritionist should also be familiar with the referral resources in the community for these infants:

- How to contact/refer to a Community Health Nurse
- How to contact the local home health agency for feeding supplies
- Know where the closest feeding and neurodevelopmental clinics are located and how to contact them
- If the community has a tertiary care hospital with a NICU, know the discharge procedures and establish a relationship with the discharge planner

Referral Criteria

These "red flags" should alert the community nutritionist of the need for further assessment, referral and follow-up: [Groh-Wargo, 573][2]

Anthropometric "Red Flags":

- Weight loss or significant decline in percentile ranking ("falling away" from expected growth curve percentile)
- Poor rate of weight gain for corrected age as listed below:

Age	Weight Gain
term – 3 mos	< 20 gm/day (< 5 oz/wk)
3 – 6 mos	< 15 gm/day (< 3½ oz/wk)
6 – 9 mos	< 10 gm/day (< 2 oz/wk)
9 – 12 mos	< 6 gm/day (< 1½ oz/wk)
1 – 2 yrs	< 1 kg or < 2 lbs in 6 mos
2 – 5 yrs	< 0.7 kg or < 1½ lbs in 6 mos

Clinical "Red Flags":

Medical complications, conditions or chronic illnesses:

- Chronic lung disease, bronchopulmonary dysplasia (BPD)
- Gastroesophageal reflux (GERD)
- Cardiac anomalies
- Necrotizing enterocolitis (NEC)
- Small bowel syndrome, short gut
- Long term TPN use (>4 weeks)
- Fetal alcohol syndrome, fetal drug exposure
- Down Syndrome, Cerebral Palsy, Cystic Fibrosis, Spina Bifida
- Other metabolic syndromes

Chronic medication use:

- Antibiotics
- Anticholinergics
- Anticonvulsants
- 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/Diet "Red Flags":

- Infant < 2 mos. corrected age, feeding fewer than 8 times in 24 hours or with fewer than 6-8 wet diapers in 24 hours
- Infant taking preterm formula or human milk fortifier if infant is currently > 2.5 kg (5½ lbs)
- Mixing formula stronger than standard dilution; mixing formula with expressed maternal milk (EMM)
- Infant taking low-iron formula, soy formula or goat's milk
- Improper formula dilution
- Adding supplements or modules to breastmilk or formula
- Volume of feeding decreasing with age instead of increasing with age
- Feeding duration > 30 minutes per feeding for infants; < 6 feedings/day for infants
- 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 who has not yet started spoon feeding
- Infant taking cow's milk before 1 year corrected age or low-fat milk before 2 years corrected age

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Sources: Executive Summary Workshop to Consider Low Birth Weight in Relation to The Revision of The NCHS Growth Charts For Infancy (Birth-3 Years). Division of Health Examination Statistics National Center for Health Statistics Hyattsville, MD, October 4-5, 1994, and Nieman, Liesje, Building Block for Life, "Follow-Up Nutrition after Discharge from the Neonatal Intensive Care Unit", 29 (1), pp. 2-3.

(1) Infant Health and Development Program (IHDP). Charts in a format suitable for clinical use are available from the IHDP (Casey et al., 1990, 1991; Ross Laboratories, 1994). This program was a serial study of 985 preterm LBW infants born in late 1984 or 1985 at eight sites in the United States. The enrollment process ensured that one-third had birth weights of 2,000 grams and two-thirds had birth weights of 2,001-2,500 grams. These proportions are close to those from national estimates (Ventura et al., 1994). Black infants were over represented in the sample compared with the total national population, particularly in the subgroups with birth weights < 1,250 grams. This overrepresentation is much less marked if considered in relation to the population of U.S. mothers with VLBW or LBW infants. It is not clear whether ethnic groups of VLBW and LBW infants differed in postnatal growth within birth weight groups. There was an overrepresentation of mothers with less than a high school education, although low educational attainment is common nationally among the mothers of VLBW and LBW infants. This may be important because postnatal growth of VLBW and LBW infants is related to the socioeconomic status of the family (Lipper et al., 1981; Qvigstad et al., 1981; Ross et al., 1990; Srivastava et al., 1978).

