



# CE PRN

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## “Parenteral Nutrition: Feeding Our Patients”

November/December 2014

In this lesson we focus on parenteral nutrition (PN). Although it is most applicable to hospital practice, the homecare setting & providing information to patients are both significant for community pharmacy as well. The goals are to increase awareness of appropriate use of nutritional therapy & the role of the pharmacist in managing these patients:

### Pharmacists will be able to:

1. Review the indications for parenteral nutrition and enteral nutrition.
2. Describe the components necessary in TPN.
3. Review the complications & adverse effects associated with TPN.
4. Describe the role of fat in TPN.
5. Describe the role of the pharmacist in managing patients receiving TPN.



### Technicians will be able to:

1. Define “TPN.”
2. List common components included in TPN.
3. Describe the role of fat in TPN.
4. Understand the pharmacy component in the TPN treatment “loop.”

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## INTRODUCTION

Nutritional support, by either the enteral or parenteral route was a major breakthrough 50 years ago.<sup>1</sup> When the body does not receive needed nutrients because of inadequate absorption, severe GI disease, or chronic poor nutrient intake, nutrition support can be administered. This specialized nutrition support is also referred to as enteral or parenteral nutrition. Nutritional support is primarily used with patients who are unable to absorb nutrients normally. It is also used to support a patient during an extended critical illness, such as infection or injury.

There are a number of medical conditions that can cause a person to lose their appetite or their ability to ingest food for an extended period of time.<sup>1</sup> A patient who is unable to eat, but has a functional gastrointestinal tract, may benefit from enteral nutrition or tube feedings. For longer-term feeding, a more permanent tube can be placed directly into the stomach or small intestine. Enteral nutrition is the preferred method of feeding when the gastrointestinal tract is functional.

Parenteral nutrition (PN) is used in patients only when the gut is not functional or when nutritional needs cannot be met via gastrointestinal feeding.<sup>1</sup> Parenteral nutrition may be used on a short-term basis to facilitate postoperative healing or long-term in patients with permanent or severe malabsorption. The focus of this lesson will be on parenteral nutrition.

## DETERMINING NUTRITION STATUS

A nutritional assessment is a tool that can determine the degree of malnutrition in a patient. Completing a nutritional assessment utilizes dietary information in conjunction with laboratory data and a physical examination of the patient. Protein-energy malnutrition occurs as a result of extended periods of a negative balance of energy and protein requirements.<sup>2</sup> Malnutrition is evaluated using a patient's body mass index (BMI). A BMI <18.5 meets the criteria for malnutrition, a BMI between 18.5 and 24.9 indicates appropriate weight, a BMI from 25-29.9 is overweight, and a BMI  $\geq$  30 indicates obesity.<sup>3</sup> Although the BMI provides a current weight, it does not account for the rate of weight change. This is an important consideration when screening for malnutrition. Recent or dramatic changes in weight provide valuable information on a patient's nutritional status.<sup>1</sup> Involuntary weight loss of greater than 10% of usual body weight over 6 months, or loss of greater than 5% of usual body weight in 1 month is considered strong evidence of malnutrition. Severe malnutrition is weight loss of > 20% or < 80% weight / height of standard. The consequences of malnutrition include poor wound healing, higher risk of infection and increased length of stay in hospitalized patients.

Up to 20% of patients admitted to a hospital are malnourished.<sup>4</sup> Approximately 60% of those malnourished individuals will have a further decline in their nutrition status during their hospitalization. Nutritional support goals include correction of the patient's caloric and nitrogen imbalances and any fluid or electrolyte abnormalities or known vitamin or trace element abnormalities.

