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A REVIEW ON NUTRITION INCLUDING TOTAL PARENTERAL NUTRITION

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ABSTRACT

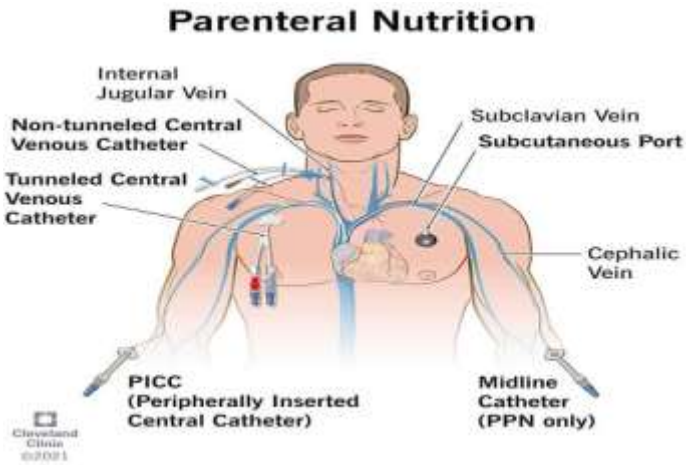
Total parenteral nutrition is a lifesaving therapy for the patient with chronic gastrointestinal failure being an effective method for suppling energy and nutrient when oral or internal feeding is impossible or contraindicated. Total parenteral nutrition (TPN) may lead to concerning kidney outcomes with long term administration. TPN should only been used when internal feeding is completely contraindicated or cannot sufficiently address nutrient in take goals due to secondary issue such as anorexia. Total parental nutrition by identifying the main complication present by patient who underwent this therapy and describe the main nursing care for the patient. TPN is given through I.V route. Parenteral means outside of the digestive tract. TPN may be administered as peripheral parenteral nutrition (PPN) or via a central line, depending on the components and osmolality. Patients who previously had no options to sustain their lives are now able to live at home, maintain employment, and continue with most daily activities. Although this therapy has been innovative and successful, it requires great financial and professional resources. Parenteral nutrition can be given for long periods of time. A large variety of complications can occur, related especially to the equipment or the nutrients. When the nutrition is given via a central venous catheter, then sepsis is a serious and possibly life-threatening complication. In case of administration via an arteriovenous shunt, thrombosis of the shunt is the most frequent problem. The administration of total parenteral nutrition involve simple action the nurse must be assume her role with in the team ensuring optimum performance instruction and training to promote and effective service to the patient.

KEYWORDS: Nutrition, Feeding, Kidney, Anorexia , Osmolality, Financial, Sepsis.

1. INTRODUCTION

Total parenteral nutrition (TPN) is a medical therapy designed to provide complete nutritional support to patients who cannot obtain adequate nutrition through oral or enteral routes. TPN involves delivering nutrients directly into the bloodstream via an intravenous (IV) catheter, bypassing the gastrointestinal (GI) tract entirely. This method is crucial for patients with conditions that impair their ability to ingest or absorb nutrients, such as severe gastrointestinal diseases, certain cancers, or major surgeries.[1]

The composition of TPN is carefully tailored to meet the individual needs of the patient and typically includes macronutrients (carbohydrates, proteins, and fats) as well as micronutrients (vitamins and minerals). Carbohydrates are usually provided in the form of dextrose, while proteins are supplied as amino acids. Lipids may be included as emulsified fats to provide essential fatty acids and additional calories. The exact formulation can vary significantly depending on the patient's age, weight, metabolic status, and specific nutritional requirements.[2,3,4,5,6] TPN can be delivered through different types of venous access, including peripheral veins or central venous catheters (CVC). Central access is often preferred for long-term TPN due to the higher concentrations of nutrients that can be administered without the risk of damaging smaller peripheral veins.[7] Indications for TPN are broad and include conditions such as short bowel syndrome, severe pancreatitis, inflammatory bowel disease, and cancer treatment where oral intake is not possible. It is also employed in patients recovering from major surgeries, particularly when their ability to tolerate enteral feeding.



