Chapter 43

Medical Nutrition Therapy for Low–Birth-Weight Infants

Krause's *Food & Nutrition Therapy*

Low–Birth-Weight Infant

- Low birth weight: an infant who weighs less than 2500 g (5½ lb) at birth
- Very low birth weight: an infant who weighs less than 1500 g (3⅓ lb) at birth
- Extremely low birth weight: an infant who weighs less than 1000 g (2¼ lb) at birth

Low–Birth-Weight Infant–cont'd

- Infancy: birth to 1 year of age
- Term infant: born 37 to 42 weeks' gestation
- Premature: an infant born before 37 weeks' gestation

Low–Birth-Weight Infant–cont'd

- Gestational age: the age of the infant at birth, determined by length of pregnancy
- Small for gestational age (SGA): weight <10th percentile of standard weight for gestational age
  - Intrauterine growth restriction (IUGR)
- Appropriate for gestational age (AGA): weight 10^{th} to 90^{th} percentile
- Large for gestational age (LGA): weight > 90th percentile

Pre-maturity

Problems of Prematurity

System	Problem
Respiratory	Respiratory distress syndrome, chronic lung disease (bronchopulmonary dysplasia)
Cardiovascular	Patent ductus arteriosus
Renal	Fluid and electrolyte imbalance
Neurologic	Intraventricular hemorrhage, periventricular leukomalacia (cerebral necrosis)
Metabolic	Hypoglycemia, hyperglycemia, hypocalcemia, metabolic acidosis
Gastrointestinal	Hyperbilirubinemia, feeding intolerance, necrotizing enterocolitis
Hematologic	Anemia
Immunologic	Sepsis, pneumonia, meningitis
Other	Apnea, bradycardia, cyanosis, osteopenia

Modified from Zerzan J, O'Leary MJ: Nutrition for preterm and low-birth-weight infants. In Trahms CM, Pipes PL, editors: *Nutrition in infancy and childhood,* ed 6, New York, 1997, WBC/McGraw-Hill.

Nutrition Requirements: Parenteral Feeding

- Fluid
- Energy
- Glucose
- Amino acids
- Lipids
- Electrolytes
- Minerals
- Trace elements
- Vitamins

Energy Needs of Premature Infants

	Parenteral	Enteral
Maintenance		
Gradually increase intake to meet energy needs by the end of the first week	30-50 cal/kg/day	50 kcal/kg/day
Growth		
Meet energy needs as soon as the infant's condition is stable	90-100 cal/kg/day	105-130 kcal/kg/day

Glucose Load in Premature Infants

Birth Weight (g)	Initial Load (mg/kg/min)*	Daily Increments (mg/kg/min)	Maximum Load (mg/kg/min)
<1000	4-6	1-2	11-12
1001-2000	<6	1-2	11-12

*Use the following formula to calculate glucose load: (% Glucose x ml/kg/day) x (1000 mg/g glucose) ÷ (1440 min/day).
For example: (0.10 x150 ml/kg/day) x (1000 mg/g glucose) ÷ (1440 min/day) = 10.4 mg/kg/min.

Parenteral Amino Acids for Premature Infants

Initial Rate (g/kg/day)*	Increments (g/kg/day)	Maximum Rate (g/kg/day)
1.5-2	Advance to meet needs	3.5-4†

From Tsang RC et al: Summary of reasonable nutrient intakes. In Tsang RC: *Nutrition of the preterm infant*, ed 2, Cincinnati, Oh, 2005, Digital Educational Publishing, Inc.
*Use the following formula to calculate protein load: % Protein x ml/kg/day = Protein g/kg/day.
For example: 2% amino acid parenteral solution provided at 150 ml/kg/day = 0.02 x150 ml/kg/day = 3 g/kg/day.
†4 g/kg/day is recommended for infants weighing less than 1000 g.

Parenteral Lipids for Premature Infants

Initial Rate (g/kg/day)*	Increments (g/kg/day)	Maximum Rate (g/kg/day)
0.5-1	0.5-1	3-4†

Tsang and colleagues (2005) recommend up to 4 g/kg/day of lipids. From Tsang RC et al: Summary of reasonable nutrient intakes, In Tsang RC, editor: *Nutrition of the preterm infant,* ed 2, Cincinnati, Oh, 2005, Digital Educational Publishing, Inc.

*Use the following formula to calculate lipid load: % Lipid x ml/kg/day = Lipid g/kg/day. For example: 0.20 x 15 ml/kg = 3 g/kg/day.

†AAP (2004) recommends 3 g/kg/day. (American Academy of Pediatrics, Committee on Nutrition: Nutritional needs of preterm infants. In Kleinman RE, editor: *Pediatric nutrition handbook,* ed 5, Elk Grove, Ill, 2004, AAP.)

