CLINICAL SCIENCE OF NUTRITION Review

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Parenteral nutrition and nursing care: A review of the recent literature

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ABSTRACT

Parenteral nutrition is a life-saving intervention for patients where enteral nutrition cannot be achieved. In recent years, parenteral nutrition has been widely used thanks to advances in medicine and technological fields. Parenteral nutrition, which is a very complicated intervention, requires good care and teamwork at the beginning, treatment process and termination stages. The purpose of this review is to summarize the current literature on parenteral nutrition, as well as to raise awareness about the duties and responsibilities of nurses, one of the most important members of the nutritional support team, in parenteral nutrition.

Keywords: Nursing, nursing care, nutritional support, parenteral nutrition

Introduction

Parenteral nutrition (PN) is the delivery of nutrients through a central venous catheter or a peripheral venous catheter for nutritional purposes in patients in whom enteral nutrition cannot be achieved owing to impaired anatomical or functional integrity of the gastrointestinal tract (1-3). The aim of PN is to take precautions before patients with nutritional risk have malnutrition or to treat this condition in patients undergoing malnutrition. In clinical practice for the last 30 years, PN has become increasingly widespread owing to the increase in the reliability of application methods thanks to modern technological developments and the production of solutions containing essential nutrients prepared according to the needs of patients, is also used to meet the increased nutritional requirements during burns and major surgical procedures. In such cases, PN is a life-saving attempt for a patient who cannot be fed enterally (3, 4).

Clinical and Research Consequences

Indications and contraindications for parenteral nutrition

1. The main indication for PN is nonachievement of oral or enteral nutrition. According to the Parenteral Nutrition Guide published by European Society for Clinical Nutrition and Metabolism (ESPEN), PN should be initiated if enteral nutrition does not take place within 24–48 hours and normal nutrition cannot be achieved within 3 days. In addition, PN should be started in the following situations (5-8):
2. The presence of short or ischemic bowel, moderate-to-severe small bowel transplantation rejection, and malabsorption syndrome
3. Pancreatitis
4. Enteric fistula
5. Nonachievement of nutritional needs enterally
6. Diffuse peritonitis
7. Uncontrolled bowel content or lymphatic leak
8. Intestinal obstruction, dysmotility syndrome

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9. Persistent vomiting, diarrhea (≥500 mL or more than 3 watery diarrhea for 2 days) or high output ostomy (≥1,000 mL)
10. Massive gastrointestinal bleeding
11. Gastrointestinal cancer
12. Nausea, vomiting, or mucositis that cannot be controlled after bone marrow transplantation.

PN is contraindicated in the following cases (7-12):
1. Patients estimated to switch to oral nutrition within 5 days
2. Patients whose >55–60% of nutritional needs can be met with enteral nutrition
3. Patients with unstable hemodynamics.

Products used in parenteral nutrition

PN solutions can be in a ready-made commercial form or can be specially prepared for the patient. In solutions in a ready-made commercial form, lipid, dextrose, and amino acid solutions are available in a single bag but not mixed together. It is mixed with each other before it is given to the patient. The patient-specific solutions are those that are prepared in the filling units separately for each patient at the rates determined daily (13).

Parenteral solutions in a ready-made commercial form: All ingredients are in a single bag. Such solutions are frequently used in clinics (13).

Parenteral solutions prepared in filling units: Solutions whose ingredients are specially determined for the patient are prepared by pharmacists, technicians, or automatic filling devices in the filling units. After the products that have been filled are checked, they should be transported to the clinic in containers having the features of a cold chain transport. The solution brought to the clinic should be checked and delivered with signature. If the delivered solution will not be administered to the patient immediately, it should be kept in the refrigerator reserved for drugs at 2–8°C. If a PN bag has been set or a drug that will settle in the bag within 24 hours has been added, the bag should be used within 24 hours. Additions to the PN solution (such as vitamins, trace elements) should be made just before the infusion. The exposure of PN solution to direct sunlight during administration, transport, and storage should be avoided.