Dia. Parenteral Nutrition.[2]

Successful intravenous nutrient administration by Dudrick and colleagues marked a major advancement in providing nutrition to patients unable to be fed orally or enterally, leading to the birth of parenteral nutrition (PN).[8] The initiation of TPN requires a multidisciplinary approach involving physicians, dietitians, pharmacists, and nursing staff. These professionals work together to assess the patient's nutritional needs, select an appropriate TPN formula, and monitor the patient's response to therapy. Regular laboratory tests are performed to evaluate electrolyte levels, liver function, and other relevant parameters.[9,10] In conclusion, Total parenteral nutrition serves as a critical intervention for patients who are unable to meet their nutritional needs through conventional means. By providing essential nutrients directly into the bloodstream, TPN supports growth, healing, and recovery in a variety of medical contexts. As the field of nutrition therapy evolves, ongoing research continues to refine TPN protocols, aiming to enhance patient outcomes and reduce associated risks.

1.1. Preparation

Compounding TPN admixtures has significantly developed since the first clinical reports by Dudrick and colleagues from the University of Pennsylvania approximately 40 years ago.[11] Today, the responsibility for the compounding of safe parenteral nutrition admixtures for patients incapable of oral or enteral nutrition primarily rests with the pharmacy department.[12] Although others may influence the desirable components to be contained therein, no one is more qualified to deal with the physicochemical issues and aseptic technique compounding requirements than a registered pharmacist. In fact, the United States Pharmacopeia (USP), the official drug compendium in the US since 1906, has published chapter 797 entitled "Pharmaceutical Compounding-Sterile Preparations", enforceable by the FDA, and makes clear the role of the pharmacist in the compounding of safe parenteral admixtures. Ultimately, after careful pharmaceutical review of the final formulation, the composition of the final admixture for infusion will be determined based on the ability to safely compound the prescribed additives in the desired quantities of a specified volume of sterile fluid. This is usually done in a dedicated place in the hospital pharmacy, the TPN unit, where aspetic conditions are maintained. A registered nurse, the hospital’s infection control officer, and a microbiologist may be part of the TPN team; and frequent auditing is needed to ensure sterile solutions and standard procedures. There will always be instances, where, for example the patient's needs cannot be safely met through the TPN admixture, primarily because of stability, compatibility and/or sterility issues.[13] When this occurs, suitable alternative methods of delivering the additives in question must be sought so as not to

compromise the safety issues of the final TPN infusion. Although there have been many advances in the development of nutritional additives, compounding devices, and containers, significant safety issues continue to arise necessitating further modification of parenteral nutrition protocols.

2. PROCEDURE

The preferred method of delivering PN is with a medical infusion pump, which allows accurate calculation of amount of fluid and rate of infusion. A sterile bag of nutrient solution with the compounded admixture according to the requirement of the patient is provided. Bags with different sizes are available (from 500 ml to 4 liters). The pump infuses a small amount (0.1 to 10 ml/hr) continuously in order to keep the vein open. Feeding schedules vary, but one common regimen ramps up the nutrition over one hour, levels off the rate for a few hours, and then ramps it down over a final hour, in order to simulate a normal metabolic response resembling meal time. This should be done over twelve to twenty-four hours rather than intermittently during the day.[11] Chronic PN is performed through a central intravenous catheter, usually through the subclavian or jugular vein with the tip of the catheter at the superior vena cava without entering the right atrium.

Another common practice is to use a PICC line, which originates in the arm, and extends to one of the central veins, such as the subclavian with the tip of the catheter in the superior vena cava. In newborns, sometimes the umbilical vein is used. Outpatient TPN practices are still being refined but have been used for years. Battery powered ambulatory infusion pumps can be used with chronic TPN patients. Usually the pump and a small (100 ml) bag of nutrient (to keep the vein open) are carried in a small bag around the waist or on the shoulder. Patients can receive the majority of their infusions while they sleep and instill heparin in their catheters when they are done to simulate a more "normal" life style off the pump. Aside from their dependence on a pump, chronic TPN patients can live quite normal lives.

2.1. TPN administration

Because the central venous catheter needs to remain in place for a long time, strict sterile technique must be used during insertion and maintenance. The TPN line should not be used for any other purpose. External tubing should be changed every 24 hours with the first bag of the day. In-line filters have not been shown to decrease complications. Dressings should be kept sterile and are usually changed every 48 hours using strict sterile techniques. If TPN is given outside the hospital, patients must be taught to recognize symptoms of infection, and

qualified home nursing must be arranged. The PN solution is started slowly at 50% of the calculated requirements, using 5% dextrose to make up the balance of fluid requirements. Energy and nitrogen should be given simultaneously. The amount of regular insulin given (added directly to the TPN solution) depends on the plasma glucose level; if the level is normal and the final solution contains 25% dextrose, the usual starting dose is 5 to 10 units of regular insulin per liter of TPN fluid.

