

Who Needs Parenteral Nutrition?

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Is Parenteral Nutrition An Appropriate Intervention?

- Key questions to ask with initial consultation
- Can the gastrointestinal (GI) tract be utilized?
- Can the GI tract be accessed?
- What is the nutrition status of the patient?
- Is the patient clinically stable?
- Is a palliative care approach planned?

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Nutrition Support Therapy Decision Making

• Parenteral Nutrition Indications

– Absolute^{1,2,3}

- Inaccessible GI tract
- Short bowel syndrome
- Non-operative mechanical bowel obstruction
- Multiple enterocutaneous fistulas or high output single fistula
- Severe paralytic ileus



¹Braunschweig CL, et al. Am J Clin Nutr 2001;74:534-542, ²Zaloga GP. Lancet 2006;367:1101-1111, ³Koretz RL, et al. Gastroenterology 2001;121:970-1001.



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Nutrition Support Therapy Decision Making

• Parenteral Nutrition Indications

– Relative^{1,2,3}

- Severe radiation enteritis
- Refractory diarrhea or vomiting
- Pseudo-obstruction
- Gut ischemia
- Intolerance to enteral feedings
- Failure to achieve enteral goals in 7 days⁴



¹Braunschweig CL, et al. Am J Clin Nutr 2001;74:534-542, ²Zaloga GP. Lancet 2006;367:1101-1111, ³Koretz RL, et al. Gastroenterology 2001;121:970-1001, ⁴McClave SA, J Parent Ent Nutr 2009;33:277



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Pediatric PN Indications

PN likely indicated:

Necrotizing enterocolitis
Diaphragmatic hernia
Omphalocele
Meconium ileus
Intestinal atresia
Gastroschisis
Short bowel syndrome

PN may be indicated:

Hemodynamic instability
High dose vasopressors?
Severe pulmonary disease
Cystic fibrosis
Congenital heart disease
Chylothorax
Renal disease on PD
Severe sepsis
Anorexia nervosa

Axelrod D, Kazmerski K, Iyer K. Pediatric enteral nutrition. *J Parenter Enteral Nutr.* 2006;30(1):S21–S26.
Samour PQ, King K. Handbook of Pediatric Nutrition. 3rd ed. Lake Dallas, TX: Helm Publishing; 2005.



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Indications for PN in Neonates/Infants

- Very low birth weight neonates who cannot be adequately fed by enteral nutrition
- Premature neonates with severe respiratory distress syndrome (RDS)
- Neonatal congenital defects (e.g., volvulus, meconium ileus, atresia, gastroschisis, severe Hirschsprung's disease, enteric fistula, diaphragmatic hernia)



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Goals of PN for Neonates/Infants

- Support normal growth and development
- Preserve tissue stores
- Provide catch-up growth for malnourished patients
- Allow for resolution of disease progression, wound healing, rehabilitation of depleted patient

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What is in PN?

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Components of PN Formulation

- Individualized to patient's needs
- Macronutrients → provide energy and structural substrates
 - Protein (i.e., amino acids)
 - Dextrose
 - Intravenous fat emulsion (IVFE)
 - Water
- Micronutrients → support variety of metabolic activities necessary for cellular homeostasis such as enzymatic reactions, fluid balance, and regulation of electrophysiologic processes
 - Vitamins
 - Trace elements
 - Electrolytes (i.e., sodium, potassium, etc.)

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What Is In the PN Formula

Macronutrients

- Carbohydrate – Dextrose
 - Anhydrous dextrose monohydrate
 - 3.4 kcal/g
 - Can be compounded in concentrations ranging 5% to 70%
 - 50 g/liter to 700 g/liter
 - 10% final concentration upper limit for peripheral infusion
 - Minimum intake suggested of 100 g/day¹
 - Maximum intake suggested not to exceed 5 mg/kg/min²

¹Wolfe R. Metabolism 1980;29:892;; ²Rosmarin D, Nutr Clin Pract 1996;11:151.