The following groups of infants were excluded from the IHDP sample: triplets and quadruplets, died within 48 hours after birth, received oxygen for more than 90 days, hospitalized for more than 60 days after term, neural tube defect, severe neurologic abnormality, severe sensory defect, chromosomal anomaly syndrome, or maternal abuse of drugs or alcohol (Casey et al., 1990). The infants were separated to two strata by birth weights (< 1,500 grams and 1,501-2,500 grams). They were measured at birth and at term and then at seven ages up to 3 years (age-adjusted). The gender-specific charts for weight, recumbent length, and head circumference for each birth weight stratum extend to 3 years age adjusted with the curves beginning at 37 weeks gestational age for weight and at term for recumbent length and head circumference. There was a high prevalence of failure-to-thrive (17.5%) when the criteria used were (i) clinical concern, (ii) weight < 5th percentile of the NCHS/CDC charts at two or more examinations after adjusting for gestational age, and (iii) weight velocity less

than the median (Casey et al., 1994; Kelleher et al., 1993; Roche & Himes, 1980). The term "failure-to-thrive" was applied in the absence of clinical concern if both other criteria were met. The IHDP charts should be regarded as reference data, not standards. New growth charts for VLBW and LBW infants will be needed as changes occur in the clinical management of these infants.

(2) Babson and Benda (1976). Also known as the Oregon Growth Record for Infants. The data from 26 weeks to term used by these authors came from Usher & McLean (1969) who measured 300 infants at birth. The data from term to 2 years are from the study by Wingerd (1970) and data for 1 to 10 years were obtained from the Child Research Council in Denver, Colorado (McCammon, 1970). Therefore the data after term are from general samples of infants and children. The data were pooled for the two genders and the way in which the data sets were combined was not reported. The charts present the means " 1 standard deviation and " 2 standard deviations from 26 weeks gestational age (GA) to 1 year GA in one chart and from 1 to 10 years in another chart. It is emphasized that the data after term in both charts are from general samples and that most of those for LBW infants were recorded in 1959.

(3) CDC Growth Charts (2000): The CDC charts may be used with preterm infants once 40 weeks gestation is reached. Corrected age should be used until age two and should be noted on the growth chart. These charts can be used to evaluate growth over time.

(4) Fenton Growth Chart (2003): Researchers performed a meta-analysis of published reference studies from 1980 to 2002 to obtain more recent data to complete the pre and post-term sections of the chart. The Fenton chart is considered to be an "updated" Babson Benda chart. Data from several population studies with large sample sizes are included. To validate the chart, the growth data from NICHD were superimposed on the new chart. The advantages of the Fenton chart include the 100-gram graph increments, the percentile curves (3, 10, 50, 90 and 97th) rather than standard deviation, and a 22-week gestation start. This growth chart can be printed from the website: http://members.shaw.ca/growthchart/.

