
ENTERAL NUTRITION FOR PRETERM INFANTS

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Objectives: After completing this module the resident will be able to...

- Present advantages and disadvantages of human milk
 - Compare and contrast contemporary commercial infant formulas
 - Recommend a plan for initiation and progression of enteral feedings
 - Prescribe appropriate vitamin and mineral supplements
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The importance of nutrition and the challenge of prematurity

- Limited reserves
 - High accretion rates
 - Rapid growth
 - Increased requirements
 - suboptimal digestion
 - Immature neuromuscular function
 - Medical/surgical complications
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Gastrointestinal Development

- *Physiological Functions:* Motility, Secretion, Digestion and Absorption
 - *Areas of Development:* Anatomic, Motor and Functional
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Gastrointestinal Development

- Anatomic: complete by ~20 weeks
 - Motor
 - Motility established ~29-31 weeks
 - Suck/swallow coordination ~34 weeks
 - Functional/enzymatic: complete by term
 - Gastrointestinal development is the basis upon which to choose the source of enteral nutrition
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Digestion/Absorption: Protein

- Gastric function limited; small intestine relatively efficient
 - Assessment:
 - Stool negative for guaiac/blood
 - Albumin/prealbumin normal for age
 - BUN normal for age
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Digestion/Absorption: Carbohydrate

- Lactase levels mature close to term
 - Assessment:
 - Reducing substances $\leq 1/4\%$
 - Stool pH ≤ 5.5
 - Stable abdominal girth
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Digestion/Absorption: Fat

- Lingual/gastric stimulated by sucking; secretion of p(ancreatic) lipase and bile may be limited; fat provides about 50% of enteral calories; medium chain triglycerides (MCT) may be better absorbed because they don't require p lipase/bile but L(ong)CT provide essential fatty acids
 - Assessment
 - Color – pale (cholestasis) or bright red (grossly bloody) warrant investigation
 - fecal fat – neutral or split fats in stools suggest malabsorption
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Enteral Nutrition: Advantages of Human Milk

- Human specific composition
 - Superior digestion and absorption
 - Physiological nutrient balance
 - Anti-infective components
 - Low renal solute load
 - Promotion of maternal-infant attachment
 - Possible protection against NEC
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Enteral Nutrition: Disadvantages of Human Milk for PT Infants

- Amount of protein
 - Concentration of calcium and phosphorus
 - Level of sodium
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Enteral Nutrition: Commercial Products for Preterm Infants

- Preterm Infant Formulas
 - Human Milk Fortifiers
 - Nutrient Enriched Formulas for Postdischarge Feeding
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Preterm Infant Formulas: Macronutrient Composition

- Carbohydrate: lactose and glucose polymers
 - Protein: whey predominant cow milk protein
 - Fat: combination of LCT and MCT
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Preterm Infant Formula: Comparison to Standard Formula

- More protein; whey predominant protein
 - More fat; MCT fat blend
 - More carbohydrate; less lactose
 - More calorically dense
 - More vitamins and minerals
 - Osmolality PF₂₄ = Osmolality of Std₂₀
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Advantages of Preterm Formula for Preterm Infants

- Improved weight, length and HC growth
 - Bone mineralization equal to intrauterine rate
 - Normal biochemical indices of nutritional status
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Preterm Formulas: Product Names

- Similac Special Care Advance 24 and 20 kcal/oz* (Ross)
 - Similac Special Care Advance 30 kcal/oz* (Ross)
 - Enfamil Premature Lipil 24 and 20 kcal/oz (Mead Johnson)

 - *MetroHealth 'house' preterm formulas; iron fortified
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Human milk fortification recommended for

- All infants <1500 grams at birth
 - Most infants 1500-1800 grams at birth
 - Few infants >1800 grams at birth
 - Decision for infants >1500g based on acuity (high acuity increases risk of nutritional inadequacy) and length of time on parenteral nutrition (TPN does not provide adequate calcium & phosphorus and increases the risk of cholestasis with associated malabsorption)
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Human milk fortification options

- Powdered
 - Liquid
 - Hindmilk
 - Individualized
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Human Milk Fortifiers: Powdered

