AN OVERVIEW ON TOTAL PARENTERAL NUTRITION

Mohamed Yasir Arafath.A.A*[1], Mujipur Rahman.J[2]

1. Associate Professor, Department of Pharmacy Practice, Vinayaka Mission's College of Pharmacy, Yercaud main road, Kondappanaickenpatty, Salem, Tamilnadu, India.
2. M.Pharm Student, Department of Pharmacy Practice, Vinayaka Mission's College of Pharmacy, Yercaud main road, Kondappanaickenpatty, Salem, Tamilnadu, India.

Corresponding Author

Dr. Mohamed Yasir Arafath A.A

Associate Professor

Department of Pharmacy Practice

Vinayaka Mission's College of Pharmacy, Salem

Vinayaka Mission's Research Foundation (Deemed to be University),

Salem, Tamil Nadu, India

ABSTRACT

Total parenteral nutritional feeding has been used in clinical practice for more than a quarter century. It has changed the treatment of potentially fatal conditions in both new-borns and adults, such as small bowel syndrome. There was no longer any condition where a patient could not be fed. Unfortunately, substantial infective and metabolic side effects hampered the favourable effects of nutritional repletion in the early days of complete parenteral feeding. With the growth of research, improved infection control techniques, the invention of appropriate equipment, and expertise, these TPN related difficulties were reduced over time. The advantages now outnumber the disadvantages. The development of advanced catheters and delivery systems has resulted from the refinement of procedures. The development of scientific parenteral solutions to suit specific scenarios has resulted from a better understanding of human nutrition and metabolic processes. In this article we evaluated the literature and described the indications, composition, and administration of TPN in both children and adults.

KEYWORDS: TPN, Parenteral nutritional feeding, Malnutrition, Parenteral solutions, Parenteral nutritional regimen.

INTRODUCTION

The positive benefits of long-term TPN on the growth and development of children, was proved by Dudrick et.al, and introduced total parenteral nutrition (TPN) into clinical practice many years ago[1]. It has come a long way since then, and it is now a standard tool in the toolbox of physicians in their quest to provide complete health care to patients. TPN's indications, as well as understanding of its limitations, side effects, and problems, are now reasonably well characterised. TPN can now be provided at the patient's home, lowering hospital costs [2]. New areas of research include the possible use of TPN in arresting and possibly reversing atherosclerotic disease process [3].

Malnutrition is a contributing factor in depressed immunocompetence, decreased response to chemotherapy, poor wound healing, increased duration of hospitalization, and increased morbidity and mortality. Clearly, malnutrition in hospitals is a major disease entity which requires prompt recognition and appropriate therapy. Parenteral nutrition is the provision of required nutrients by intravenous routes. It is commonly referred to as total parenteral nutrition (TPN) or hyper alimentation. TPN should be considered when oral or enteral feeding is impossible, or when gastrointestinal absorption and other functional activities are impaired. The two primary goals of nutritional intervention are: a) To meet the energy demands of the individual patient so that no energy deficit exists, b) To provide amino acids in sufficient amounts to support optimal rates of protein synthesis. Methods of parenteral nutrition delivery include central and peripheral vein administration [26].

INDICATIONS

The most common use of TPN is in critically ill patients who are unable to feed themselves. It can also be used to make up for a lack of oral intake [4]. TPN is only

effective when patients are carefully chosen, the procedure is well-understood, and the risks are understood.

1. New-borns with gastrointestinal anomalies such as tracheoesophageal fistula, large intestinal atresia, difficult meconium ileus, massive diaphragmatic hernia, gastroschisis, omphalocele or cloacal exostrophy, and untreated pyloric stenosis are some of the more common indications for TPN.

2. Short bowel syndrome, malabsorption, inflammatory bowel disease, enzyme deficiencies, and chronic idiopathic diarrhoea are all causes of failure to thrive in babies.

3. Necrotizing enterocolitis, intestinal fistulae, severe trauma, burns, surgical infections, and malignancies are among the other paediatric indications.