An interdisciplinary nutrition team, if available, should monitor such patients. Weight, CBC, electrolytes, and BUN should be measured and recorded daily for inpatients. Plasma glucose concentration should be measured every 6 hours until both the patients and the blood glucose levels become stable. Fluid intake and output should be monitored continuously. When patients become stable, blood tests can be done much less often.[15] Plasma proteins (e.g., serum albumin, transthyretin and retinol-binding protein), prothrombin time, plasma and urine osmolality, as well as calcium, magnesium and phosphate should be measured twice per week. Changes in transthyretin and retinol binding protein reflect overall clinical status rather than nutritional status alone. If possible, blood tests should not be done during glucose infusion.

2.2. TPN Support during Bone Marrow Transplantation

Hematopoietic stem cell transplantation (HSCT) is a sophisticated procedure used in the treatment of solid tumors, hematological diseases and autoimmune disorders. All patients undergoing HSCT require intensive chemotherapy and radiation as part of procedure protocol. The majority of those patients suffer from severe mucositis in the oral cavity and esophagus, and enteritis due to cytotoxic therapy and immune dysregulation, resulting in prolonged decreased oral intake, nausea, vomiting and diarrhea. In addition, cytotoxic drugs enhance catabolism and produced negative nitrogen balance and a greater loss of lean body mass than body weight or body fat mass. The combined adverse effects lead to malnutrition. While total parenteral nutrition is often given to patients in order to maintain their nutritional status during the peri or post-transplant period, there is conflicting evidence to support its routine use. The reasons for this controversy may reside in the heterogeneity of the patients studied and of the study designs. Few prospective randomized studies have reported increased survival and decreased relapse in HSCT patients who received TPN compared to control subjects.[17,18]

These results suggest that among patients receiving bone marrow transplants, those who cannot eat for a prolonged period, particularly if they are severely malnourished, may benefit from TPN. However, some other prospective randomized studies showed no difference in survival between TPN and enteral nutrition support in bone marrow transplant recipients.[19,20] We evaluated the small number of prospective randomized and nonrandomized controlled trials that assessed important clinical outcomes such as time to engraftment, rates of infection, overall survival and length of hospitalization. Believe that the data do not support the routine use of parenteral nutrition as first-line therapy but should be reserved for those patients who are unable to tolerate enteral feedings. We also believe that glutamine supplementation cannot be recommended to all HSCT (Hematopoietic Stem Cell Transplantation) recipients as it has been shown to increase morbidity and mortality rates in autologous transplant patients.

3. INDICATION

Parenteral nutrition is indicated to prevent the adverse effects of malnutrition in newborns and children who are unable to obtain adequate nutrients by oral or enteral routes either because of prematurity, necrotizing enterocolitis or other neonatal complications.[21,22] TPN has extended the lives of many children who were born with nonexistent or severely deformed organs, and those who were critically ill.[23,24]

Additional indications in childhood are short bowel syndrome, high-output fistula, prolonged ileus, malignant diseases, severe inflammatory bowel disease, malabsorption, and persistent diarrhea.[25,26] However, the decision to initiate PN needs to be made on an individual patient basis, as different patients will have differing abilities to tolerate starvation. In adults parenteral nutrition is provided when the GI tract is nonfunctional because of an interruption in its continuity or because its absorptive capacity is impaired.[27,28] It has been used also for comatose patients, patients with severe burns, and after surgery.[29,30] Although enteral feeding is usually preferable, and less prone to complications in such cases.

Total parenteral nutrition (TPN) is indicated in various clinical scenarios where patients cannot meet their nutritional needs through oral or enteral feeding. Here are the key indications for TPN in detail:[31]

- Gastrointestinal Disorder
- Malignancies and Cancer Treatments
- Critical Illness

- Postoperative Recovery
- Chronic Conditions
- Intolerance to Enteral Feeding
- Congenital or Genetic Disorders
- End-of-Life Care

4. MECHANISM OF ACTION

TPN is a mixture of separate components which contain lipid emulsions, dextrose, amino acids, vitamins, electrolytes, minerals, and trace elements. Clinicians should adjust TPN composition to fulfil individual patients' needs. The main three macronutrients are lipids emulsions, proteins, and dextrose.[36,37]