## INDICATIONS FOR PARENTERAL NUTRITION

Parenteral nutrition is indicated for adults in the following situations:<sup>1,4</sup>

- Poor GI absorption of nutrients (chronic malabsorption, bowel obstruction, GI fistula)
- Cancer cachexia

- Severe pancreatitis
- Critical care patients
- Hyperemesis gravidarum, anorexia (when enteral nutrition not tolerated)
- Malnourished postoperative patients

When a decision is made to initiate PN, the prescriber will write specific orders for the formulation they want the patient to receive. Since PN is not an urgent therapy, it is generally started within 24 hours of receiving the order. Until the PN solution is dispensed it is common practice to infuse Dextrose 10% at a rate of 30-40 mL/hour.

## DETERMINING THE PN FORMULA

When beginning PN solution, it is necessary to calculate the patient's nutritional needs.<sup>4, 6</sup> This is done by using a variety of equations to estimate a patient's basal energy expenditure (BEE). Once the BEE is determined, estimating additional caloric requirements is done using an injury factor which corresponds to the stress or disease the patient is experiencing. An alternative way to estimate caloric needs is to calculate based on the patient's specific condition and weight as shown in Table 1.

**Table 1. Estimating caloric needs<sup>4</sup>**

Condition	Caloric Need
Wound Healing:	30-35 kcal/kg, increase to 35-40 kcal/kg if the patient is underweight or losing weight
Sepsis and Infection	20-30 kcal/kg
Trauma	25-30 kcal/kg
Organ Transplant	30-35 kcal/kg
Severe Acute Pancreatitis	35 kcal/kg
Cancer	30-35 kcal/kg

## COMPONENTS OF PARENTERAL NUTRITION

### Dextrose

Dextrose is the primary energy source in PN solutions.<sup>4</sup> Dextrose concentrations range from 5% to 70%. The concentration of dextrose used in PN is calculated based on a number of variables including patient age, diagnosis and energy needs. It is important to avoid high concentrations of dextrose, to reduce the risk of hyperglycemia or fatty liver. In addition, dextrose solutions above 10% must be administered via a central line. Infusion of higher concentrations peripherally results in severe phlebitis.

### Amino Acids

Amino acids are used for protein synthesis.<sup>4</sup> Standard amino acid solutions are available and contain a balance of essential and non-essential amino acids. They are intended for general use in adult patients. Specialized solutions are available for patients who have altered protein requirements, such as those with hepatic or renal failure, metabolic stress or trauma, as well as for neonates and pediatric patients. There are also highly concentrated amino acid solutions

(20%) that are often used in critically ill patients who have high protein needs but may be fluid restricted. These specialized amino acid solutions are expensive and generally reserved for specific patient types. Specialized amino acid solutions for pediatric/neonatal patients contain higher concentrations of certain amino acids that premature infants may not be able to produce.

## Fat

Intravenous fat emulsion is used as a concentrated source of calories and essential fatty acids.<sup>4</sup> These products are produced from soybean oil and are available in concentrations up to 30%. The use of fat emulsion as a caloric source is extremely efficient and reduces the risk of hyperglycemia, liver toxicity, or increased carbon dioxide production. Fat emulsion is used to prevent or treat essential fatty acid deficiency. Essential fatty acid deficiency can affect wound healing, platelet function, and brain development in infants. Adult patients should receive 100 gram of fat emulsion weekly to prevent essential fatty acid deficiency, while infants require an infusion of 500 mg to 1 gram daily.

Fat emulsion should be avoided in patients with hyperlipidemia, lipoid nephrosis and hypertriglyceridemia.<sup>4</sup> The product is also contraindicated in patients with an allergy to eggs. Common adverse effects reported with fat emulsion include headache, nausea and fever. Reduction of the infusion rate may lessen these effects. The lower concentrations of fat emulsion (10 and 20%) may be infused centrally or peripherally. The higher concentration of 30% fat is designed to be combined into the same infusion bag as the PN solution and infused centrally.

