Parenteral nutrition (PN) can be defined as the administration of nutrients through any means other than the GI tract. The focus of this discussion will involve intravenous administration for nutritional management. PN is sometimes referred to as total or partial parenteral nutrition, and these definitions are taken directly from the human literature. Total parenteral nutrition (TPN) implies that all energy and nutrient needs are met by the intravenous solution. These solutions are capable of maintaining a patient for months or years if necessary. Partial or peripheral parenteral nutrition (PPN) supplies a portion of the energy and nutrient needs. These solutions are typically used for short durations (days to weeks). In veterinary medicine, the strict definition of TPN cannot be met because solutions that contain the total caloric energy needs do not meet the requirements for vitamins, macrominerals, and trace elements required for long-term feeding. Although this discussion may seem academic, it is important to realize the limitations of this treatment choice in regard to the critically ill patient.

The appropriate time to start nutritional support is determined by numerous factors. However, once the decision has been made to institute nutritional support, enteral feeding (utilizing the GI tract) is preferred to parenteral for several reasons. Enteral nutrition is more physiologic, prevents GI tract atrophy, reduces gut stasis, and limits bacterial overgrowth, to list some of the underlying benefits. However, not every patient can tolerate enteral nutrition. Examples of patients who may be a good candidate for PN include patients with intractable vomiting, those at increased risk for aspiration, poor anesthetic candidates, and those unable to tolerate the total caloric intake orally.

PN solutions are composed of carbohydrates, amino acids, lipid substrates, and other components. The carbohydrate source is usually 50% dextrose. The use of a central intravenous line (e.g., jugular catheter) is necessary if the concentration of dextrose is greater than 10% in the PN solution. Dextrose provides a readily usable energy source for most patients. However, in critically ill patients insulin resistance may alter the body’s ability to utilize this energy source. This is one of the reasons PN solutions rely on multiple energy sources to provide nutritional support. Crystalline amino acid solutions help maintain lean body tissue and positive nitrogen balance. They help the body maintain normal immune function, improve wound healing, and aid the function of many organs. These solutions are available in various concentrations, from 3.5% to 15%. An 8.5% solution with or without electrolytes is the most common preparation utilized in veterinary medicine. These solutions lack taurine, but given the short duration of treatment, this deficiency is rarely a concern. Lipid emulsions provide the majority of the energy density of a PN solution. They supply essential fatty acids and are isotonic, which helps decrease the osmolarity of the solution. These solutions are available in various concentrations, from 10% to 30%. A 10% or 20% solution is the most common preparation utilized in veterinary medicine. Electrolytes, vitamins, and trace elements are other components that can be added to PN solutions. The most common electrolyte abnormalities that occur in patients receiving PN administration include hypokalemia and hypophosphatemia. These electrolytes can be supplemented in the PN solution. However, most patients receiving PN will also have a second line for crystalloid administration. Given the fact that these electrolyte abnormalities can change rapidly, it makes more sense to supplement them in the crystalloid solution rather than having to compound a new PN bag.

PN solutions can be compounded in-house, via a pharmacy, veterinary referral institution, or human health care company. Although the cost may be more to have the PN solution compounded at an outside facility, this may be a better way to obtain several days of treatment in a quick, aseptic manner. Typically all that is required by the outside facility is a nutritional calculation sheet and/or prescription detailing the amounts of each substrate that need to be added to the solution. If it is elected to compound the PN solution directly at your hospital, one of three methods can be utilized. The first and least desirable method uses a syringe to directly transfer each nutrient solution into a sterile, empty fluid bag. The concern with this technique is contamination of the system given the multiple transfers required to create the PN solution. The second option involves using a 3-in-1 sterile bag and gravity flow to create the PN solution. Each component of the PN solution can be connected to the bag and the nutrients are transferred directly by gravity flow. This method is faster and safer, avoiding the potential for underlying contamination. However, transfer of exact quantities of nutrients is impossible, and partially unused components are wasted. The final method involves utilizing a semiautomated, closed-system PN compounding machine. This method allows exact quantities of solution to be created, and multiple bags can be made very quickly. The major downside of this method is the cost of the compounding machine. Once compounded, a PN solution can be stored for days or weeks at refrigerated temperatures.
It is recommended to administer PN solutions through a dedicated catheter placed in an aseptic manner. Whether the solution can be administered via a peripheral catheter or central line is directly related to the osmolarity of the solution. Simplistically, this decision is directly related to the dextrose concentration of the solution. As previously stated, a solution greater than 10% dextrose should be administered through a central line to avoid thrombophlebitis. Catheters composed of silicone, polyurethane, or tetrafluoroethylene are also recommended to avoid this complication. PN solutions are typically administered as a constant rate infusion over a 24-hour period. Once the solution is warmed to room temperature, it is recommended to utilize the entire solution in this time frame to prevent contamination and lipid particle destabilization. Reevaluation of the nutritional plan should be performed daily while administering PN. If the patient is not improving with this modality over several days and remains anorectic, options to institute enteral nutrition should be considered.

Potential complications with PN administration can be classified into three main categories, including mechanical, metabolic, and septic. Mechanical complications usually involve catheter-related problems. Examples include occlusion, premature removal, line disconnection/breakage, and/or thrombophlebitis. These problems can be limited by strict adherence to aseptic technique and careful monitoring of patients. Metabolic complications are more likely to occur with PN solutions formulated to deliver total caloric requirements. The most common metabolic complication is hyperglycemia. Insulin therapy may be required to control this event. Other complications include hypertriglyceridemia, hyperammonemia, or electrolyte changes consistent with refeeding syndrome (e.g., hypokalemia, hypophosphatemia, hypomagnesemia). Reformulation of the PN solution is required if any of these problems occur. The most serious and potentially life-threatening complication is sepsis. This problem is rare when adhering to aseptic techniques. If signs of sepsis develop without an identifiable source, contamination of the solution and/or intravenous catheter should be suspected. A culture and sensitivity of both should be considered. It is due to this potential complication that many authors recommend having the PN solution compounded at an outside facility.

In summary, PN solution is a viable nutritional choice for small animal patients. Proper patient selection is important to ensure an acceptable outcome. Compounding of the PN solution is available through outside facilities or can be performed in a private practice setting. A dedicated intravenous line should be utilized to administer the PN solution. Understanding some of the potential complications that can occur should enhance the effectiveness of this treatment option.

References/Suggested Reading