4.1. Lipid Emulsions

It provides calories and prevents fatty acid deficiency. Essential fatty acid deficiency may develop within three weeks of fat-free TPN.25% to 30% of the total calories are in the form of lipids.[38]

4.2. Proteins

A solution that contains essential and non-essential amino acids except arginine and glutamine This change is based on the condition of the patient. Critically ill patients require 1.5 gm/kg/day, patients with chronic renal failure are given 0.6 to .0.8 gm/kg/day, and patients with acute hepatic encephalopathy need temporary protein restriction to 0.8 gm/kg/day, patients on hemodialysis need 1.2 to 1.3 gm/kg/day.[38]

4.3. Carbohydrate

Provided through dextrose monohydrate in a variety of concentrations, most commonly 40, 50, and 70% Glucose utilization maximum rate is 5 to 7 mg/kg/min. Excess carbohydrate supplementation can result in hyperglycemia and hypertriglyceridemia.

4.4. Electrolytes, Trace Elements, and Vitamins are Micro-nutrients

Trace elements and vitamin dosing can be according to recommended daily requirements. Electrolytes recommendation per liter of parenteral nutrition:

- Sodium: 100 to 150 mEq
- Magnesium: 8 to 24 mEq
- Calcium: 10 to 20 mEq

- Potassium: 50 to 100 mEq
- Phosphorus: 15 to 30 mEq

5. BASIC ADULT DAILY REQUIREMENT FOR TPN (CHART)

Basic Adult Daily Requirements for Total Parenteral Nutrition	
Nutrient	Amount
Water (/kg body weight/day)	30-40 mL
Energy* (/kg body weight/day)	
Medical patient	30-35 kcal
Postoperative patient	30-45 kcal
Hypercatabolic patient	45 kcal
Amino acids (/kg body weight/day)	
Medical patient	1.0 g
Postoperative patient	2.0 g
Hypercatabolic patient	3.0 g
Minerals	
Acetate/gluconate	90 mEq
Calcium	15 mEq
Chloride	130 mEq
Chromium	15 mcg
Copper	1.5 mg
Iodine	120 mcg
Magnesium	20 mEq
Manganese	2 mg

Potassium	100 mEq
Selenium	100 mcg
Sodium	100 mEq
Zinc	5 mg
Vitamins	
Ascorbic acid	100 mg
Biotin	60 mcg
Cobalamin	5 mcg
Folate (folic acid)	400 mcg
Niacin	40 mg
Pantothenic acid	15 mg
Pyridoxine	4 mg
Riboflavin	3.6 mg
Thiamin	3 mg
Vitamin A	4000 International units
Vitamin D	10 mcg (400 units)
Vitamin E	15 mg
Vitamin K	200 mcg

Requirements for energy increase by 12% per 1° C of fever.[42]

6. Adverse Effect

The main adverse effects can be metabolic abnormalities, infection risk, or associated venous access.

6.1. Venous Access

It is associated with the insertion of the central line catheter. • Pneumothorax • Air embolism • Bleeding • Venous thrombosis • Vascular injury.[43,44]

6.2. Catheter Site Infections

- Central line-associated bloodstream infection (CLABSI)[45]
- Local skin infection at insertion or exit site.

6.3. Metabolic Abnormalities

- Refeeding syndrome in chronic alcoholic patients and in patients who have nothing-bymouth status (NPO) for more than 7 to 10 days.
- Hyperglycemia.
- Sudden discontinuation can lead to hypoglycemia. Hypoglycemia is correctable with 50% dextrose.
- Serum electrolyte abnormalities
- Wernicke's encephalopathy[43,46]
- Parenteral-associated cholestasis

Due to safety concerns and the complexity of administration, parenteral nutrition is considered high risk by the ISMP (Institute for Safe Medication Practice).[47]

6.4. Toxicity

Generally, the toxicity of TPN is related to the individual toxicity of its components. Increased caloric amounts due to TPN glucose and lipid excess can lead to hepatic toxicity; this risk can be decreased by using decreased glucose and greater lipid content. A glucose infusion rate greater than 5 mg/Kg/min can result in a fatty liver because increased glucose in the blood induces hepatic lipogenesis.[48] and increased glucose levels induce increased insulin levels, leading to more lipogenesis. This effect is preventable by decreased dextrose dosage to under 5 g/kg day, less than 5mg/kg min, cyclic PN for 8 hours as it decreases excessive insulin secretion and substituting 30% of dextrose energy with lipids. Parenteral nutrition supplementation rather than total parenteral nutrition is harmful to pediatric patients in the pediatric intensive care unit (PICU).