## Electrolytes

PN solutions contain electrolytes, including sodium, potassium, calcium, magnesium, phosphorus, chloride, and acetate to correct specific deficiencies.<sup>6</sup> Patients with normal renal function can receive a standard electrolyte formula. In patients with renal dysfunction, reducing the potassium by 50% or removing it completely may be appropriate. Patients should be monitored daily and adjustments made in the electrolyte formulation based on laboratory reports. See Table 2 for standard doses of electrolytes.

**Table 2. Standard doses of electrolytes in PN solution<sup>6</sup>**

Electrolyte	Standard formula (per liter)
Sodium	77 mEq
Potassium	40.5 mEq
Chloride	90.5 mEq
Acetate	92.8 mEq
Magnesium	8 mEq
Calcium	5 mEq
Phosphate	15 mM

## Vitamins and Trace Elements

There are currently 13 essential vitamins required for maintaining good health.<sup>7</sup> These include 4 fat-soluble and 9 water-soluble vitamins.

**Table 3. Daily requirements of vitamins<sup>7</sup>**

<b>Water-soluble</b>	<b>Recommended daily parenteral dose</b>
Vitamin C	200 mg
Thiamine	6 mg
Vitamin B12	5 mcg
Vitamin B 6	6 mg
Niacin	40 mg
Pantothenic acid	15 mg
Biotin	60 mcg
Folic acid	600 mcg
Riboflavin	3.6 mg
<b>Fat- soluble</b>	
Vitamin A	990 mcg or 3,300 IU
Vitamin D	5 mcg or 200 IU
Vitamin E	10 mg or 10 IU
Vitamin K	

Although there are adult and pediatric multi-vitamin products available commercially, there is not a specific product marketed for premature infants in the United States.<sup>7</sup> The American Society of Parenteral and Enteral Nutrition (ASPEN) reviewed the current guidelines for daily vitamins and suggested that there may be a need to increase the amount of Vitamin D. In 2010 the Institute of Medicine changed the recommended daily allowance of vitamin D from 400 IU to 800 IU. The current IV multivitamin formulations contain 200 IU which may not address deficiencies. Pharmacists may see supplemental doses of vitamin D being added to PN solution.

Currently there are 5 trace elements that are recommended for supplementation in PN solutions.<sup>7</sup> These include chromium, copper, manganese, selenium and zinc. The products provide the daily adult requirements for the trace elements considered essential. The combination products for neonates and pediatric patients contain only chromium, copper, manganese, and zinc. Individual trace elements are available to customize PN solutions; however, the extreme drug shortages threaten the supply of these agents. See Table 4 for recommended daily doses of trace elements.

**Table 4. Recommended daily requirements of trace elements<sup>5,7</sup>**

<b>Trace Element</b>	<b>Recommended daily requirement</b>	<b>Comments</b>
Chromium	10-15 mcg	
Copper	0.3-0.5 mg	
Manganese	60-100 mcg	Use with caution if obstructed biliary tract
Zinc	2.5-5.0 mg	Requirements increase with high GI output
Selenium	20-60 mcg	Use in critically ill and long-term care patients

The individual requirements for trace elements change depending on the clinical condition of the patient.<sup>7</sup> For example, higher doses of zinc are needed in patients with high-output ostomies or diarrhea. The gastrointestinal tract is the main route of excretion for zinc. Chromium and selenium are excreted renally and should be restricted in patients with renal failure.

## ROUTES OF ADMINISTRATION FOR PARENTERAL NUTRITION

### Peripheral Route

This route is generally reserved for patients who will be receiving PN for a short period of time (10-14 days). PN solutions that are administered peripherally cannot exceed an osmolality of 900 mOsm/L and a dextrose concentration of 10% due to the risk for severe phlebitis. The peripheral administration of PN is associated with a lower risk of complications.<sup>8</sup>

### Central Route

Central PN is the preferred route for patients who require PN for extended periods during hospitalization or those using PN at home.<sup>8</sup> These formulas are hypertonic and often are very concentrated to meet the nutritional needs of the patient. Since the large central veins have higher blood flow, the PN solution is rapidly diluted. There is a greater risk for infections with central PN and it requires meticulous care of the catheter and catheter site.