4. Adults with short bowel syndrome as a result of a large small-bowel resection or an internal or exterior enteric fistula.

5. Malnutrition caused by achalasia, oesophagealstrictures and neoplasms, pyloric blockage, and stomach neoplasms.

6. Sprue-related malabsorption, enzyme and pancreatic shortages, regional enteritis, ulcerative colitis, granulomatous colitis, and berculous enteritis are all possible causes of malabsorption.

7. Idiopathic diarrhoea, psychogenic vomiting, and anorexia nervosa are examples of functional gastrointestinal disorders.

8. Tube feeding is not an option for patients with a depressed sensorium (for example, after a head injury or intracranial surgery).

9. Hypercatabolic states can occur as a result of severe sepsis, full-thickness burns, large fractures, polytrauma, and major abdominal procedures, among other things.

10. Fecal soiling is a concern for paraplegics/quadriplegics with pressure sores in the pelvic or perineal regions.

11. Patients with cancer for whom malnutrition could endanger the delivery of a treatment option (surgery, chemo or radiotherapy).

12. Organ failures- liver,renal, respiratory moderate to severe catabolism with or without malnutrition when enteral feeding is contraindicated

13. Hyper emesis gravidarum.

14. Eating disorders - parenteral nutrition should be considered for patients with anorexia nervosa who require compulsory feeding but who cannot tolerate enteral support for physical or emotional reasons [26].

CONTRAINDICATIONS

Treating a patient with TPN when it isn't essential is not only inconvenient for the doctor and the patient, but it is also a waste of valuable resources. The following are clear contraindications to TPN:

1. If stomach feeding is an option. Almost always, this is the most effective technique to feed the patient [5].

2. Patients with an excellent nutritional status who will only need TPN for a brief time.

3. Patients who are irreversibly decerebrated.

4. Lack of a clear treatment goal: If death is unavoidable, TPN should not be administered to extend life [6].

5. Cardiovascular instability or metabolic disturbances. Before attempting intravenous hyperalimentation, these should be addressed.

6. Infants with a tiny intestinal length of less than 8 cm, as it have been firmly demonstrated that they cannot adapt to enteral nutrition despite continuous TPN.

CONSTITUENTS OF TOTAL PARENTERAL NUTRITION SOLUTION

TPN solutions are composed of a variety of constituents such as carbohydrate (e.g., dextrose), protein (e.g., crystalline amino acids), fat, electrolytes, trace elements, vitamins and water. Other additives that are sometimes added to TPN solutions are insulin,heparin, and albumin [26].

Water: Water functions as solvent for biological systems. Water is distributed in the intracellular space and extracellular space. Water is essential to the body. For a patient on TPN the intake of water is from the TPN mixture and from tissue metabolism plus the oxidation of food substrates in the body.

Carbohydrates: This is the main source of energy provided during TPN. The monohydrate form of glucose is the primary source of carbohydrates used in TPN. Each gram of dextrose used in TPN, provides 3.4 kcal of energy. Other carbohydrate source such as ethanol, fructose, galactose and sorbitol should not be used as energy sources in TPN. Dextrose is commercially available as 5%, 10%, 20%, 50% and 70% w/v solution in water. The amount of glucose provided in TPN is limited by the weight of the patient, glucose tolerance, and the route of administration and the required osmolality of the solution.

Fat: This is the primary source of essential fatty acid (linoleic acid) in TPN. Linoleic acid is useful as precursors of prostaglandin and in the synthesis of other fatty acids which are essential for cell membrane integrity. Fat is obtained from lipid emulsions which are available as 10% and 20% w/v solutions, Fat supplies 9 kcal/g intravenous respectively. Lipid emulsions supply 1.1 kcal/ml and 2 kcal/ ml from 10% and 20% lipid emulsions respectively.