Main Points

- PN is a treatment process that requires good and effective nursing care.
- For this reason, there is a need to increase the resources in order to transfer the effective methods that nurses can use in care to the clinic.
- This need can be achieved by increasing randomized trials with high level of evidence.
- This article was written to summarize the roles and responsibilities of nurses in PN treatment and to create awareness for further studies in the light of current literature information.

The solution should be brought to room temperature before it is administered to the patient. Before implementation to the patient, the information on the solution and the patient information should be compared once again. The presence of particles under light should be visually checked for discoloration or precipitation. Paying attention to the principles of asepsis, PN set should be prepared and infusion pump should be used, if possible. The time and speed of feeding should be recorded (13).

Access ways and nursing care in parenteral nutrition

PN can be administered to the patient in 2 ways depending on the amount of calories required, on the amount of fluid to be given, and on the duration of nutritional support required (14):
- Peripheral parenteral nutrition (PPN)
- Central parenteral nutrition (CPN)

Peripheral parenteral nutrition

PPN is often a short-term route used as a bridge to the enteral route or CPN. PPN is widely used because of its advantages such as safer vascular access and easier protection from technical and infectious complications in the use of central venous catheterization (12-15). The peripheral route should be preferred when feeding is needed for less than 10–14 days. The concentration of the solution is very important in PPN. Solutions of low concentrations should be preferred, and the osmolality of the solutions should not exceed 900 mOsm/L (15). When applying PPN, short peripheral catheters should not be used, wide veins should be preferred for catheterization, and the application site should be frequently checked for phlebitis (14, 15).

Central parenteral nutrition

CPN is mostly provided by subclavian, jugular, and femoral routes. The femoral route is not preferred owing to a high risk of infection and thrombosis. The catheter to be used for CPN should be of the smallest diameter, preferably placed in the presence of ultrasound and polyurethane or silicone, under strict sterile conditions, and by trained and experienced people, and the development of complications should be controlled after the procedure. It is especially recommended to use double-lumen catheters to prevent the mixing of parenteral solution and other

drugs in patients requiring PN (15-17). After the catheter is placed, it is recommended to wash the catheter with heparin or isotonic solution to prevent clogging, to remove the catheter in case of catheter-related infection, and to apply appropriate antibiotic therapy. Patients who are at a high risk of thrombosis and applied CPN may be offered heparin treatment at the request of a physician and these patients should be checked frequently for obstruction (16, 17).

The steps of nursing practices for PN are examined in detail in Table 1 (15-17). The points that differ in PN applications in pediatric patients compared with adult patients are explained in a different table (Table 2) (18-20).

Important notes

- Transparent dressings with chlorhexidine applied to the catheter area are changed as they become dirty or every 7 days, and dressings made with sterile gauze/sponge are changed as they become dirty or every 48 hours. There is no need to do this procedure in the lumen to be used.
- Flow should not be interrupted during daily visit, examination, inspection and care procedures, and fluid exchanges.
- After confirming with the chest radiograph that the tip of the newly inserted catheter is in the right place, it should be used with the recommendation of the doctor.
- Immediately after the peripherally inserted central catheter (PICC) is in place, IV fluid should be attached and the fluid should not be disconnected in any way. In order to prevent PICC occlusion and catheter-related thrombosis, 0.5–1 mU/mL heparin should be added to IV fluid in accordance with the physician's request.
- Catheter lumen should be washed with saline before and after drug administration.

Drug administration and nursing in parenteral nutrition

Drug treatment of patients receiving PN treatment is also very important in terms of treatment processes. It is vital not to disrupt the drug treatments of patients, but to prevent drug–food and drug–drug interactions. For this reason, the responsibilities of nurses for drug treatment in the patient receiving PN treatment are listed below (21).

- Drugs should not be added to PN bags as far as possible.
- If drug administration is inevitable with PN, the pharmacist should be consulted to ensure the compliance and compatibility of the drug with PN.
- In the case of adding drug to the PN bag, the compliance and compatibility of which cannot be assured:
  - The drug can react with bag material (such as EVA (Etil Vinil Asetat), PVC (Poli Vinil Clorur), polyolefin).
  - With the reaction of some nutrients, the drug may lose its effect.
  - The drug may cause toxicity by reacting with nutritional components (such as precipitate, radical formation).
- If information about the compliance and compatibility of the drug cannot be obtained, the drug should definitely be administered via a separate intravenous route.
- Insulin should not be added to the PN bag as its effectiveness will decrease.