## PARENTERAL NUTRITION ORDER PROCESS

PN is classified as a high alert medication, which means there are significant risks for medication errors with these solutions.<sup>8</sup> Surveys have shown less than 60% of hospitals have strategies in place to reduce these errors. One method to reduce errors is to employ a standardized process for ordering PN solution. ASPEN has developed resources that include a list of the required components for PN ordering and the sequence that should be used as well as sample PN standard order forms. These processes are designed to reduce prescribing errors and improve efficiency/productivity. In addition, adopting a standardized PN order format designed with ingredients listed in the same sequence may reduce errors when patients transition care from hospital to home care. **See Table 5.** Home care providers should create a home PN order template that provides a safe plan for multiple days of therapy. The prescription for home PN therapy should be written in a format that specifically reflects trends in laboratory values and previous days of PN therapy. A hospital daily PN order format should not be used as a home PN prescription.<sup>9</sup>

**Table 5. Required components of PN orders<sup>9</sup>**

Required Components for PN Orders and Preferred Sequence
Patient Information (Name Identifier, birth date)
Patient location
Allergies
Indication of PN
Height and weight
Central or peripheral access
Administration time and date
Individual components

### Required Components for PN Orders and Preferred Sequence

Amino Acid
Dextrose
Fat
Electrolytes
Vitamins
Trace Elements
Other additives (insulin)
Instructions (Infusion rate, total volume)
Prescriber information

## STANDARD FORMULAS VERSUS CUSTOMIZED FORMULAS

In addition to standardizing the process for ordering PN, the use of standardized PN formulas can further reduce the risk of medication errors.<sup>9</sup> In addition, a standard formula PN ensures patients receive a stable, balanced formula. Standard PN formulations are available from manufacturers, which further reduces the risk of contamination during compounding. Customized PN solutions are preferred in certain patient populations. These customized formulas allow the practitioner to develop an individualized formula for each patient addressing any unique requirement such as fluid restriction or high protein requirements. It is important for prescribers to assess the risks and benefits of using these formulas.

## COMPOUNDING CONCERNS

The compounding of injectable sterile drugs, including parenteral nutrition products has been under fire recently because of the tragedy reported at the New England Compounding Center (NECC) in 2012.<sup>10</sup> There was a fungal meningitis outbreak from contaminated corticosteroid injections that were compounded in the NECC facility. NECC employees were not properly trained in aseptic technique which resulted in contaminated sterile product. Fungal meningitis infections were reported in 20 states. A total of 64 individuals died from fungal meningitis and over 750 patients became ill. As a result of these events, Congress passed the Drug Quality and Security Act (DQSA) on November 27, 2013.<sup>11</sup> The legislation is intended to regulate compounding pharmacies and establish a track-and-trace pedigree system for drugs. There are now 3 categories of sterile compounding as shown in Table 6. Hospitals and some home care providers fall into the 503A category. This legislation was initially intended to address the compounding risks reported with outsourcing facilities, but traditional pharmacy compounders, including hospitals, should also be held to the highest of standards to protect patients.



**Table 6. Categories of Sterile Compounding<sup>11</sup>**

Category	Description	Regulatory oversight	Comments
503A	Traditional pharmacy compounding	States	<p>Cannot compound the following:</p> <ul style="list-style-type: none"> <li>• Drugs removed from the market</li> <li>• Not on "difficult to compound" list</li> <li>• Not copies of commercially available drugs</li> <li>• Cannot distribute &gt; 5% of total prescriptions to other states</li> </ul>
503B	Voluntary outsourcing facility	Food and Drug Administration	<p>Must be compliant with current applicable good manufacturing practice (cGMP).</p> <p>Subject to routine and risk-based FDA inspection.</p> <p>Must report which products they are compounding and any associated adverse events.</p> <p>Cannot compound copies of drugs already on the market, unless they are on a drug shortage list.</p>
Manufacturer	Pharmaceutical manufacturers	Food and Drug Administration	<p>Most strict</p> <p>No change in current requirements</p>