Parenteral Electrolytes for Premature Infants

Electrolyte	Amount (mEq/kg/day)
Sodium	2-4
Chloride	2-4
Potassium	1.5-2

Parenteral Minerals for Premature Infants

Minerals	Amount (mg/kg/day)*
Calcium	80-100
Phosphorus	43-62
Magnesium	6-10

From American Academy of Pediatrics, Committee on Nutrition: Nutritional needs of preterm infants. In Kleinman RE, editor: *Pediatric nutrition handbook,* ed 5, Elk Grove, Ill, 2004, American Academy of Pediatrics.

*These recommendations assume an average fluid intake of 120 to 150 ml/kg/day with 2.5 g of amino acids per 100 ml. The amino acid concentration prevents the precipitation of these minerals.

Parenteral Trace Elements for Premature Infants

Trace Elements	Amount (mcg/kg/day)
Zinc	400
Copper	20*
Manganese	1*
Selenium	2†
Chromium	0.2†
Molybdenum	0.25†
Iodine	1

From American Academy of Pediatrics, Committee on Nutrition: Nutritional needs of preterm infants. In Kleinman RE, editor: *Pediatric nutrition handbook,* ed 5, Elk Grove, Ill, 2004, AAP.
*Reduced or not provided for infants with obstructive jaundice.
†Reduced or not provided for infants with renal dysfunction.

Parenteral Vitamins for Premature Infants

	Preterm*
Percentage of one 5-ml vial of MVI-Pediatric†	40%/kg

*Data from American Academy of Pediatrics, Committee on Nutrition: Nutritional needs of preterm infants. In Kleinman RE, editor: *Pediatric nutrition handbook,* ed 5, Elk Grove, Ill, 2004, American Academy of Pediatrics.
Maximum volume intake is 5 ml/day, which is achieved at 2.5 kg body weight.
†MVI-Pediatric (5 ml) contains the following vi-ta-mins: 80 mg of ascorbic acid, 2300 USP units of vi-ta-min A, 400 USP units of vi-ta-min D, 1.2 mg of thiamin, 1.4 mg of riboflavin, 1 mg of vi-ta-min B_6, 17 mg of niacin, 5 mg of pantothenic acid, 7 USP units of vi-ta-min E, 20 mcg of biotin, 140 mcg of folic acid, 1 mcg of vi-ta-min B_{12}, and 200 mcg of vi-ta-min K.

Respiratory Distress Syndrome (RDS)

- Insufficient surfactant in lungs (treated with surfactant supplements into lungs)
- Made from lipids (especially phospholipids) and proteins
- Choline: conditionally essential
- Choline added to premature infant formulas at level in human milk
- Vitamin A supplements

Transition From Parenteral to Enteral Feeding

- Benefits of early enteral feeding
  - Stimulate GI enzyme development and activity
  - Promote bile flow
  - Increase villous growth
  - Promote mature GI motility
  - Decrease cholestatic jaundice and physiologic jaundice
  - Improve subsequent feeding tolerance

Factors to Consider When Initiating or Increasing Enteral Feedings

Category	Factors
Perinatal	Birth asphyxia
Respiratory	Stability of ventilation, blood gases, apnea, bradycardia, cyanosis
Medical	Vital signs (heart rate, respiratory rate, blood pressure, temperature)
Gastrointestinal	Anomalies (gastroschisis, omphalocele), patency, gastrointestinal tract function (bowel sounds pres-ent, passage of stool), risk of necrotizing enterocolitis
Procedure	Pending intubation or extubation

Modified from Zerzan J, O'Leary MJ: Nutrition for preterm and low-birth-weight infants. In Trahms CM, Pipes PL, editors: *Nutrition in infancy and childhood,* ed 6, New York, 1997, WCB/McGraw-Hill.

Enteral Energy Needs of Preterm Infants

- Increased by stress, illness, and rapid growth
- Decreased by neutral thermal environment
- May require concentrated feedings to meet energy needs with limited ability to tolerate fluids

Energy Requirements of Low–Birth-Weight Infants

Activity	Average Estimation (kcal/kg/day)
Energy expended	40-60
Resting metabolic rate	40-50*
Activity	0-5*
Thermoregulation	0-5*
Synthesis	15†
Energy stored	20-30†
Energy excreted	15
Energy intake	90-120

Modified from American Academy of Pediatrics, Committee on Nutrition: Nutritional needs of preterm infants. In Kleinman RE, editor: *Pediatric nutrition handbook,* ed 5, Elk Grove, Ill, 2004, AAP; Committee on Nutrition of the Preterm Infant, European Society of Paediatric Gastroenterology and Nutrition (ESPGAN): *Nutrition and feeding of preterm infants,* Oxford, 1987, Blackwell Scientific.