- Similac Human Milk fortifier (Ross; 'house' MetroHealth powdered fortifier); Enfamil Human Milk Fortifier (Mead Johnson)
 - Provides protein, carbohydrate and fat, and vitamins and minerals
 - Initiated
 - When infant receiving 100ml/kg or full feedings
 - Mixed initially 1 packet:50ml expressed human milk
 - Increased to 1 packet:25 ml as tolerated
 - Results in ~ 24 kcal/oz mixture (1pkt:25ml)
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Human Milk Fortifiers: Liquid

- Preterm formula 24 kcal/oz mixed 1:1 with expressed human milk (EHM):
22 kcal/oz
 - Special Care 30 kcal/oz mixed 1:1 with EHM:
25 kcal/oz
 - Special Care 30 kcal/oz mixed 2:1 with EHM:
27 kcal/oz
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Comparison of Liquid vs Powdered Human Milk Fortifiers: Advantages

- Powdered:
 - Utilizes greater volume of human milk
 - Offers increased caloric density
 - Liquid:
 - Mixes easily
 - Stretches supply of human milk
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Comparison of Liquid vs Powdered Human Milk Fortifiers: Disadvantages

- Powdered:
 - Higher osmolality may result in poor tolerance
- Liquid:
 - Dilutes benefits of human milk



Human Milk Fortifiers: Hindmilk

- Milk at the end of the feeding or pumping session
 - High in fat and calories (~26 kcal/oz)
 - Mixed with powdered human milk fortifier (1 pkt: 25 ml) yields ~30 kcal/oz
 - For success, need a mother with (a) an excellent milk supply, and (b) a mother willing to separate each collection aliquot into containers marked 'foremilk' and 'hindmilk'
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Human Milk Fortifier: Individualized

- Usual target nutrients are protein and macrominerals such as calcium and phosphorus
 - Products are modular protein powders, individually weighed mineral powders, and/or elemental formula powders
 - For success, need good pharmacy and nursing support for safe and accurate delivery
 - Most common rationale for use: allergy and/or sensitivity to cow milk protein in the powdered and liquid human milk fortifiers
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Enteral Nutrition: Other Products Fed to High-Risk Newborns

- Soy Formulas (ex Isomil; Prosobee)
 - Protein Hydrolysate Formulas (ex Alimentum, Nutramigen, Pregestimil)
 - Amino Acid Formulas (ex EleCare, Neocate)
 - Note: none of the above products are recommended for preterm infants but must be used sometimes because of medical/surgical complications and/or intolerance to the preterm formulas
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Powder formula use in the NICU

- Fatal case of meningitis in an NICU infant reported in 2002 (MMWR. 51: 297-300, 2002)
 - The infection was caused by *Enterobacter sakazakii* and the organism was traced to contaminated powdered infant formula
 - The case resulted in review of infection control policies related to powder formula use in the NICU and new recommendations from the FDA and the CDC
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Recommendations for the use of powder formulas in the NICU

- Choose alternatives when possible
 - Use trained personnel & aseptic technique
 - Prepare in a designated space
 - Follow manufacturer's instructions
 - Refrigerate reconstituted product immediately
 - Discard if not used within 24 hours
 - Limit 'hang time' to 4 hours
 - Change tubing and reservoir every 4 °
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Additional comments

- Recommendations apply to the NICU – not at home
 - Infants older than 3 months may have some of their own immunological protection
 - Written hospital guidelines should be available in the event of a manufacturer product recall including a notification system of HCP and a system to follow-up use of specific formula products
 - Powder formulas are not and have never been sterile
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Expressed human milk and fortification

- Powdered human milk fortifiers are not sterile but come packaged in unit dose and provide the most complete nutrition for VLBW infants
 - Other powder modular products should be weighed in a designated area
 - Up to a 24^h supply of fortified human milk can be safely prepared if refrigerated at 35-40° F
 - Limit hang time of fortified human milk to 4^h; change tubing and reservoir every 4^h
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Common NICU vitamin-mineral supplements

- NeoVits (MetroHealth specific): 750 IU vitamin A, 200 IU vitamin D, 17.5 mg vitamin C (from 0.5 ml Tri-vi-sol) and 5 IU vitamin E (from 0.1 ml Aquasol E); total dose 0.3 ml PO BID
 - Multi-vitamin (Poly-vi-sol): vitamin C, B vitamins and fat soluble vitamins
 - Iron (Fer-in-sol): 15 mg elemental iron in 0.6 ml
 - Vitamin E (Aquasol E): 50 IU in 1 ml
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Vitamin-Mineral Supplements for Preterm Infants