APPENDIX A: GROWTH CHARTS COMMONLY USED TO MONITOR PRETERM INFANTS

Growth Chart	Description of Data Included	Advantages	Disadvantages
Infant Health and Developmental Program (IHDP) Growth Percentiles	• Data from LBW and VLBW infants from 40 weeks gestation to 36 months corrected age • Data collected in 1984-85 before enriched formulas were routinely used • Overrepresentation of Black infants and infants born to mothers with less than a high school education	• Growth may be assessed against infants of similar birth weight (separate growth charts for low birth weight vs. very low birth weight) • Includes weight for length • Separate charts for males and females	• Must age adjust for preterm infants • Have to choose from multiple growth charts depending on birthweight of infant • Does not determine "normal" or abnormal growth
Babson & Benda (The Oregon Growth Record for Infants)	• 26-40 weeks gestation are cross-sectional data from 1959 • Male and female data combined • Used in Oregon to plot weight, height and head circumference on preterm infants until they reach 40 weeks gestation	• Weight, length, and head circumference (OFC) on one chart • Use until infant is old enough to be plotted on CDC growth charts (40 weeks gestation)	• Males and females combined on one growth chart • Does not include weight for length • Difficult to interpret when catch-up growth has not occurred • Have to convert to metric measurements
CDC 2000 Growth Charts *(used in Oregon WIC Program)*	• 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. or 3.3 lbs.)	• Includes weight for length for birth to 24 months and BMI for children over 24 months • Graphs can be downloaded from the CDC website (www://cdc.gov)	• Age adjust for preterm infants until infant turns 2 years old • Difficult to interpret when catch-up growth has not occurred • Does not include < 40 weeks gestation
Fenton Growth Charts *(used in Oregon WIC program)*	• Meta-analysis of published reference studies from 1980 to 2002 • Considered an updated Babson & Benda chart • Graph can be downloaded from http://members.shaw.ca/growthchart/	• 100 gm graph increments • Percentile curves (3,10, 50, 0- and 97th) rather than standard deviation • 22-week gestation start	• Just starting to be more widely used

Adapted from: Groh-Wargo, 3rd edition[10], p. 571

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APPENDIX B: NEONATAL INTENSIVE CARE AGE CORRECTION CHART

The corrected age is calculated by subtracting the number of weeks premature from the actual age in months. For example, if an infant was 6 weeks premature, and the infant's actual age is 10 months old, then 10 x 4 = 40 weeks - 6 weeks = 34 weeks or 8½ months, corrected age.

Preterm infants and toddlers up to 24 months of age without significant associated complications should be plotted at their corrected age rather than date of birth. (Cox, p. 44)[6] Some practitioners recommend using corrected age until 42 months (3-1/2 years) for VLBW infants and/or infants with continuing significant medical issues. (Groh-Wargo, p. 18)[2]

Gestational Age*	Weeks Early	30 Day Correction
39 weeks	1	7 days
38 weeks	2	14 days
37 weeks	3	21 days
36 weeks	4	28 days
35 weeks	5	1 m, 5 d
34 weeks	6	1 m, 12 d
33 weeks	7	1 m, 19 d
32 weeks	8	1 m, 26 d
31 weeks	9	2 m, 3 d
30 weeks	10	2 m, 10 d
29 weeks	11	2 m, 17 d
28 weeks	12	2 m, 24 d
27 weeks	13	3 m, 1 d
26 weeks	14	3 m, 8 d
25 weeks	15	3 m, 15 d
24 weeks	16	3 m, 22 d
23 weeks	17	3 m, 29 d

*Gestational Age = weeks of gestation at birth

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APPENDIX C: FEEDING YOUR PRETERM BABY STEP-BY-STEP

Name: _____ Date: _____ Date of Birth: _____

Actual Age: _____ Corrected Age: _____

Date	Actual Age	Corrected Age	Developmental Stages and Feeding Skills	Foods	Feeding Tips
Birth ___ to _____ 	0 to ____ months	0-4 mos	• Mouth is closed most of the time • Breast milk or formula leaks from sides of mouth • Pushes spoon out with tongue	• Breast milk or Formula	• Nurse baby on demand, at least 5-10 minutes on each breast. • Six wet diapers a day is a good sign of adequate hydration. • No need to force a baby to finish a bottle. • Putting baby to bed with a bottle could cause choking. • Heating expressed breast milk or formula in the microwave is not recommended.
_____ to _____ 	___ to ___ months	5-6 mos	• Sits with support • Grabs things & puts them in mouth • Chews by moving mouth up and down	• Breast milk or Formula • Baby cereal (iron fortified)	• May need to start baby cereal (iron-fortified). • Feed only one new cereal each week. • No need to add salt or sugar to cereal. • Use microwave with caution.
_____ to _____ 	___ to ___ months	7-8 mos	• Sits without support; sits in highchair • Holds bottle; can drink from cup • Presses lips against spoon when being fed • Holds things with thumb and second finder	• Breast milk or Formula • Baby cereal (iron fortified) • Bread or Crackers • Fruit • Fruit Juice • Vegetables	• Add strained fruits and vegetables once baby taking cereals. Add mashed or finely chopped fruits and cooked vegetables later on. • Feed only one new fruit or vegetable each week. • Take out of the jar the amount of food for one feeding, and refrigerate the remaining food. • Try giving baby fruit juice in a cup - limit fruit juice to 4 oz/day.
_____ to _____ 	___ to ___ months	8-12 mos	• Moves mouth in circles when chewing (like adult) • Licks food from bottom lip • Tries to feed self; grabs spoon • Has poor control of wrists	• Breast milk or Formula • Baby cereal (iron fortified) • Bread or crackers • Fruit • Fruit juice • Vegetables • Cheese • Plain yogurt • Cottage cheese • Chicken, beef, pork, beans, or egg yolks	• Add strained or finely chopped meats now. • Feed only one new meat per week. • Offer baby extra water with solid feedings. • Wait until baby's first birthday to feed egg whites. Some babies are sensitive to egg white. It's okay to give baby the cooked yolks. • Offer fresh fruit and cooked vegetables in bite sized portions. • Some fruits may need to be peeled (apples, pears). • Be patient. Babies make a mess when they feed themselves. • Always taste heated foods before serving them to baby to make sure food temperature is safe.