Protein: Protein is provided by crystalline amino acids (CAA). They are used to prevent nitrogen loss or in the treatment of negative nitrogen balance. Although crystalline amino acids have a calorific value of 4 kcal/gm, they are not counted towards the supply of energy to the patient as carbohydrates and fat are used for this purpose. The principal use of CAA is protein synthesis. 1 gm. of nitrogen is produced by 6.25 gm. of protein (amino acids). There are many commercial preparations of amino acids, most of which are regarded as standard solutions.

Electrolytes: These include sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), chloride (Cl), phosphate and acetate. Ca, Mg and phosphorous are sometimes referred to as minerals. Electrolytes form an essential part of TPN regimens. They are used to maintain normal body metabolism.

Trace elements: These are zinc (Zn), copper (Cu), chromium (Cr), manganese (Mn), molybdenum (Mo), selenium (Se), Iodine (I), Iron (Fe).

Vitamins: Water and lipid soluble vitamins are required for the metabolism of carbohydrate, protein, and fat. Fat soluble vitamins include vitamins A, D, E and K. The water soluble vitamins are vitamins B1, B2, B6, B12, and C. Also included in this group are Pantothenic acid, niacin, and biotin.

The following metrics should be measured on a daily basis during TPN: Estimation of body weight; 12-hourly intake-output chart; estimation of urine sugar; serum sodium, potassium, bicarbonate, calcium, and chloride; blood urea and serum creatinine, serum proteins and liver function tests should be done twice a day [26].

CALCULATING THE PARENTERAL NUTRITION REGIMEN

Although computer software for calculating volumes of base solutions for parenteral nutrition regimens is now widely available, the steps for manual calculations are briefly reviewed. There are several guidelines or clinical rules of thumb that may help the pharmacist to calculate a parenteral nutrition regimen after a patient's nutritional requirements have been decided. For example, patients receiving only parenteral nutrition therapy will likely need larger volumes of fluid to provide maintenance requirements and replace extra renal losses. However, patients requiring other intravenous drug therapy will likely receive adequate fluids through the use of a standard intravenous maintenance solution such as 0.45%w/v NaCl in 5% w/v dextrose and piggy-backed medications. Depending on individual institutional practices, maximally concentrating the parenteral nutrition solution and utilizing an inexpensive maintenance fluid to manage hydration may provide a cost - effective regimen that requires fewer adjustments. Another guideline that may be helpful in designing a parenteral nutrition regimen where the CAA/dextrose base is infused separately from the IVFE (Intravenous Fat Emulsion) is to allow a volume of approximately 50-100 mL/L of base solution for electrolytes and other additives. Given this guideline , two clinically useful and highly concentrated base solutions are (final concentration) 7% w/v CAA / 15% w/v dextrose, which can be prepared from 10% CAA and 70% dextrose stock solutions , or 8% w/v CAA/ 25% w/v dextrose compounded from 15% CAA and 70% dextrose stock solutions. Parenteral nutritional regimens for patients,

who require very small amounts of additives such as those with renal failure, may be further concentrated [26].

ADMINISTRATION

Vascular Access during TPN - Some form of access route is required for the provision of total parenteral nutrition. The peripheral or central veins are usually employed for this purpose.

Peripheral access during TPN - Peripheral veins are used for this purpose. Blood flow is low in these small veins, thus the infusion of hypertonic TPN solutions through them can result in pain, thrombophlebetis, and haemolysis. As a result, severe restrictions are often placed on the osmolality of TPN solutions to be infused. There is also the need for frequent change of the infusion site especially for patients on long term nutrition support therapy.

Central access during TPN - This route is reserved especially for patients whose metabolic requirements are high. With this technique hyperosmolar TPN solutions do not present a problem, as these large veins have a high blood flow resulting in the solution being diluted about 1000 times. Although there are many central access routes cited in the literature, the most common method is the cannulation of the superior vena cava via the subclavian vein. Percutaneous puncture of the subclavian vein by the infraclavicular route is the procedure of choice for TPN [26].