Complications of parenteral nutrition and nursing management

Complications of PN are more serious and mortal than enteral nutrition and some of them are pneumothorax, hydrothorax, chylothorax, buffered pericardial effusion, arterial injury, brachial plexus injury, catheter embolism, air embolism, venous thrombosis, and thrombophlebitis (22, 23).

Complications that may occur during PN administration can be grouped under 3 headings: mechanical, septic, and metabolic.

Mechanical complications can be classified as inserting the catheter into the wrong place, clogging in the catheter, central vein thrombosis and/or thromboembolism, bleeding, local hematoma or abscess, and catheter embolism.

Septic complications can be classified as catheter-induced septic infections and sepsis.

Metabolic complications can be classified as acute metabolic complications such as hyperglycemia, hypoglycemia, electrolyte imbalances, etc. and chronic metabolic complications such as liver steatosis, cholestasis, refeeding syndrome, gallstones, cholecystitis, and bone diseases.

Mechanical complications have been reported to include complications such as pneumothorax, hemothorax, hydrothorax, injury; arrhythmia due to the entry of the catheter into the right atrium or ventricle; fat embolism and air embolism (21-23).

The most common complication in total PN is catheter-related septic infections. The frequency of infection and sepsis varies between 2% and 30% (22, 23). *Staphylococcus aureus* has been reported to be most frequently responsible for infection (22). In practice for the prevention of infection:

- Surgical aseptic technique should be used, a special place for this application should be left;

Table 1. Nursing Practice Steps for Parenteral Nutrition in Adults (15-17)	
Practice steps	**Reasons**
1- Solution coming from filling unit is delivered. Label information on the PN bag is compared with patient information. It is delivered by signature. If the solution is precipitated or discolored, it is returned. Parenteral nutrition bags can be stored for 6 days at 2-8°C on the refrigerator shelf or unless the asepsis deteriorates. In ready-made commercial products, storage conditions may vary according to the manufacturer's recommendations.	It is to assure that the right solution is provided to the right patient. The solution with impaired stability is prevented from being administered to the patient.
2- Nutrition solution is prepared. Solution bag is set and becomes ready. The solution must be at room temperature before it is administered to the patient.	
3- The procedure and its purpose are explained to the patient and consent is obtained from the patient.	This application relieves the anxiety of the individual. This provides patient's compliance and participation to the procedure.
4- During the PN administration setup and catheter tip connections, the following administration steps are followed. Hand hygiene is provided, Gloves and masks are worn. The patient is asked to turn his head in the opposite direction of the catheter, or the patient is put on a mask, A non-sterile cover is placed on the patient's chest, After the bag is mixed, it is hung on a high hanger, hands are cleaned again with antiseptic solution, A new sterile cover is laid on the other cover, the distal end of the application set is placed on the sterile cover and the air of the set is removed, Hands are cleaned again with antiseptic solution, Distal tip of the catheter is wiped with sterile gauze with antiseptic, The catheter cover is opened and the catheter tip (hub) is wiped with an antiseptic, It is washed by sending some SF from the catheter and its obstruction is checked, • PN administration set is connected to the catheter, Connection points of PN set are wrapped with sterile gauze and closed. The lumen of the catheter is fixed so that it does not break over the patient's chest and is in a comfortable position.	Following asepsis principles decreases the risk of infection.
5- Patient monitoring in parenteral nutrition treatment. Feeding is started slowly, the planned dose is reached within 2-3 days, Vital findings and input-output are followed, Laboratory findings are monitored, The patient's daily weight is followed, It is by infusion pump, The rate of delivery of the solution is recorded, Infusion set is changed every 24 hours, The date and time of dressing are recorded, The type of catheter (central, peripheral) is recorded, Dressing material used (transparent dressing material, sterile gauze) is recorded, Double lumen catheters are recommended to prevent the mixture of PN and drugs.	The patient is allowed to tolerate nutrition. The development of complications is prevented, and early treatment is ensured when complications develop. Legal basis is obtained for reaching data for subsequent procedures and for nursing. Medicines can interact with the solution and lose their effectiveness.
SF: serum physiological	