FYI:
- Do not add honey to food, water or formula because it can be a source of spores that cause botulism poisoning in infants. Processed foods containing honey should not be given to infants.
- Infants' gums and teeth should be cleaned twice per day.

Developed by Diane Smith, MA, RD, LD, Sasha Elliot and Alison Goerl, Dietetic Interns, Nutrition Services, Child Development and Rehabilitation Center, OHSU, 11/2000

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APPENDIX D: ESTIMATING CATCH-UP GROWTH REQUIREMENTS

1. **Plot** the child's measured length or height and weight on the sex-appropriate CDC growth chart.
2. **Height Age**: Determine the age at which the child's current length or height 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:

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

Example 1: Toby is a 7 month old infant who is 62 cm long and weighs 5.8 kg. Using the CDC growth chart, Toby's current height would be at the 50th percentile at 4.5 months. This is his height age. A 4.5 month old child's weight would be at the 50th percentile at 6.4 kg. This is Toby's ideal weight for height age.

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

Calculation for Protein requirements:

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

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

$$\frac{\text{RDA for protein for ht. age (2.2 gm/kg) X ideal wt for ht age (6.4 kg)}}{\text{Actual wt (5.8 kg)}} = 2.4 \text{ gm pro/kg}$$

RDA's for Energy and Protein

Category	Age	Energy (Kcal/kg)	Protein (gm/kg)
Infant	0-6 mos	108	2.2
Infant	6-12 mos	98	1.6
Child	1-3 yrs	102	1.2
Child	4-6 yrs	90	1.1

References:

Goldbloom, R.B. (1987). Growth failure in infancy. *Pediatr Rev, (57)61.*

Spady, D.W., Payne, R.R., Picou, D., Waterlow, J.C. (1976). Energy balance during recovery from malnutrition. *Am J Clin Nutr, 29,* 1073-1088.

APPENDIX E: SELECTION OF FEEDING AT DISCHARGE

Feeding strategies 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. Birth weight, weight at discharge, and NICU course are usually better predictors of risk than gestational age at birth. Breastfeeding after premature birth is recommended and encouraged whenever possible. Lactation consultation is encouraged to promote successful breastfeeding and use of a breast pump if needed.

1. High Risk – Very Low Birth Weight Infant

Category Definition:

- Birth weight $\leq$ 1500gm (3.3 lbs)
- History of TPN and diuretics
- Demonstrates poor growth
- Poor intake (< 150 ml/kg/day)
- Elevated alkaline phosphatase (> 500 U/L) and/or low phosphorus (< 4)

Formula Feeding Recommendations:

- In majority of cases, these infants will need transitional formulas (EnfaCare or Neosure) until 9 months corrected age. If change to a term formula, check labs and monitor growth.
- Continue on transitional formula unless:
  - Infant cannot tolerate formula
  - Excessive rate of weight gain
  - Calcium and Phosphorus exceed normal limits

Breastfeeding Recommendations:

- Supplement breastfeeding with a transitional formula (Similac Neosure or Enfamil EnfaCare) until infant able to sustain growth, ad lib milk intake, and lab values are within normal limits
- Discuss family's breastfeeding goals in order to support breastfeeding while still maintaining infant's growth and lab values.