Clinicians should withhold parenteral nutrition supplementation in the first week in the PICU independent of age or nutritional status; this is because amino acids in the PN suppress the autophagy process needed for cellular damage removal. Excess amino acids a shuttled to urea production. Increased urea levels can pose harm to the kidneys and liver.[49] Long-term usage of TPN, ranging from weeks to months, can be associated with the rare complication of manganese toxicity. Manganese exposure via TPN is characterized by high bioavailability

due to bypassing the GI tract regulatory mechanisms. Over time, this high manganese concentration leads to its deposition in the liver, brain, and bone.

7. Complications

The maintenance of the central venous catheter for the infusion of TPN was one of the major complications described during the analysis of the articles. The pathogenesis of the infection of catheters is related to the deposit of microorganisms in the catheter upon insertion, their migration through the skin and along the catheter, and contamination of both the connection and the infusion liquid in addition to the infection focus distance.[52]

One study reported that complications related to TPN were responsible for 12 deaths, nine by systemic infection and two due to a massive pulmonary embolism, both caused by the prolonged presence of the catheter in the central vein.[53] In another study involving 16 patients who underwent the implantation of a central venous catheter for the infusion of TPN, there were 21 episodes of infection, where the most common etiologic agent was Staphylococcus epidermidis (57%), followed by fungi, gram negative bacilli (E.coli, Serratia Marcescens, Enterobacter Cloacae) and Staphylococcus aureus. The colonization by Staphylococcus epidermidis can be explained by the immunosuppression of patients and the overuse of antibiotics, leading to the development of resistant strains.[52]

8. ADVANTAGES AND DISADVANTAGES

8.1. Advantages

Total parenteral nutrition (TPN) offers several advantages, particularly for patients who cannot obtain adequate nutrition through oral or enteral means. Here are some key benefits:[58]

1. Nutritional Support
2. Gastrointestinal Rest
3. Control Over Nutritional Composition
4. Rapid Nutritional Recovery
5. Administration Flexibility
6. Improved Quality of Life
7. Support During Tretment

8.2. Disadvantages

Total parenteral nutrition (TPN) has several disadvantages and potential risks, which

include:[58]

1. Infection Risk
2. Metabolic Complications
3. Liver Dysfunction
4. Gastrointestinal Atrophy
5. Nutrient Deficiencies or Excesses
6. Cost and Resource Intensive
7. Psychological Impact

9. CONCLUSION

Total parenteral nutrition (TPN) is a critical medical intervention designed to provide essential nutrients directly into the bloodstream for patients unable to consume food orally or through enteral routes. This method has transformed the management of patients with various medical conditions, including gastrointestinal disorders, post-surgical recovery, and severe malnutrition. One of the primary advantages of TPN is its ability to deliver a complete nutritional profile tailored to individual patient needs. This includes macronutrients such as carbohydrates, proteins, and fats, as well as micronutrients like vitamins and minerals. TPN can promote rapid recovery in patients who require nutritional support during intensive treatments like chemotherapy or major surgeries. Additionally, by allowing the gastrointestinal tract to rest, TPN can facilitate healing in conditions such as inflammatory bowel disease or bowel obstructions. However, TPN is not without its challenges and risks. The use of central venous catheters to administer TPN carries a significant risk of infection, which can lead to severe complications. Metabolic complications, such as hyperglycemia, electrolyte imbalances, and liver dysfunction, are also concerns associated with prolonged use. Moreover, the lack of gastrointestinal stimulation can lead to atrophy of the intestinal mucosa, complicating future transitions to oral feeding.

Cost and resource demands are also important considerations. TPN requires careful preparation and monitoring, necessitating specialized training and equipment, which can be burdensome for healthcare facilities and financially taxing for patients and families. Additionally, the psychological impact of relying on TPN can affect patients' quality of life, as it limits normal eating experiences and social interactions. In conclusion, TPN is a valuable tool in modern medicine, providing essential nutritional support for patients with specific medical needs. While it offers significant benefits, including rapid nutritional

recovery and individualized care, healthcare providers must carefully weigh these against the potential risks and complications. Ongoing monitoring and management are crucial to maximizing the benefits of TPN while minimizing adverse effects. As medical technology advances, further refinements in TPN protocols may enhance its safety and efficacy, making it a more accessible option for those in need of specialized nutritional support.

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