Who Needs Parenteral Nutrition?

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?
Nutrition Support Therapy
Decision Making

• Parenteral Nutrition Indications
  – Absolute1,2,3
    • Inaccessible GI tract
    • Short bowel syndrome
    • Non-operative mechanical bowel obstruction
    • Multiple enterocutaneous fistulas or high output single fistula
    • Severe paralytic ileus

Gastroenterology 2001;121:970-1001.

• Parenteral Nutrition Indications
  – Relative1,2,3
    • Severe radiation enteritis
    • Refractory diarrhea or vomiting
    • Pseudo-obstruction
    • Gut ischemia
    • Intolerance to enteral feedings
    • Failure to achieve enteral goals in 7 days4

Pediatric PN Indications

PN likely indicated:
- Necrotizing enterocolitis
- Diaphragmatic hernia
- Omphalocele
- Meconium ileus
- Intestinal atresia
- Gastrochisis
- 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

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., volvolus, meconium ileus, atresia, gastrochisis, severe Hirschprung's disease, enteric fistula, diaphragmatic hernia)

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

What is in PN?
Components of PN Formulation

- Individualized to patient’s needs
- Macronutrients \(\rightarrow\) provide energy and structural substrates
  - Protein (i.e., amino acids)
  - Dextrose
  - Intravenous fat emulsion (IVFE)
  - Water
- Micronutrients \(\rightarrow\) 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.)

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/day\textsuperscript{1}
  - Maximum intake suggested not to exceed 5 mg/kg/min\textsuperscript{2}

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

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
Infant Amino Acid Products

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

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
Amino Acid Requirements – Neonates/Infants

<table>
<thead>
<tr>
<th></th>
<th>PROTEIN (g/kg/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low Birth Weight</td>
<td>3-4</td>
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<tr>
<td>Preterm</td>
<td>2.5-3</td>
</tr>
<tr>
<td>Infant / neonate</td>
<td>2-2.5</td>
</tr>
<tr>
<td>Infant</td>
<td>1.5-2</td>
</tr>
</tbody>
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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
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/day\(^1\)
    - 30% of total energy intake
  - Limit usage in those receiving propofol or with critical illness\(^2\)
  - Avoid with hypertriglyceridemia (> 400 mg/dL)\(^2\)


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
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

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