Table 2. Differences in Nursing Practice for Parenteral Nutrition in Children (18-20)	
Practice steps	**Reasons**
1- Catheter dressing: Starting from the catheter exit point, it is wiped for 30 seconds with a sponge moistened with antiseptic solution (2% chlorhexidine) from the center to the surrounding (5 cm in infants and 7-10 cm in older children), this process is repeated at least 3 times. A separate sterile cloth/sponge is used each time the procedure is repeated.	
2- If the lumen will be washed: If lumen will be used. Lumen is washed with 3-10 mL of saline. If the lumen will not be used for more than 8 hours: It is washed with heparinized saline in the amount recommended by the manufacturer. The catheter is clamped while the process of delivering saline/heparinized fluid to the lumen continues. The distal end of the lumen is wiped 3 times with an antiseptic and the covers are changed and closed.	If the catheter diameters are too small, such as 1-2 French, and the fluid flow is interrupted for any reason, the catheter will clog.

- Macroscopic control of total PN bag/bottle should be performed before use;
- The application steps mentioned above must be followed;
- In case of the development of an infection despite following aseptic principles, catheter should be removed immediately, nutritional support should be provided in a different way after treatment is interrupted for a period (20-23).

Hyperglycemia, hypoglycemia, and some electrolyte imbalances (Na, K, Ca, Cl, Mg, P) are common acute metabolic complications in PN. Hypoglycemia and hypophosphatemia caused by lack of nutrition are clinically important complications because they can cause death. Hypoglycemia can be caused by nutritional deficiencies as well as by a change in insulin administration in patients with diabetes or a sudden cessation of glucose infusion given at a high rate. Hypophosphatemia is a serious electrolyte disorder that is also caused by the patient's malnutrition and manifests with symptoms such as paresthesia, muscle weakness, confusion, convulsion, hemolysis, cardiac arrhythmias, and respiratory failure. Hyperglycemia can develop with the patient's overfeeding with hypercaloric products as well as with insufficient or irregular use of insulin in patients with diabetes. In this case, patients may also develop complications such as ketoacidosis due to hyperglycemia. Therefore, in order to prevent acute metabolic complications, it is very important to properly plan and apply the patient's nutritional regimen and to regularly monitor laboratory findings related to fluid electrolyte; urinary density; and symptoms such as glycosuria, and blood glucose.

Again, symptoms indicating fluid electrolyte imbalance such as paresthesia, muscle cramps, and muscle weakness should be closely monitored. In addition to the selection of the product to be used in patients with diabetes, the insulin treatment and dosage to be administered are also of great importance (23). Replacing missing elements will also prevent complications related to them (24, 25). Fatty liver is a frequent chronic metabolic complication in patients requiring PN and is thought to be the result of long-term nutrition with hypercaloric products. It has been reported that the risk of liver fattening decreases with intermittent PN (25, 26). Refeeding syndrome develops as a result of rapid and intensive nutrition in individuals who have severe malnutrition and have lost more than 10% of their body weight in the past 2 months. Refeeding syndrome is mostly characterized by hypophosphatemia, hypomagnesemia, hypokalemia, vitamin deficiency, and fluid retention, and is a serious complication that creates high morbidity and mortality. In order to prevent refeeding syndrome, high-risk patients with anorexia nervosa, chronic malnutrition, chronic alcoholism history, and prolonged fasting should be known, and while giving PN support to this group, it should be started with 50% of the planned energy intake. As the patient tolerates the given amount, the full dose can be achieved by gradually increasing the rate (27, 28).

Conclusion and Suggestions

Although PN is life-saving for patients who cannot be fed enterally, it requires a good and effective maintenance process as it is a complicated intervention. It is a common view that effective interventions and effective care of nurses, who are an important part of nutritional support teams, will decrease the mortality and morbidity rates in patients. However, in the literature review, there are few randomized controlled nursing studies in this area. For this reason, there is a need to increase the number of randomized studies with high level of evidence regarding nursing interventions in patients receiving PN to increase evidence-based nursing practices.

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