Parenteral Nutrition (PN)

Parenteral nutrition (PN) is an intravenous form of nutritional supplementation containing dextrose, amino acids, electrolytes, vitamins, minerals, trace elements, and fluids. Lipid emulsion may be infused separately or added to the solution, called total parenteral nutrition (TPN), total nutrient admixture (TNA), or 3-in-1 parenteral nutrition. PN is more complicated and more expensive than enteral (gastric or intestinal) feeding and is associated with increased incidence of infection and longer length of hospital stay. As such, PN should be prescribed only in patients who cannot utilize the enteral route for nourishment. The goals of PN therapy include improving nutritional status, correcting hypoproteinemia, repairing muscle loss, and replacing other nutritional deficits (Seres, 2024a).

Clinical Indications (Lippincott Procedures, 2023)

- Severe illness lasting over two weeks
- Loss of 10% or more of pre-illness weight
- Serum albumin level less than 3.5 g/dL
- Significant nitrogen loss from wound infection, fistulas, or abscesses
- Kidney or liver failure
- Moderate to severe pancreatitis
- Nonfunctioning GI system for more than 5 days in a severely catabolic patient

Common disorders that may inhibit a patient's ability to absorb nutrients and require PN include:

- Inflammatory bowel disease
- Radiation enteritis
- Severe diarrhea
- Unmanageable vomiting
- Moderate to severe pancreatitis
- Massive small-bowel resection
- Bone marrow transplant
- High-dose chemotherapy or radiation therapy
- Major surgery

PN may be instituted in the following situations :

- Mechanical ventilation lasting more than 36 hours, if enteral nutrition is contraindicated (Seres, 2024a)
- Inability to achieve or maintain enteral access due to hemodynamic instability, massive gastrointestinal bleeding, or high risk for procedural complications related to obtaining enteral access.

Contraindications (Seres, 2024a)

- Severe hyperglycemia
- Severe electrolyte abnormalities
- Volume overload
- Inadequate IV access
- Inadequate attempts to feed enterally
- Relative contraindications: sepsis, systemic inflammatory response syndrome, minor

vomiting, gastrointestinal bleeding, short-term mechanical ventilation, and conditions expected to reverse quickly that temporarily prevent enteral feeding

PN Prescription (Siparsky, 2024c)

- Ordered for 24-hour periods, often with a 12-hour lead time based on lab studies from hours prior.
- Fluids and electrolytes are best managed with conservative prescriptions anticipating what the patient will need once stabilized.
- External supplementation of electrolytes or fluids as needed is recommended to avoid overdosing and to allow administration in a timely manner.

PN Content

The type of PN solution prescribed depends on the patient's condition and metabolic needs (Lippincott Procedures, 2023). The composition and infusion rate should be determined by a multidisciplinary team of nutritionists, pharmacists, and providers.

- Determine patient's calorie and protein requirements based on current weight (Seres, 2024a)
  - For well nourished patients with normal weight, target 24 to 30 kilocalories (kcal)/kg/day.
  - For malnourished patients who are stable and in recovery, increase target goal to 35 kcal/kg/day.
  - Begin feeding at 12 kcal/kg of dosing weight per day and slowly increase to target goal over the next 2 to 3 days.

The PN solution typically contains the following:

- Water: 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%
  - 1.2 to 2.0 g/kg of protein per day
- 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 or facility protocol

Nursing Considerations

Initiating PN (Lippincott Solutions, 2023)