Even before DQSA, hospital and home care pharmacies were regulated by the United States Pharmacopeia (USP) Chapter 797.<sup>12</sup> This chapter provides the requirements for compounding sterile preparations. Although all pharmacies that compound sterile products must comply with USP 797, the 2013 USP 797 Compliance Survey shows that the overall compliance rate is 77.2%.<sup>13</sup> This remains nearly unchanged from the 2012 rate. Budgetary restrictions and physical plant limitations were among the top barriers to compliance reported. Since the NECC tragedy, hospitals and home care providers have redoubled their efforts to ensure compliance with USP 797 and DQSA. Many organizations have limited their compounding to products that are not available as a premixed product.

## COMPLICATIONS ASSOCIATED WITH PN

There are 3 specific categories that describe the complications of PN. These categories include infection, technical and metabolic complications.<sup>4</sup>

### Infectious Complications

Infectious complications are a potential risk for all patients receiving PN.<sup>4</sup> Infections can be the result of contamination of the catheter site, the catheter hub or catheter-related blood stream infection. Patients receiving PN have additional risk factors for infection including reduced immunity and malnutrition. Another concern, since the NECC tragedy, is contamination of the PN solution. As described above, pharmacists must follow USP 797 standards and ensure that the protocol for compounding PN is strictly followed. If the pharmacy uses a pharmacy compounding partner for preparation of PN solutions, they must verify they are following these strict guidelines as well.

### Technical Complications

Pharmacists must ensure the infusion pump, tubing and catheter are all working properly to prevent technical or mechanical errors.<sup>4</sup> Infusion pump errors can be reduced by routine servicing and inspection of equipment by qualified staff. Organizations should verify that personnel understand how to program and use the pumps. Complications with the catheter range from insertion errors, occlusion and infection. Appropriate placement and management of the catheter site is imperative to reduce these complications.

### Metabolic Complications

There are a number of metabolic complications associated with PN. Some of the most frequently reported complications include hyperglycemia, refeeding syndrome, hypertriglyceridemia and liver disease.<sup>14</sup>

#### Hyperglycemia

Hyperglycemia is a common problem in patients receiving PN.<sup>14</sup> It is recommended that serum glucose levels be maintained below 180 mg/dL for adult patients. Patients receiving PN may require insulin to control their blood sugar. Insulin can be administered by the subcutaneous route or it can be added to the PN bag.

#### Refeeding Syndrome

Refeeding syndrome may occur in severely malnourished patients who receive rapid nutrition replacement.<sup>14</sup> These patients include stressed patients who have not been fed >10 days, and patients with chronic conditions associated with nutrition complications such as cancer or cirrhosis. Refeeding syndrome results in rapid and significant reduction in serum electrolytes and fluid retention. Patients at risk for this syndrome should begin PN therapy with 25-50% of the calculated non-protein calories with escalation of calories over the next 3-4 days. It is recommended that patients at risk receive no more than 100 to 200 grams of dextrose per day in their initial PN solution.

#### Hypertriglyceridemia

Hypertriglyceridemia may occur in patients receiving PN solution in combination with

intravenous fat emulsion.<sup>14</sup> Hypertriglyceridemia is defined as serum triglyceride concentrations > 400 mg/dL for adults. Risk factors include preexisting liver or pancreatic damage, sepsis, renal failure, and the dose and infusion rate of fat emulsion. When patients exhibit hypertriglyceridemia, the rate of infusion or dose of fat emulsion may be reduced.

### **Fatty Liver Disease**

Fatty liver is reported in patients on PN solutions, usually within the first month of therapy.<sup>14</sup> It results in elevations in liver enzymes (< 3 times the upper limit of normal). This condition can be reversed with changes in the PN formula or discontinuation of PN. Risk factors for fatty liver include liver disease, sepsis, malnutrition, excessive calorie intake and long term PN use.