*Energy for maintenance.

†Energy cost of growth.

Enteral Macronutrient Needs of Preterm Infants

- Protein
  - 3.5 to 4 g/kg/day
  - Whey preferred to casein
- Lipids
  - 40% to 50% kcals
  - EFA: 3% of kcals; include ARA and DHA
  - MCT
  - Better digestion and absorption of fat in human milk
- Carbohydrates
  - 40% to 50% of kcals
  - Lactose

Enteral Micronutrient Needs of Preterm Infants

- Formulas and human milk fortifiers
- Calcium and phosphorus
- Vitamin D
- Vitamin E
- Iron
- Folic acid
- Sodium

Feeding Methods

- Gastric gavage
- Transpyloric feeding
- Nipple-feeding
- Breast-feeding
- Tolerance of feedings

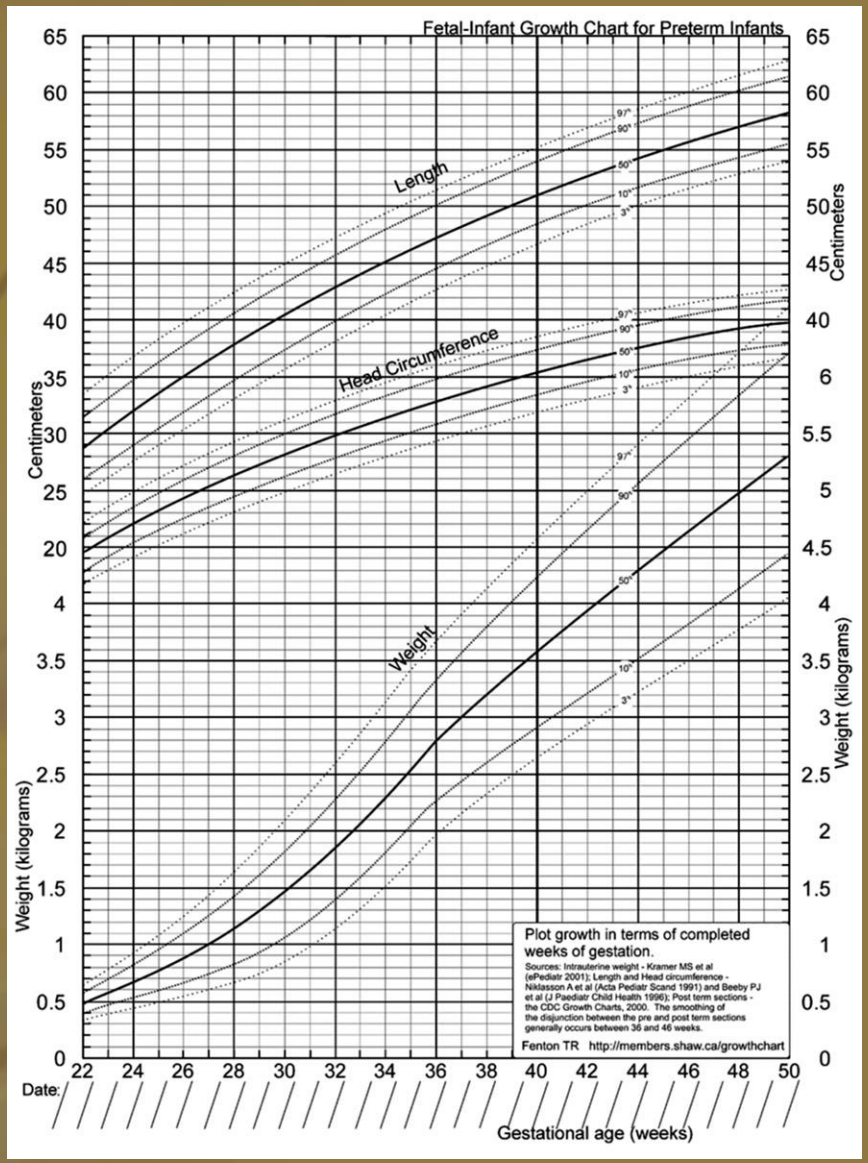
Selection of Enteral Feeding

- Human milk
- Premature infant formulas
- Transitional infant formulas
- Formula adjustments
  - Concentration: 24-30 kcal/oz
  - Caloric supplements: MCT oil, glucose polymers