2. Moderate Risk – Low Birth Weight Infant

Category Definition:

- Infant had BW $\geq$ 1500 gm (3.3 lbs), has good growth, use of TPN and diuretics was minimal and alkaline phosphatase level WNL
- Osteopenia evidenced by serum phosphorous <4mg/dl, alkaline phosphatase > 500 U/L
- Weight for corrected age is less than 5th percentile on CDC 2000 growth grids
- Infant has bronchopulmonary dysplasia/chronic lung disease with steroid use

Formula Feeding Recommendations:

- Provide transitional formulas (EnfaCare or Neosure) to 9 months corrected age.
- Continue on transitional formula unless:
  - Infant cannot tolerate formula
  - Excessive rate of weight gain
  - Calcium and Phosphorus exceed normal limits
  - If change to a term formula, check labs and monitor growth

Breastfeeding Recommendations:

- Supplement breastfeeding with a transitional formula (Similac Neosure or Enfamil EnfaCare) until infant able to sustain growth, ad lib milk intake, and lab values are within normal limits
- Discuss family's breastfeeding goals in order to support breastfeeding while still maintaining infant's growth and lab values.

3. Low Risk – Low Birth Weight Infant

Category Definition:

- Birth weight > 2000 gm (4.4 lbs)

Formula Feeding Recommendations:

- Offer standard 20 kcal/oz iron fortified infant formula such as Enfamil Lipil or Similac Advance until 1 year corrected age.

Breastfeeding Recommendations:

- Breastfeed on demand.
- If milk intake or supply is insufficient, as evidenced by slow growth on CDC growth grid, assess the need for lactation support or supplementation with standard formula such as Enfamil Lipil or Similac Advance.

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APPENDIX F: HUMAN MILK AND FORMULAS

Human Milk	
Considered the "gold standard" for infant nutrition due to the unique combination of nutrients, enzymes, hormones and immunological components. Preterm milk initially is higher in calories and protein than term milk. After about two weeks, human milk does not support intrauterine growth rates in very low and extremely low birth weight preterm infants without fortification.	
Human Breastmilk	~ 20 calories per ounce

Preterm Formula and Human Milk Fortifiers		
Preterm formulas and fortifiers for breast milk are designed with increased protein, vitamins, minerals and calories for the rapidly growing preterm infant. Not for use in infants over 1800-2500 grams (4 lbs) as may exceed renal solute load. Prolonged use associated with vitamin D toxicity and may supply several times RDA for vitamin A at intake > 500 ml per day. Not for post-discharge use with full-term infants or failure to thrive.		
Human Milk Fortifiers: • Similac Natural Care Advance (liquid/RTU) • Similac Human Milk Fortifier (powder) • Enfamil Human Milk Fortifier (powder)	Ross MJ	Supplement for human milk to increase nutrients for the rapidly growing preterm infant. Infants are rarely discharged on HMF.
24-Calorie/oz Preterm Formulas: (liquid/RTU) • Enfamil Premature Lipil • Similac Special Care Advance 24	 MJ Ross	Preterm infant formula not for use for infants over 1800-2000 grams (4 lbs). Higher protein, vitamin A, vitamin D, vitamin B6, calcium, phosphorus, and zinc; fortified with DHA/ARA.

Discharge or Transitional Formula		
Designed to provide additional protein, minerals and vitamins needed by the preterm infant after discharge from the NICU.		
• Similac Neosure Advance (powder and Ready-to-Feed) • Enfamil EnfaCare Lipil (powder only)	Ross MJ	Provide 22 calories/oz with standard preparation. Increased protein, calcium, phosphorous, vitamins A and D. Can also be used to supplement or fortify breast milk feedings.

