Parenteral Nutrition (PN)

Parenteral nutrition (PN) is a form of nutritional supplementation containing dextrose, amino acids, electrolytes, vitamins, minerals, trace elements, and fluids delivered intravenously. Lipid emulsion may be infused separately or added to the solution, called total nutrient admixture (TNA) or 3-in-1 parenteral nutrition. PN should be prescribed only in patients who cannot utilize the enteral (intestinal) route for nourishment. The goals of PN therapy include improving nutritional status, preserving muscle mass, promoting weight gain, and supporting healing (Seres, 2017; Malone, 2014).

Clinical Indications (Worthington & Gilbert, 2012)

- Unmanageable diarrhea, impaired absorption
  - Short bowel syndrome with weight loss
  - High-output enterocutaneous fistula
  - Severe infectious colitis, such as Clostridium difficile
  - Small bowel obstruction
  - Severe inflammatory bowel disease
  - Ischemic bowel
- Motility disorders
  - Prolonged ileus
  - Pseudo-obstruction
  - Scleroderma
- Inability to achieve or maintain enteral access
  - Hemodynamic instability
  - Massive gastrointestinal bleeding
  - High risk for procedural complications related to obtaining enteral access

General Parameters for Initiation of PN (Seres, 2017; McClave et al., 2016)

- In adequately nourished patients with contraindications or intolerance to enteral nutrition, initiate PN after the first 7 days of intensive care unit admission.
- For inadequately nourished patients who have contraindications to enteral nutrition expected to persist for a week or more, start PN within the first few days of intensive care unit (ICU) admission.
- Supplemental PN may be used in patients at either low or high nutritional risk after 7 to 10 days of hospitalization if they are not able to meet >60% of energy and protein requirements by enteral route alone.
- Initiate PN dose at ≤ 20 kcal/kg/day (or 80% of estimated daily energy need) in the first week of ICU admission. Then slowly increase to a general goal of 25-30 kcal/kg/d which is an accepted formula to estimate daily energy requirements and nutritional supplementation. Daily energy requirements increase in the critically ill or surgical patient.
Utilize current or actual body weight to determine estimated caloric needs in patients who are underweight, normal weight or overweight. For patients who are obese (BMI ≥ 30 kg/m²), measure actual body weight (ABW) and height. Calculate ideal body weight (IBW). Then utilize the following calculation: IBW + 0.4 (ABW - IBW) for dosing.

Contraindications (Seres, 2017)
- Hyperosmolality
- Severe hyperglycemia
- Severe electrolyte abnormalities
- Volume overload
- Inadequate IV access
- Inadequate attempts to feed enterally

PN Content (Worthington & Gilbert, 2012)
- Water: Adults require about 30 to 40 mL/kg of fluid daily.
- Carbohydrate: dextrose, available in 40, 50, and 70% concentrations.
- Fat: intravenous lipid emulsion (IVLE).
- Protein: crystalline amino acids (essential and nonessential); concentrations of 5.5% to 15%.
- Electrolytes: sodium, potassium, magnesium, calcium, phosphorus, chloride and acetate.
- Vitamins: based on patient requirements to prevent deficiency without causing toxicity. High intake of fat-soluble vitamins A, D, E, and K can lead to toxicity.
- Trace elements: include chromium, copper, manganese, and zinc (iron and iodine not typically added). Act as cofactors for enzymes and transport of substances across cell membranes.
- Insulin: may be added to control hyperglycemia; monitor glucose levels per unit protocol.

Nursing Considerations

Initiating PN
- Obtain appropriate IV access (Seres, 2017):
  - PN may be administered through a peripherally inserted central catheter (PICC), subclavian, internal jugular, or femoral central venous catheter. Tunneled catheters (i.e. Hickman, Groshong, or implanted infusion port) may be preferred if recurrent infection.
When possible, infuse PN into a dedicated single lumen central venous catheter; multiple lumen central venous catheters should have one port dedicated to the infusion of PN. Partial parenteral nutrition (PPN) solutions contain a lower concentration of dextrose than total parenteral nutrition (TPN). PPN can be administered through a larger peripheral vein while TPN solutions must be infused through a central venous access device.

- Some additives may not be stable in the solution for more than 24 hours (i.e. multivitamins, trace elements, medications such as insulin) and must be added to the bag just before administering. Add clearest additives first.
- Remove PN solution bag from refrigerator at least 1 to 2 hours before hanging to allow solution to warm up to room temperature. Do not place in hot water, warmer or microwave.
- Verify PN orders including composition and infusion rate with label on the bag; check expiration date and ensure the solution will not expire while it is infusing. Solutions may hang for a maximum of 24 hours.
- Observe bag for leaks, color, separation, and precipitate formation. If signs of separation (“oiling out”), immediately discard the bag.
- Always administer PN using an electronic infusion pump.
- If PN must be stopped unexpectedly, administer 10% dextrose in water (as ordered) at same rate as nutrition solution to prevent hypoglycemia.
- Provide line care using infection control techniques including hand hygiene, aseptic technique to change dressings and caps; never use a stopcock to administer PN solution.
- Change tubing every 24 hours. Change dressings per hospital protocol or if soiled, wet, or loose.

**Monitoring**

- Assess routinely for signs and symptoms of infection including new hyperglycemia, leukocytosis, fever, chills, or tenderness, warmth, drainage, pain, and swelling at the catheter site.
- Perform physical assessment per unit specific protocols. Obtain laboratory data: electrolyte levels, including calcium, phosphorus, and magnesium monitored daily until stable; aminotransferases, bilirubin, and triglyceride levels once a week during treatment.
- Measure and document fluid intake and output.
- Glycemic control: target blood glucose range of 140 or 150-180 mg/dL for ICU patients.
- Monitor vitamin and trace element levels in long-term PN therapy.

**Complications**

- Refeeding Syndrome: In patients with significant weight loss or long-term malnutrition, starting PN can induce “refeeding syndrome” manifested by electrolyte disturbances and fluid shifts or overload. Hypophosphatemia (may be lethal), hypokalemia, low magnesium and any electrolyte imbalance should be corrected before PN is started. In
patients at risk, begin PN at 25% of estimated daily needs and slowly increase to goal. Provide supplemental thiamine for the first 3 days.

- **Central Line Associated Bloodstream Infection (CLABSI):** high risk due to malnourishment, immunocompromised state, and long-term IV therapy.
  - Adhere to your institution’s central line bundle protocol
  - Dedicated single-lumen subclavian catheter for PN administration may decrease CLABSI.
- PN-associated liver disease (PNALD): symptoms range from transient elevations in liver function tests (LFTs) to fibrosis, cirrhosis, and irreversible hepatic failure.
- Metabolic bone disease (MB): abnormal bone metabolism resulting in decreased bone density and increased fracture risk; monitor serum calcium, phosphorus, and magnesium.
- Destabilization of formula which may lead to emboli: monitor PN solution for faint cream layer, separation of oil and water.
- Hyperglycemia: compounded by metabolic stress, steroid therapy, diabetes, obesity, sepsis and excessive glucose formulations.
- Hypercapnea: results from oxidation of glucose to carbon dioxide.

**Transitioning to enteral nutrition (EN) (Malone, 2014):**
In patients stabilized on PN, periodically repeated efforts should be made to initiate EN.

- As tolerance improves and the volume of EN calories delivered increases, the amount of PN calories supplied should be reduced.
- PN should be discontinued when > 60% of target energy requirements are being delivered by the enteral route.

**References:**


