

Parenteral Nutrition
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LEARNING OBJECTIVES:

Upon successful completion of this lecture, the student will:

- Recognize appropriate candidates to receive parenteral nutrition (PN).
- Recognize the components of an appropriate PN regimen.
- Recognize complications associated with PN and know how the risk of such complications may be minimized.
- Understand the need for laboratory and clinical monitoring of a patient on PN.
- Understand the implications of PN complications.

SUGGESTED READING:

- Hark L and Morrison G. Medical Nutrition and Disease. A Case-based Approach. Blackwell Publishing, Malden, 2003, pages 378-391.
- Souba W. Nutritional support. *N Engl J Med* 1997;336:41-8. (on reserve in library)
- Jensen GL, Binkley J. Hazards of Overfeeding. In: Nutritional Considerations in the Intensive Care Unit. Shikora S, Martindale R, Schwaitzberg S, eds. Kendall/Hunt, Dubuque, Iowa. 2002, pp 111-118. (on reserve in library)
- Heyland DK, Rupinder D, Drover JW, et al. Canadian Clinical Practice Guidelines for Nutrition Support in Mechanically Ventilated, Critically Ill Adult Patients. *J Parent Enter Nutr*. 2003;27:355-373.

Goals of Nutrition Support

1. To provide bowel rest.
2. To maintain or minimize lean body mass loss while a patient is unable to eat for a prolonged period.
3. To maintain or minimize lean body mass loss while a patient is unable to absorb adequate nutrients for a prolonged period.

Determining Route of Administration: **“If the gut works, use it!”**

- A. Indications for parenteral nutrition
 1. Bowel rest
 - a. Inflammatory bowel disease
 - b. Acute pancreatitis (moderate or severe)
 2. Prolonged nil per os (NPO)
 - a. Gastrointestinal surgery
 - b. Critically ill patients (multi-organ system failure)
 - c. Hyperemesis gravidarum
 2. Impaired absorption
 - a. Short bowel syndrome

- b. Cancer/chemotherapy patients/Bone Marrow transplantation
- c. Severe malnutrition with nonfunctioning GI tract

Parenteral Nutrition

A. Components

1. Macronutrients

- a. Dextrose (3.4 kcal/gram)
- b. Amino acids (4 kcal/gram)
- c. Lipids (9 kcal/gram)

2. Micronutrients

- a. Electrolytes (Na, K, Ca, PO₄, Mg, Ac, Cl)
- b. Vitamins (fat and water soluble)
- c. Trace elements (zinc, copper, manganese, chromium, selenium)

B. Designing a parenteral nutrition regimen

- 1. Initiate modest doses until tolerance is demonstrated
- 2. Order contents in dose/day.
- 3. Adjust regimen to attain goals, but “do no harm”.

C. Compounding issues

- 1. Compounding process
- 2. Compatibility issues
- 3. Stability issues
- 4. Filtration

D. Access devices

- 1. Short term central access
- 2. PICC access
- 3. Hickman catheters

E. Complications

1. Technical complications primarily related to central venous catheter placement
 - Pneumothorax
 - Vascular injury with hemothorax
 - Brachial plexus injury
 - Cardiac arrhythmia

Incidence of non-infectious catheter-related complication < 2%
2. Catheter-related venous thrombosis
 - Adherent thrombus propagates and occludes vein
 - Observe tissue swelling, venous distension, collaterals
 - Role for anticoagulation
3. Infectious complications
 - Central line infection rate 5-15%
4. Metabolic complications
 - a. Macronutrient tolerance
 1. Carbohydrate intolerance
 - Hyperglycemia is the most frequent complication associated with PN therapy. This complication is seen primarily during initiation of PN therapy. If left untreated, hyperglycemia can result in glucosuria and significant osmotic diuresis.

Sudden and unexplained hyperglycemia may be the first warning sign of systemic sepsis. An elevation in blood sugar is often seen several hours before the patient demonstrates signs such as fever, chills, tachycardia or hypotension. Other complications that may cause hyperglycemia include CO₂ retention, hepatic steatosis, cancer, trauma or stress, and some drugs (steroids, furosemide, cyclosporine, and octreotide).

2. Protein intolerance
 - Patients with renal insufficiency, hepatic failure, or dehydration often demonstrate intolerance to the protein load in PN therapy. Elevations in the blood urea nitrogen (BUN) or serum creatinine (SCr), azotemia, or hyperammonemia can all be indications that the patient is not tolerating the protein in the PN therapy. The treatment in these patients is related to the primary condition, but often requires a decrease in the protein dose. Glucose tolerance and fluid load should be carefully assessed in a patient demonstrating protein intolerance to avoid further insult to the renal function.

3. Lipid intolerance

Slight elevations in serum triglyceride levels are expected during the infusion of a lipid containing PN. If significant increases are seen, the rate and/or frequency of lipid infusion should be reduced. Injectable lipid emulsions are contraindicated in patients with pathologic hyperlipemia, lipoid nephrosis, or acute pancreatitis if accompanied by hyperlipemia.

