Parenteral Nutrition

Indications for parenteral nutrition

- **Patients who cannot eat**
  - Ileus: large intestine shuts down to protect itself, after major surgeries
  - Obstruction of small intestine: NPO for at least 5 days

- **Patients who should not eat**
  - High output enterocutaneous fistula: surgeon accidentally nicks intestine → hairline sliver → ↑temp + ↑WBC + small stream flowing from intestine
  - Inflammatory bowel disease: Crohn’s, ulcerative colitis
  - Acute pancreatitis: any food or water will aggravate it
  - Radiation therapy: disrupts GI motility
  - Major abdominal surgery

- **Patients who cannot eat enough**
  - Surgery
  - Hyperemesis gravidarum: occurs during 2nd or 3rd trimester of pregnancy → uterus press on ab → N/V
  - Short bowel syndrome: ↓absorption
  - Chemotherapy: disrupts GI motility, can causes stomatitis, severe vomiting & diarrhea

Routes of administration

<table>
<thead>
<tr>
<th>TPN</th>
<th>total parenteral nutrition</th>
<th>PPN</th>
<th>peripheral parenteral nutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Central venous access via inferior vena cava</strong></td>
<td><strong>Peripheral venous access via a peripheral vein</strong></td>
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<tr>
<td>Long term therapy &gt; 2 weeks</td>
<td>Short term therapy &lt; 2 weeks</td>
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<tr>
<td>Allows high nutrient conc &amp; high osmolality (up to 35%D5W)</td>
<td>Limits macronutrient conc, max osmolality &lt;900mOsm</td>
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<tr>
<td>Able to fluid restrict (e.g. for renally impaired pts)</td>
<td>Inadequate source of calories</td>
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Potential complications

- **Mechanical complications**: pneumothorax, hemothorax, hydrothorax, intravascular misplacement, catheter embolization, air embolism, venous thrombosis, thoracic duct injury, internal/external bleeding, phlebitis (PPN)

- **Metabolic complications**
  - Glucose metabolism
    - Hyperglycemia: hyperglycemic hyperosmolar nonketotic coma, need Accuchecks q6hr + continuous insulin infusion if glucose > 400 mg/dL
    - Hypoglycemia: if abruptly stop TPN
    - ↑CO₂ production: pt on mechanical ventilator → dextrose end product CO₂ accumulates
    - Hepatic steatosis: liver biopsy with fat deposits because too much glucose
  - Protein metabolism
    - Azotemia (↑BUN), hyperammonemia
  - Fat metabolism: EFAD, hypertriglyceridemia
  - Electrolyte disturbances
    - Refeeding syndrome: severely stressed malnourished patients if give too much initially
    - Hypokalemia, hypophosphatemia, hypocalcemia, hypomagnesemia
  - Acid-base disturbances
  - Septic complications: due to improper catheter placement
  - Hypovitaminosis, trace element deficiency: prevent by giving MVI-12 + MTE-4 to all patients
  - Abnormalities of liver functions: due to high glucose infusion rate (>4-5 mg/kg/min), imbalanced AA solution, lacking essential AA, tryptophan degradation products in liver failure patients, EFAD, excess lipid emulsion admin
# Substrate intolerance in parenteral nutrition

<table>
<thead>
<tr>
<th>Complications</th>
<th>Possible causes</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hyperglycemia</strong></td>
<td>Stress, infection, corticosteroids, pancreatitis, diabetes, peritoneal dialysis, excessive dextrose admin</td>
<td>↓Dextrose load (↓infusion rate or ↓concentration), ↑calories from fat, admin insulin</td>
</tr>
<tr>
<td><strong>Hypoglycemia</strong></td>
<td>Abrupt dextrose withdrawal, insulin overdose</td>
<td>↑Dextrose intake, ↓insulin</td>
</tr>
<tr>
<td><strong>Excess CO₂ production</strong></td>
<td>Excess dextrose intake</td>
<td>↓Dextrose intake, balance calories from fat &amp; dextrose</td>
</tr>
<tr>
<td><strong>Hypertriglyceridemia</strong></td>
<td>Stress, pancreatitis, excess IVLE dose, rapid IVLE infusion rate</td>
<td>↓IVLE dose, ↓IVLE infusion rate, d/c IVLE</td>
</tr>
<tr>
<td><strong>Abnormal LFTs</strong></td>
<td>Stress, infection, cancer, excess carb intake, excess calorie intake, EFAD</td>
<td>↓Dextrose load, ↓total calories, EFA</td>
</tr>
</tbody>
</table>

## Monitoring parameters

- Intake: nutritional intake, fluid input/output
- Labs: electrolytes, glucose, serum proteins, ABG, CBC + differential, PT/PTT, INR
- Renal: BUN, SCr, 24hr urine collection (UUN, creatinine)
- Vital signs, daily weights
- Frequency of monitoring: baseline + long term to maximize therapy

## Ordering parenteral nutrition

- Assess for specialized nutrition support
- Calculate caloric + amino acid requirements
- Start solution at 42-63 mL/hr
- Order Accuchecks q6hr + regular insulin sliding scale
- Advance solution to goal rate as tolerated
- Order 24hr urine collection for UUN within 5 days → assess nitrogen balance
- Add electrolytes according to guidelines on day 1 → from day 2 on, adjust according to labs
- Check for drug – nutrient interactions
- Order labs as indicated

## Solution stability

- **Base solution**: admin immediately, refrigerate within 1 hr, use within 24hrs if refrigerated, protect from light, okay to stockpile if don’t add MVI/MTE
- **3-in-1 TNA** (total nutrient admixture): good for 14 days refrigerated without MVI, don’t use in-line filter due to lipids
- **Nutrient & drug additives**
  - Insulin
  - Albumin: never used
  - Calcium & phosphate salts
    - Ca x P <45 mEq/L
    - Precautions: add phos first then Ca, ↓pH helps ↓precipitation, use CaGluconate (not CaCl), avoid Y-site infusion, avoid room temp
  - Vitamins (in multidose vials): stable for 48hrs refrigerated, 24hrs at room temp
  - Heparin: generally not recommended, sometimes used in long term care (1000-2000U)

## TPN osmolarity

- **Cations**: total mEq/L x 2
- **Dextrose/L**: total g x 5
- **AA/L**: total g x 10
- Sum of all these to get mOsm/L
- If high osmolarity → central line