Cow's Milk-based Formula		
Milk proteins casein and whey are modified to resemble human milk to aid in absorption. A higher level of nutrients is included in infant formulas because they are less well absorbed than those in breast milk.		
• Enfamil Lipil • Similac Advance • Various store brands of infant formula	MJ Ross Wyeth	Have added DHA and ARA.
• Similac PM 60/40	Ross	Has lower minerals for renal patients.
• Enfamil LactoFree Lipil • Similac Lactose Free Advance	MJ Ross	Casein/whey with reduced lactose for lactose intolerance.
• Enfamil AR Lipil	MJ	For simple reflux. Added rice starch is hydrolyzed in the stomach to thicken formula. Not for use with preterm infants.

Hydrolysate Protein Formulas – Whey Predominant		
Protein partially hydrolyzed to small peptides. Not true hypoallergenic formula, but more available and less expensive than fully hydrolyzed formulas. All are iron-fortified.		
• Nestle Good Start Supreme • Enfamil Gentlease Lipil	Carnation MJ	Not indicated for known allergy to cow's milk.

Hydrolysate Protein Formulas – Casein Predominant		
Protein hydrolyzed to amino acids and small peptides. For use in protracted diarrhea, multiple food allergy, carbohydrate/fat malabsorption.		
• Similac Alimentum Advance	Ross	33% of fat is MCT oil. RTU is also corn free. Iron-fortified, lactose-free, and fortified with DHA/ARA.
• Enfamil Pregestimil Lipil	MJ	55% of fat from MCT oil; sucrose and lactose-free. Also used for cystic fibrosis and short gut.
• Enfamil Nutramigen Lipil	MJ	Sucrose and lactose-free.

Free Amino Acid Elemental Formulas		
100% free amino acids as protein source (not a protein hydrolysate), hypoallergenic, nutritionally complete. Use in cow's milk sensitivity, multiple food protein intolerance, GERD, short bowel syndrome, eosinophilic esophagitis.		
Neocate Infant	Nutricia	Mixing ratio differs from standard infant formula.
Elecare	Ross	Not guaranteed to be hypoallergenic.

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APPENDIX G: STORAGE GUIDELINES FOR BREASTMILK AND FORMULA

Guidelines for Pumped Breastmilk:

- Use containers that have been washed in hot, soapy water and rinsed.
- All milk should be dated before storing.
- Storing milk in 2-4 ounce amounts may reduce waste.
- Refrigerated milk has more anti-infective properties than frozen milk.
- Cool fresh pumped milk in refrigerator before adding to frozen milk.

Unfortified Breastmilk Storage Guidelines					
	Room Temperature	**Cooler with 3-Frozen Ice Packs**	**Refrigerator**	**In-refrigerator and "frost-free" Freezers**	**Freezer (<u>not</u> "frost free")**
Freshly expressed breastmilk	4 hours at 66-72° F (19-22° C)	24 hours at 59° F (15° C)	5 – 7 days at 32-39° F (0° C)	3 – 4 months	6 – 12 months at 0°F (-19° C)
Thawed breastmilk (previously frozen)	Do not store	Do not store	24 hours	Never refreeze thawed milk	Never refreeze thawed milk

Source: Medela, Inc.

Expressed breastmilk can be kept in a common refrigerator at the workplace or in a day care center. The US Centers for Disease Control and the US Occupational Safety and Health Administration agree that human milk is not among the body fluids that require special handling or storage in a separate container.

If breastmilk has been frozen and thawed, it can be refrigerated for up to 24 hours for later use. It should not be refrozen. 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.

Storage Instructions for Prepared Formula & Fortified Breastmilk:	
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 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; Do not refrigerate for later feedings

Source: Mead Johnson Nutritionals "Instructions for Safe Infant Formula Preparation, Storage and Use"

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APPENDIX H: CONCENTRATING FORMULAS AND FORTIFYING HUMAN MILK

The recipes in this appendix are intended for the preterm infant, and so are designed to provide smaller final volumes than would be prepared for a full-term infant. Recipes can be doubled if more volume is needed. If more volume than a doubled recipe is needed, prepare two or more batches to keep same concentration.