Nutritional Assessment and Growth

- Dietary intake
- Growth rates and growth charts
- Laboratory indices

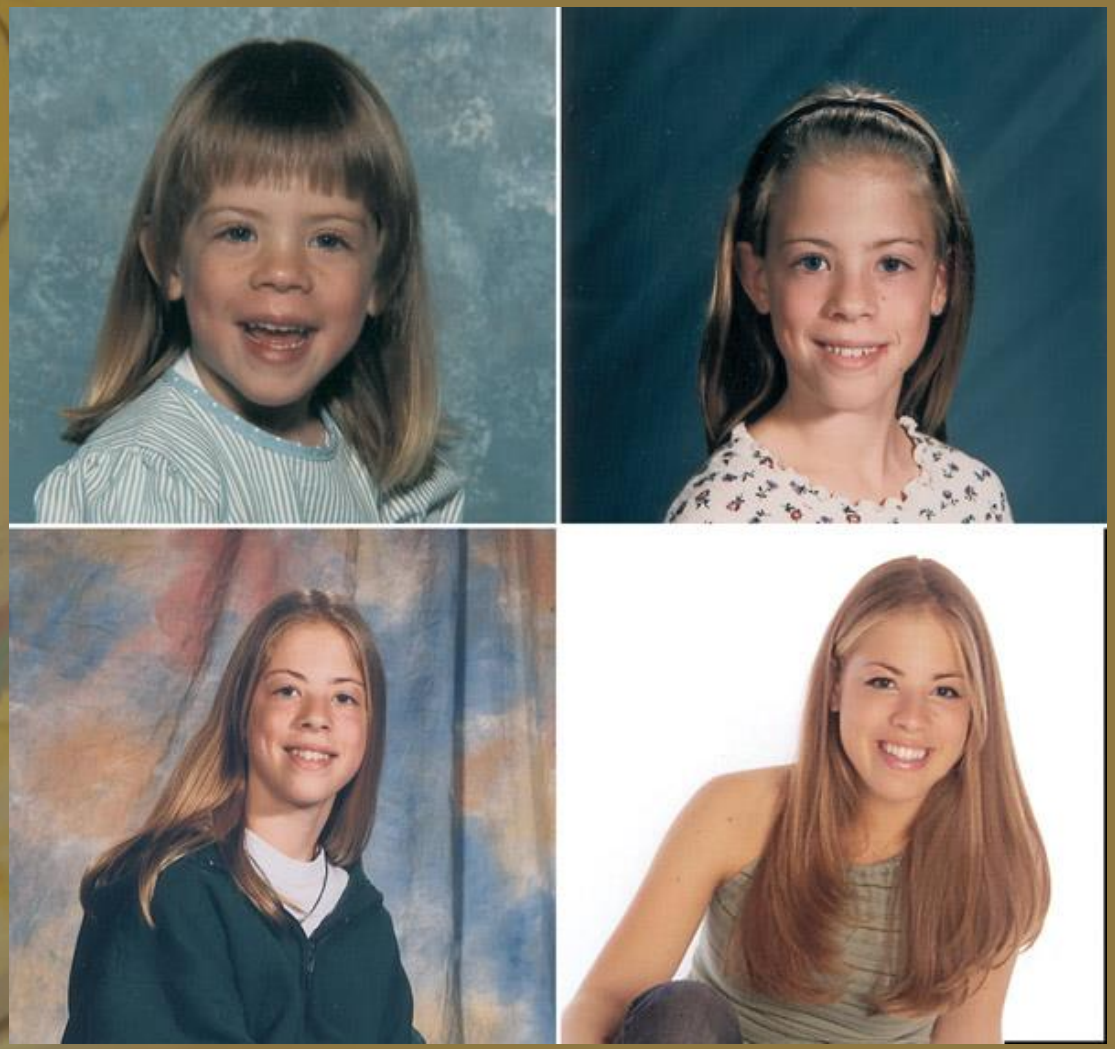
Growth Charts



Discharge Care and Neurodevelopmental Outcome

- Discharge care
  - Discharge criteria
  - Feeding skills and behavior
  - Feeding environment
- Neurodevelopmental outcome
  - Short-term and long-term quality of life

Outcome of a Premature Infant



Focal Points

- Nutritional management of the LBW or premature infant is a dynamic process as the nutritional needs change based on the rapid growth of the infant.
- Parenteral and enteral nutrition guidelines are used to feed these high-risk infants.
- Nutrition fortifiers for human milk and infant formulas, specially designed for the premature infant, help tremendously in meeting the tremendous nutritional needs of these infants.
- Assessments and concerns for the neurodevelopmental outcome of premature infants reveal that the nutritional efforts provided help them reach adulthood in good health.