- Human Milk: 1 ml PO QD multi-vitamin
 - Fortified Human Milk: 0.3 ml PO BID NeoVits
 - Premature Formulas: 0.3 ml PO BID NeoVits
 - Other Formulas: 1 ml PO QD multi-vitamin
 - Iron: Recommendation is 2-4 mg/kg per day no later than 2 months; iron fortified formula provides 2 mg/kg; Fer-In-Sol is prescribed as needed
 - Epogen: 6 mg/kg Fe and 10 IU vitamin E per day
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Feeding Initiation and Progression in PT Infants

- Initiation: Priming Feeds @ low volumes of ~ 10-15 ml/kg/d by DOL # 3-7 and continued for 3-5 days
 - Progression: Increase by ~ 15-20 ml/kg/d but no more than 35 ml/kg per day
 - Common methods of feeding include
 - NG and OG gavage feeding
 - continuous and intermittent schedules
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Monitoring tolerance to enteral feedings

- Acceptable residuals
 - Less than 50% of previous intermittent feeding
 - Less than 2 times the hourly feeding rate for continuous feedings
 - Stable abdominal girth
 - Minimal episodes of emesis
 - Regular stooling (see slides # 6, 7, 8)
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Nutrition Concerns at Discharge

- Poor nutrient stores at birth
 - Rapid third trimester accretion missed
 - Survival of ELBW infants increasing
 - Delayed growth at time of discharge common
(nearly 100% of infants <1kg at birth plot <10%ile at time of discharge)
 - Discharge often at 2 kg and 36 weeks (well before term size and age)
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Infants at highest risk at discharge

- Infants < 1 kg at birth AND < 2 kg at discharge
 - High acuity and/or long length of stay
 - These two categories of infants may deserve
 - Continued powdered human milk fortifier (1 packet: 50 ml expressed human milk) if human milk is available OR
 - Continued Special Care 20 or 24 kcal/oz with iron if human milk is not available or available in small amounts only
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Enriched Formulas for PostDischarge Feeding of PT Infants: Composition

- Designed for PT infants at discharge
 - Composition midway between standard and preterm formulas
 - NeoSure (Ross; MetroHealth 'house' enriched formula) and EnfaCare (Mead Johnson)
 - Transition from preterm formula to enriched formula prior to discharge
 - Enriched formula may be the initial feeding for the 1500-1800 gram preterm infant at birth
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Enriched Formulas for PostDischarge Feeding of PT Infants: *Advantages*

- Increased weight and length gain postdischarge
 - Improved bone mineral content
 - Normal biochemical indices of nutritional status
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Suggested Schedule: Use of NEF

Birthweight:

< 750 g

750-1000 g

1000-1500 g

1500-2000 g

2000-2500 g

> 2500 g

Length of use (CA):

12 months

9 - 12 months

6 - 9 months

3 - 6 months

1 - 3 months

term - 1 month

CA=corrected age

Conclusions

- Enteral feeding should be initiated as soon as possible and increased as tolerance allows
 - Human milk, with fortification in selected babies, offers advantages for the high risk infant
 - For preterm infants, preterm and enriched formulas are preferred over other formulas
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References

- Groh-Wargo S, Thompson M, Cox JH (editors), Nutritional Care for High-Risk Newborns, Revised Third Edition. Chicago: Precept Press, 2000.
 - Tsang R, Uauy R, Koletzko B, Zlotkin S (editors), Nutrition of the Preterm Infant: Scientific Basis and Practical Guidelines, Second Edition. Digital Educational Publishing, 2005.
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Question #1: Human milk should be fortified for all VLBW infants. The most important reason is:

- A) to increase protein and mineral intake
 - B) to maximize calories
 - C) to improve feeding tolerance
 - D) to prevent cholestatic jaundice
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Question #2: If human milk is not available, a preterm formula like Similac Special Care is the most appropriate choice for a preterm infant. Which of the following statements most correctly describes preterm formula.

- A) Is the only formula available in 24 cal/oz strength
 - B) Has a macronutrient composition matched to the preterm infant's digestive capacity
 - C) Should be given to preterm infants at discharge
 - D) Has a micronutrient composition like human milk
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Question #3: An 850g infant is receiving 1.5 ml/hr of fortified human milk (1 pkt:25 ml). The feeding is increased to 3 ml/hr. Is this a reasonable volume increase? Why or why not.

■ Response:

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