## **ROLE OF THE PHARMACIST**

The pharmacist can have a significant impact on the care of patients receiving PN solutions, in the hospital or at home. Pharmacists should be trained in clinical nutrition if they are responsible for developing the nutritional formula for patients. There are many resources available for the pharmacist to expand their knowledge of clinical nutrition. Many pharmacists are members of multi-disciplinary nutritional support teams and are responsible for the clinical care of patients receiving PN solution in the hospital.

With the recent NECC tragedy, pharmacists are in a unique role, both in the hospital and as home care providers, to ensure that all PN solutions are compounded and prepared using the strictest of aseptic technique. All personnel involved in compounding PN solutions should undergo specialized training and education to ensure they comply with all aspects of USP 797. In addition to providing competency, pharmacists must rigorously oversee the preparation of these products to ensure they are compounded properly, labeled correctly and dispensed to the nurse or patient (in case of home care).

Pharmacy managers have an important role in ensuring their hospital or home care agency is in compliance with all rules and regulations related to sterile compounding. In those hospitals that choose to outsource this compounding function, the pharmacy manager is responsible for ensuring the outsourcing facility is in compliance with all rules and regulations. The pharmacy manager is still responsible for ensuring a safe and sterile product is being used in the patients.

There are a number of resources available to the pharmacist related to sterile compounding and parenteral nutrition. These links are given below.

## **CONCLUSIONS**

Parenteral nutrition is a high alert medication that can result in medication errors. Errors can occur in the prescribing and administration steps as well as in the compounding process. The pharmacist is responsible for ensuring all PN solutions are clinically appropriate, sterile and stable products. It is necessary for the hospital and home care pharmacist to ensure they are compliant with DQSA and USP 797 when preparing sterile preparations.

### **PATIENT CASE #1.**

*GH is a 71 year old male patient (6 ft. tall, 160 lbs) who was admitted to the hospital with a diagnosis of acute bowel obstruction. GH was immediately transferred to the operating room for surgery and is now in the recovery room. He is not expected to be able to take*

nutrition through the gastrointestinal tract for a minimum of 10 days after his surgery. Upon evaluation he is undernourished and slightly dehydrated. His current laboratory tests indicate his electrolytes and renal function are within normal limits. He is being transferred to the step down unit and the house staff has ordered PN to begin tomorrow.

### His PN nutrition formula contains the following:

Component	Per Liter
Amino Acid	4.25%
Dextrose	25%
Sodium	140 mEq
Potassium	40 mEq
Chloride	90 mEq
Magnesium	8 mEq
Calcium	5 mEq
Phosphate	15 mM
Acetate	93 mEq
Multivitamin	1 vial
Trace Elements	1 vial

#### 1. Is this formula appropriate for GH?

No. There is no indication that GH has a need for such a high amount of sodium. His laboratory values came back normal and his renal function is normal. The standard daily dose of sodium in PN solution is 70 mEq/ Liter.

#### 2. What should you do as the pharmacist verifying the order for GH?

Contact the prescribing physician and verify that the dose is correct. After contacting the prescribing physician, you determine that the sodium dose was calculated incorrectly and you change the order.

### Patient case #2.

LB is a 56 year old female patient who has had a 20 lb weight loss in the past month. She has cirrhosis of the liver. Her appetite remains poor and she is unable to take nutrition through the gastrointestinal tract. She is being started on PN to address her nutritional deficiencies. The physician asks you to evaluate the patient and make recommendations.

#### 1. What are your concerns about starting LB on PN solution?

LB has cirrhosis of the liver and has a chronic condition associated with nutrition complications. It is important to avoid rapid nutrition replacement to prevent refeeding syndrome.

#### 2. What are the risks associated with refeeding syndrome?

Refeeding syndrome results in rapid and significant reduction in serum electrolytes and fluid retention.