Standard Infant Formulas:

Powder

Desired caloric concentration Kcal/oz	Measurement of powdered formula (Level scoop)	Water in oz (Measure water first, then add powder)
20 Kcal/oz	1 scoops	60 ml (2 oz)
22 Kcal/oz	3 scoops	165 ml (5.5 oz)
24 Kcal/oz	3 scoops	150 ml (5 oz)
27 Kcal/oz	3 scoops	128 ml (4.25 oz)

Concentrate (Liquid)

Desired caloric concentration Kcal/oz	Measurement of concentrate formula	Water in oz
20 Kcal/oz	30 ml (1 oz or 2 Tbsp) Concentrate	30 ml (1 oz)
24 Kcal/oz	90 ml (3 oz) concentrate	60 ml (2 oz)
	390 ml (13 oz) conc.	255 ml (8.5 oz)
27 Kcal/oz	60 ml (2 oz) concentrate	30 ml (1 oz)
27 Kcal/oz	390 ml (13 oz)	180 ml (6 oz)

Ready-to-Use (RTU) – (Note: Measure water first, then add powder)

Desired caloric concentration Kcal/oz	Measurement of powder	Amount of RTU in oz
24 Kcal/oz	1 scoop powder	300 ml (10 oz) RTU
27 Kcal/oz	2 scoops powder	300 ml (10 oz) RTU

Transitional Infant Formulas:

EnfaCare or Neosure

Desired caloric concentration Kcal/oz	Measurement of powdered EnfaCare formula (Packed, level scoop)	Water in ml (Measure water first, then add powder)
22 Kcal/oz (standard dilution)	1 scoop	60 ml (2 oz)
24 Kcal/oz	3 scoops	165 ml (5.5 oz)
27 Kcal/oz	5 scoops	240 ml (8 oz)

Fortifying Human Milk:

Human Milk Fortifier

Desired Caloric Concentration	Measurement of powdered Human Milk Fortifier	Total amount of breast milk in ml (Measure breast milk first, then add powder)
22 Kcal/oz	1 packet	50 ml (1.7 oz)
24 Kcal/oz	1 packet	25 ml (1 oz)

EnfaCare or Neosure to fortify Human Milk

Desired caloric concentration Kcal/oz	Measurement of powdered formula (*Packed, level teaspoon*)	Total amount of breast milk in ml (Measure breast milk first, then add powder)
22 Kcal/oz	1 teaspoon	180 ml (6 oz)
24 Kcal/oz	1 teaspoon	90 ml (3 oz)
27 Kcal/oz	2 teaspoons	90 ml (3 oz)

Measurement Equivalents: 1 oz = 2 Tbsp
1 Tbsp = 3 teaspoons
1 oz = 30 ml

Reference:

Groh-Wargo (pp. 651-656), Cox (p. 199)

APPENDIX I: NUTRIENT RECOMMENDATIONS FOR PRETERM AND TERM INFANTS

NUTRIENT	PRETERM*	0 – 6 months	7 – 12 months
Energy	110 - 150 kcal/kg	108 kcal/kg RDA 92 - 93 kcal/kg DRI	98/kg RDA 80 - 81 kcal/kg DRI
Protein	3.4 - 4.4 g/kg	2.2 g/kg RDA 1.52 g/kg DRI	1.6 g/kg RDA 1.5 g/kg DRI
Vitamin A	210 - 450 mcg/kg or 700 - 1500 IU/kg	400 mcg/day or 1330 IU/day DRI	500 mcg/day or 1665 IU/day DRI
Vitamin D	3.75 - 10 mcg/kg or 150-400 IU/kg maximum of 400 IU/day	5 mcg/day or 200 IU/day DRI	5 mcg/day or 200 IU/day DRI
Vitamin E	4 - 8 mg/kg or 6 -12 IU/kg	4 mg/day or 6 IU/day DRI	5 mg/day or 7.5 IU/day DRI
Calcium	100 - 220 mg/kg	210 mg/day DRI	270 mg/day DRI
Phosphorous	60 - 140 mg/kg	100 mg/day DRI	275 mg/day DRI
Iron	2 - 4 mg/kg	0.27 mg/day DRI or 6mg/day RDA	11 mg/day RDA
Zinc	1 - 3 mg/kg	2 mg/day DRI	3 mg/day RDA