- b. Fluid and electrolyte derangements may include disorders of sodium and water; intolerances to glucose, protein, or fat; imbalances in potassium, magnesium, phosphate, or calcium, and acid-base disorders. (see attached tables)

Adjustments to the dose of individual PN components may be warranted to avoid complications. Unfortunately, changes to therapy do not follow a standard formula based on laboratory values.

4. Refeeding syndrome -

- a. Definition - both the metabolic and physiologic consequences associated with the depletion, repletion and compartmental shifts of phosphorus, potassium, and magnesium as well as alteration in glucose metabolism and fluid status.
- b. Clinical Sequela
can include hypertension, cardiac insufficiency, peripheral edema, coma and convulsions temporally related to the restoration of normal food and fluid intake.
- c. Prevention
 1. Patient risk identification.
Disease states associated with weight loss would include malabsorption, excessive diarrhea, short bowel syndrome, and recent gastrointestinal surgery. Behaviors associated with poor nutrient intake include anorexia nervosa, bulimia, alcoholism, intravenous drug abuse, and fad diets.
 2. Replete electrolytes prior to initiating nutrition therapy
 3. Initiate nutrition regimen slowly and advance as tolerance is demonstrated

5. Hepatobiliary complications
 - a. *Hepatic Steatosis*
Occurs within 1-3 weeks; Moderate increases in aminotransferases and alkaline phosphatase
Hepatic enlargement, RUQ pain in severe cases
 - b. *Cholestasis*
Lesions present as bile plugging, bile staining surrounding hepatocytes. Clinically presents as elevated alkaline phosphatase, followed by elevations in bilirubin

F. Monitoring parenteral nutrition therapy

1. **DO NO HARM**
2. Evaluate changing nutritional requirements.
3. Evaluate the effectiveness of the chosen therapy.
 - a. laboratory monitoring (visceral proteins, electrolytes)
 - b. physical evaluations
 - Weight gain
 - Improved wound healing
 - Reduced risks of complications associated with malnutrition (Compromised immune function, poor wound healing, lack of energy)
4. Recognize and prevent adverse effects related to overfeeding
 - Hyperglycemia
 - CO₂ production
 - Weight/fluid gain
 - Hepatobiliary complications
 - Refeeding issues
 - Potential immune effects

Common Misconceptions about TPN

- A. Rapid repletion of visceral proteins
- B. A little is good, more is better
- C. A low serum level requires more substrate
- D. Appetite suppression
- E. Immune and Hepatobiliary issues

THINGS TO KNOW

1. Know the indications for parenteral nutrition therapy.
2. Know the caloric values of intravenous amino acids, dextrose, and lipids.
3. Know the laboratory and clinical sequelae of the “refeeding syndrome.”
4. Know the infectious, technical, metabolic, and hepatobiliary complications associated with parenteral nutrition therapy.
5. Know common misconceptions about TPN

Sample Questions

1. Which of the following patient populations is the least likely to require parenteral nutrition?
 - A. Crohn’s Disease
 - B. Acute Pancreatitis
 - C. Small bowel obstruction
 - D. Anorexia nervosa

2. TT is a 69 year old female with a 3 month history of weight loss (15 pounds), fatigue, and loss of appetite. She is diagnosed with colon cancer and has a resection. You as the practitioner recognize her need for adequate nutrition during the postoperative period. Which of the following statements is INCORRECT?
 - A. The decision to feed TT with parenteral nutrition would depend upon the anticipated length of time before her bowel function returns after surgery.
 - B. TT’s total calorie requirements should be calculated, and she should be fed immediately at her calculated target as soon as her bowel function returns.
 - C. One should anticipate the potential for depletion of electrolytes when TT is started on a nutrition regimen.
 - D. One would expect a drop in TT’s albumin level after surgery.

3. Which of the following statements is **NOT** valid regarding the choice between enteral versus parenteral nutrition?
 - A. Bacterial translocation is more likely to occur with parenteral nutrition because of the lack of gut stimulation.
 - B. The cost of enteral nutrition is considerably less than that of parenteral nutrition.
 - C. Parenteral nutrition provides a more rapid repletion of protein to restore lean body tissue when compared with enteral nutrition.
 - D. Parenteral nutrition requires placement of an access device, which is associated with technical placement risks as well as infectious risks.

4. Which of the following electrolyte disturbances occurs with the refeeding syndrome?

- A. Hyperkalemia, hypermagnesemia, hyperkalemia
- B. Hypokalemia only
- C. Hypophosphatemia, hypomagnesemia, hypokalemia
- D. Hypomagnesemia only
- E. Hyperphosphatemia only

Answers:

- 1. d
- 2. b
- 3. c
- 4. c

Selected References

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