### 3. What recommendations do you provide to the physician in your consultation?

Begin PN therapy with 25-50% of the calculated non-protein calories with escalation of calories over the next 3-4 days. It is recommended that patients at risk receive no more than 100 to 200 grams of dextrose per day in their initial PN solution.

#### USEFUL RESOURCES

- American Society of Parenteral and Enteral Nutrition. <http://www.nutritioncare.org/>.
- American Society of Healthsystem Pharmacists Sterile Compounding Resource Center. <http://www.ashp.org/menu/PracticePolicy/ResourceCenters/Compounding>.
- United States Pharmacopeial Convention. <http://www.usp.org/usp-nf/official-text/revision-bulletins/general-chapter-pharmaceutical-compounding-sterile-preparations>.
- Institute for Safe Medication Practice. <http://www.ismp.org/tools/guidelines/IVSummit/IVCGuidelines.pdf>.

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**LESSON EVALUATION**

Please fill out this section as a means of evaluating this lesson. The information will aid us in improving future efforts. Either circle the appropriate evaluation answer, or rate the item from 1 to 7 (1 is the lowest rating; 7 is the highest).

1. Does the program meet the learning objectives?

Review indications for PN	YES	NO
Describe components necessary in PN	YES	NO
Review complications of PN	YES	NO
Describe the role of fat in PN	YES	NO
Describe the role of the pharmacist with PN patients	YES	NO

2. Was the program independent & non-commercial YES NO  
 Low Relevance Very Relevant

3. Relevance of topic 1 2 3 4 5 6 7

4. What did you like most about this lesson? \_\_\_\_\_

5. What did you like least about this lesson? \_\_\_\_\_

**Please Mark the Correct Answer(s)**

1. The maximum concentration of dextrose that should be infused peripherally as part of PN is:

- A. 5%      B. 10%  
C. 15%      D. 20%

2. An outsourcing pharmacy is registered as 503B. They must be compliant with current applicable good manufacturing practice (cGMP); are subject to routine & risk based FDA inspection; must report which products they are compounding; & any associated adverse events.

- A. True      B. False

3. What is the maximum osmolarity of peripheral PN solution that should be infused?

- A. 500 mOsm/Ls      B. 750 mOsm/L  
C. 900 mOsm/L      D. 1200 mOsm/L

4. Standard formula PN contains \_\_\_\_\_ mEq/L of potassium.

- A. 20 mEq      B. 40 mEq  
C. 60 mEq      D. 80 mEq

5. The recommended daily parenteral dose of vitamin A is:

- A. 500 mcg or 1,500 IU  
B. 660 mcg or 1,800 IU  
C. 880 mcg or 2,200 IU  
D. 990 mcg or 3,300 IU

6. What are the 5 trace elements recommended for supplementation for adults receiving PN?

- A. Cr, Cu, Mn, Se, Zn      B. Cr, Cu, Fe, Mn, Zn  
C. Cr, Cu, Mn, Se, Mo      D. Cr, Fe, Mn, I, Zn

7. In a patient at risk for refeeding syndrome, the amount of dextrose infused should be no more than 100 to 200 grams of dextrose per day in the initial PN solution.

- A. True      B. False

8. LW is a 72 year old patient who weighs 72 kg. She is admitted with severe pancreatitis. The physician is calculating her caloric needs. What are your recommendations.

- A. 25 Kcal/kg (1800 kcal)      B. 35 Kcal/kg (2520 kcal)  
C. 40 Kcal/kg (2880 kcal)      D. 45 Kcal/kg (3240 kcal)

9. Which of these indications is NOT appropriate for PN solutions?

- A. Bowel obstruction  
B. Severe pancreatitis  
C. Depression  
D. Cancer cachexia

10. Adult patients should receive 100 grams of fat emulsion weekly to prevent essential fatty acid deficiency.

- A. True      B. False

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