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Dextrose for Neonates

- Will accept up to 12.5% dextrose peripherally
- GIR (glucose infusion rate) is everything!
 - Initially 4-8 mg/kg/min
 - Typical max of 11-14 mg/kg/min
 - Some exceed if cycling PN or using minimal lipids

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What Is In the PN Formula Macronutrients

- Amino Acids – crystalline amino acids (CAA)
 - 4 kcal/g
- Varying mixtures of essential and non-essential amino acids
- Concentrations range from 3% to 20%
 - Highest concentration useful for patients needing fluid restriction or significantly ↑ protein requirement
- CAA solutions can contain electrolytes

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TABLE 15-1 Commercially Available Crystalline Amino Acids Solutions

Brand Name Concentrations	Type/Indication	Stock
Travasol	Standard	3.5%, 4.25%, 5.5%, 8.5%, 10%
Clinisol	Standard/fluid restriction	15%
Prosol	Standard/fluid restriction	20%
Aminosyn III	Standard	3.5%, 4.25%, 5%, 7%, 8.5%, 10%, 15%
FreAmine III	Standard	8.5%, 10%
HepatAmine	Hepatic failure	8%
Hepatasol	Hepatic failure	8%
FreAmine HBC	Metabolic stress	6.9%
Aminosyn HBC	Metabolic stress	7%
Branchamine	Metabolic stress	4%
NephrAmine ^a	Renal failure	5.4%
Aminess ^a	Renal failure	5.2%
Aminosyn RF ^b	Renal failure	5.2%
Renamin ^c	Renal failure	6.5%

^aContains essential amino acids only.

^bContains essential amino acids + arginine.

^cContains essential amino acids and some nonessential amino acids.

American Society of Parenteral and Enteral Nutrition. The A.S.P.E.N. nutrition support core curriculum: a case-based approach – the adult patient.
Ed. MM Gottschlich. ASPEN, Spring Field, MD:2007.

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Infant Amino Acid Products

- Specialized formulation to provide essential and conditionally essential amino acids for infants
- Based on breastmilk
- Available products
 - TrophAmine®
 - Aminosyn® – PF

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TrophAmine®

- Comes as 6% or 10%
- More acidic pH than adult products
- Contains: little sodium/chloride, a lot of acetate
- Often add l-cysteine at 40 mg per gram of amino acid (lowering pH further)
- When administered in conjunction with cysteine, results in normalization of plasma amino acid concentrations to profile consistent with that of breast-fed infant

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Aminosyn®-PF

- Comes as 7%
- More acidic pH than adult products
- Contains: no sodium/chloride, less acetate than TrophAmine
- Often add l-cysteine at 40 mg per gram of amino acid (lowering pH further)
- When administered in conjunction with cysteine, results in normalization of plasma amino acid concentrations to profile consistent with that of breast-fed infant

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Amino Acid Requirements – Neonates/Infants

	PROTEIN (g/kg/d)
Very Low Birth Weight	3-4
Preterm	2.5-3
Infant / neonate	2-2.5
Infant	1.5-2

American Society of Parenteral and Enteral Nutrition. The A.S.P.E.N. nutrition support core curriculum: a case-based approach – the pediatric patient. Ed. MR Corkins. ASPEN, Spring Field, MD:2010.

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What Is In the PN Formula Macronutrients

- Fat emulsion (IVFE)
 - Aqueous emulsion of soybean oils
 - Long chain triglycerides
 - Linolenic and linoleic acids
 - Egg yolk phospholipid included as emulsifier
 - Glycerol
 - Contributes additional energy – 10 kcal/g of IVFE
 - 10%, 20% or 30% concentration options
 - 1.1, 2 or 3 kcal/ml

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What Is In the PN Formula Macronutrients

- Fat emulsion (IVFE)
 - Minimum final concentration of 2% for total nutrient admixture
 - Maximum dose of 1 g/kg/day¹
 - 30% of total energy intake
 - Limit usage in those receiving propofol or with critical illness²
 - Avoid with hypertriglyceridemia (> 400 mg/dL)²

¹Jensen G. J Parent Ent Nutr 1990;14:467; ²McClave S. J Parent Ent Nutr 2009;33:277

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Differences in Neonates

- Fatty acids are components of biological membranes and essential for central nervous system development
- Usually start at 0.5-1 g/kg/day by 24 hours of age
- Max of 3 g/kg/day or total of 30-35% of total calories
- Almost always given as separate infusion

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Fat Emulsions – Hang Whole Package vs. Syringes

- Increased risk of infusing entire container if use whole package
 - Discard after 24 hours
- Increased risk of infection if withdraw fat emulsion into syringes
 - Discard after 12 hours
- Tubing exposed to fat emulsion must be discarded every 24 hours

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Macronutrient - Water

- Affected by total volume of PN ordered (i.e., volume to maintain fluid balance) and volume of other ingredients ordered
- Not truly ordered by prescriber
- Added as sterile water for injection (SWI)
- QS to volume ordered for PN

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