- PN is typically started at half the daily requirements on day one and, if tolerated without uncontrolled hyperglycemia, electrolyte imbalance, or reaction to lipids, increased to target rate on day 2 (Seres, 2024b).
- Obtain appropriate IV access (Seres, 2024b).
  - 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.
    - Peripheral parenteral nutrition (PPN) solutions contain a lower concentration of dextrose (10%) and the osmolality is typically below 900 mOsm/L, less hypertonic compared to 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.
- Use a 1.2-micron filter for the lipid emulsion if administering as a separate solution. Piggyback the lipid emulsion solution below the parenteral nutrition filter. Ensure that any administration set to be used for lipids is di(2-ethylhexyl)phthalate (DEHP)-free (Lippincott Procedures, 2023).
- Add certain additives to the bag just before administering as some may not be stable in the solution for more than 24 hours (i.e., multivitamins, trace elements, or medications such as insulin). Add clearest additives first.
- Keep PN refrigerated and protected from light until 1 hour before use to prevent vitamin oxidation. Remove PN solution bag from refrigerator at least 1 hour before hanging to reduce the risk of hypothermia, venospasm, and pain. Do not place in hot water, a warmer, or microwave.
- Verify PN orders including patient identifiers and weight, administration date/time, route (central or peripheral), dextrose concentration, and component names and dosages (amount per day), total volume and infusion rate, duration of infusion (continuous or cycled) and appropriate filter size (Lippincott Procedures, 2023). Check expiration date and ensure the solution will not expire while it is infusing.
    - PN solutions containing dextrose and amino acids alone or with IV lipid emulsion added as a 3-in-1 formulation may hang for a maximum of 24 hours.
    - IV lipid emulsion alone shouldn't hang for more than 12 hours.
- Observe bag for leaks, color, cloudiness, separation, and precipitate formation. If signs of separation ("oiling out") appear, immediately return the solution to the pharmacy.
- Always administer PN using an electronic infusion pump and initiate slowly.
    - Set the infusion rate, concentration, and volume to be infused.
    - Set alarm limits appropriately.
- Label the container and IV administration set with the date of initiation or the date when change is required as directed by your facility.
- If PN must be stopped unexpectedly, administer 10% dextrose in water (as ordered) at same rate as nutrition solution to prevent blood glucose fluctuations and hypoglycemia.
    - Do not adjust the rate for off-schedule infusion starts or change the infusion rate in response to fluid needs.
- 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.
- Avoid piggybacking other medications into the same line as PN solution.
- Change tubing every 24 hours. For lipids, change the administration set with each new container and at least every 12 hours. Change dressings as directed by your facility 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.
- Laboratory data (Seres, 2024b)
    - Monitor glucose and electrolyte levels including calcium, phosphorus, and magnesium daily until stable.
    - Check aminotransferases and bilirubin levels once a week for the first few weeks.
    - Draw triglyceride levels daily for the first 2 to 3 days, and if stable, check weekly for a few weeks and then monthly.
- Measure and document fluid intake and output. Assess for edema and weigh the patient daily. Suspect fluid imbalance if the patient gains more than one pound (0.5 kg) daily.
- 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 (Seres, 2024b; Dudek, 2021)
- Refeeding syndrome: Results from a rapid change in fluid and electrolytes when patients with significant malnutrition are given oral, enteral or PN feedings. This condition may be life-threatening and is marked by severe hypophosphatemia (including respiratory failure, cardiovascular collapse, rhabdomyolysis, seizures, and delirium) as well as hypokalemia and low magnesium.
- Central line-associated bloodstream infection (CLABSI): Patients may be at high risk due to malnourishment, immunocompromised state, and long-term IV therapy.
    - Adhere to your facility's central line bundle protocol; use proper hand hygiene and maximal barrier precautions during insertion.
    - A dedicated single-lumen subclavian catheter for PN administration may decrease the risk of CLABSI.
- PN-associated liver disease (PNALD): Symptoms can range from transient elevations in liver function tests (LFTs) to fibrosis, cirrhosis, steatosis, hypertriglyceridemia, and irreversible hepatic failure.
- Metabolic complications may include hyperglycemia, hypoglycemia, serum electrolyte changes, macro- or micro-nutrient excess or deficiency, and Wernicke's encephalopathy.
- Metabolic bone disease may be caused by abnormal bone metabolism resulting in decreased bone density and increased fracture risk; monitor serum calcium, phosphorus, and magnesium.
- Destabilization of formula may lead to emboli; monitor PN solution for faint cream layer, separation of oil and water.
- Hypercapnea may result from oxidation of glucose to carbon dioxide.
- Venous access complications include bleeding, vascular injury, pneumothorax, venous thrombosis, arrhythmia, and air embolism.
- Extravasation of PN solution can lead to tissue necrosis.

Documentation (Lippincott Procedures, 2023)
Document the following in the patient medical record:
- Type and location of the access device used, including catheter tip confirmation; condition of the catheter insertion site; presence of blood return
- PN formulation and additives

- Infusion rate and volume of solution administered
- Patient assessment and response to therapy
- Complications and interventions
- Teaching provided to the patient and family (if applicable), their understanding of that teaching and any need for follow-up education

If the central venous access device or peripheral IV catheter used for PN is discontinued, document the following:

- Date and time the catheter was removed
- Condition of the catheter insertion site
- Type of dressing applied

Transitioning to enteral nutrition (EN):

In patients stabilized on PN, periodic 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 greater than 60% of target energy requirements are being delivered by the enteral route.

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