***** In most cases, use the lower value in the recommended range for preterm infants in the community setting.

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APPENDIX J: IMPORTANT LAB VALUES FOR PRETERM INFANTS

Bone health is a concern for many preterm infants, especially the high risk, very low birth weight infants. During the last 3 months of pregnancy, large amounts of calcium and phosphorus are transferred from the mother to the baby for bone growth. When an infant is born prematurely, the infant may not receive the required amounts of calcium and phosphorus to form strong bones. Vitamin D helps with the absorption of calcium. Low levels of Vitamin D or the inability of the premature infant to properly metabolize Vitamin D postnataly may lead to improper absorption of calcium and phosphorus.

The condition of decreased bone density in the low-birth-weight infant is called osteopenia of prematurity, which may or may not be seen in conjunction with rickets. These two conditions are characterized by low levels of calcium and phosphorus and high levels of serum alkaline phosphatase.

Osteopenia of prematurity is most commonly seen in:

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

Recommendation for checking labs:

- 1-month post-discharge for the infants born < 1500g and IUGR with birthweight < 1800 g.
- 1-month post-discharge if any of the labs at discharge (if known) are outside the reference range.
- If the premie is transitioning to the breast or a term formula < 3-6 months corrected age.
- If the premie has had marginal intake and slower growth.

Bone health can be assessed using the following labs. In the absence of other disease conditions, alkaline phosphatase provides an indirect indicator of bone cell activity.

Higher alkaline phosphatase along with lower calcium and phosphorus levels may indicate a need for further assessment and supplementation. These labs are usually done in the hospital setting, and may be done in the community up until 6-9 months corrected age.

Reference Table for Lab Values

Biochemical Marker	Reference Range*	Interpretation
Alkaline Phosphatase	82 - 500 mg/dl	• Marker of bone formation. • Levels may be elevated during periods of bone growth. • Levels > 500 U/L in preterm infants may indicate a risk of osteopenia and need for further evaluation.
Calcium	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	4 - 8 mg/dl (< 40 wks GA) 4 - 6.5 mg/dl (> 40 wks GA)	• Cellular anion involved in bone formation. • Elevated levels indicate skeletal 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.

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

References:

Groh-Wargo, S, Thompson, M, Fox J. (Eds.) (2000). *Nutritional Care for High-risk Newborns*. Chicago, IL: Precept press, Inc.

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APPENDIX K: 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 • Shuts down • 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 mins. • 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 mins., 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	
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	

Feeding Problem	Symptoms/Characteristics	Nutrition Counseling Guidelines
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

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APPENDIX L: SEVEN RECOMMENDED PRINCIPLES OF FAMILY-CENTERED CARE

1. Promotes a relationship in which family members and professionals work together to ensure the best services for the child and the family;

2. Recognizes and respects the knowledge, skills and experience that families and professionals bring to the relationship;

3. Acknowledges that the development of trust is an integral part of a collaborative relationship;

4. Facilitates open communication so that families and professionals feel free to express themselves;

5. Creates an atmosphere in which the cultural traditions, values, and diversity of families are acknowledged and honored;

6. Recognizes that negotiation is essential in a collaborative relationship;

7. Brings to the relationship the mutual commitment of families, professionals, and communities to meet the needs of children and their families.

Adapted from: Bishop K, Woll J, Arango P. Family/Professional Collaboration for Children with Special Health Care Needs and Their Families, 1993, reprinted with permission from Nutrition for Children with Special Health Care Needs: A Self-Study Curriculum, Pacific West MCH Distance Learning/University of Washington, 2001.