COMPLICATIONS

Parenteral nutrition can be a safe effective therapy when appropriate patients have been selected and the course of therapy is correctly monitored and adjusted as a patient's metabolic condition dictates. However, parenteral nutrition support is a complex therapy

that is associated with numerous complications. These complications may be divided into four categories:

• Mechanical or technical,

• Infectious,

• Metabolic, and

• Nutritional [26].

NUTRITIONAL ASSESSMENT

While the need for TPN may be self-evident in the majority of patients, it is recommended that some type of nutritional assessment be performed prior to the start of TPN so that the therapy may be planned and clear therapeutic goals can be set[4]. Historical, anthropometric, biochemical, and immunological parameters are examples of traditional approaches. A complete history-taking should include pre-existing sickness, a ten percent weight loss, weakness, and oedema[7]. Triceps skinfold thickness is the most crucial element of physical examination, aside from evident indicators of malnutrition. Anthropometric measurements such as height-weight ratio and total body surface area provide a rudimentary assessment. Serum albumin and transferrin levels are simple biochemical markers that have been widely employed in clinical practice. Visceral reserves are also reflected by retinol-binding protein and thyroxin-binding globulin, but these tests are rarely used in clinical practice. The total lymphocytic count not only evaluates immunological state, but also reflects visceral protein reserves. Delayed cutaneous hypersensitivity to PPD and candida antigens can be used to further measure immunological state. In terms of morbidity and mortality, or survival, a combination of

these characteristics is highly predictive. The PNI (Prognostic Nutritional Index) is a tool for forecasting the likelihood of septic complications and death.

PNI (%) =158 - 16.6 (ALB) - 0.78 (TSF) - 0.20 (TFN) - 5.8 (DB)

TSF stands for triceps fold thickness in mm, TFN stands for serum transferrin level in mg/dl, and DH stands for delayed cutaneous hypersensitivity. In critically ill patients, a PNI of less than 40% is associated with a low risk of complications and death, whereas a PNI of 50% or higher is related with a 33% mortality rate [8].

NUTRITIONAL REQUIREMENTS AND DELIVERY OF TPN

TPN is injected into the superior vena cava through the subclavian or internal jugular vein with a large bore central venous catheter. This can be accomplished through a "cutdown," but it is far better to utilise one of the modern percutaneous catheter-systems, as the risk of infection is considerably lower. During the catheter placement, strict asepsis must be observed. Prior to starting feeding, a chest radiograph should be obtained to establish the position of the catheter-tip and to rule out traumatic pneumothorax, the most common complication associated with catheter installation. To avoid catheter thrombosis, the catheter should be flushed with dilute heparin on a daily basis. A central catheter can be used to give TPN for several days or even weeks with careful management. While the Harris-Benedict equation or its Long's version[9] can be used to determine energy requirements, the implementation of TPN is far more difficult. The therapy is now thoroughly standardised, but it still gives the treating physician a lot of leeway. However, certain basic guidelines must be followed. The calories-to-nitrogen ratio must be acceptable (at least 100 to 150 kcal/g nitrogen), and the two materials must be infused at the same time because nitrogen utilisation decreases significantly when they are given at

different periods. The full day's supply of TPN should be made in the hospital pharmacy under stringent aseptic conditions. From commercially available kits/solutions, the basic solution should comprise 20% to 25% dextrose and 3 percent to 5 percent crystalline amino acids. Lipid emulsions are not only a good source of energy, but they help keep vital fatty acid deficit at bay.

TPN IN SPECIAL SITUATIONS

- TPN IN PAEDIATRIC PRACTICE

In 1944, Helfrick and Abelson were the first to report that a newborn with Hirschsprung's disease could receive complete intravenous nourishment [12]. TPN's indications in the paediatric age group have already been discussed. Silicone catheters are inserted into the external or internal jugular veins, as well as the anteriorfacial, cephalic, and femoral vein [13]. The use of the umbilical vein for TPN is presently not suggested due to the significant risk of catastrophic consequences. The use of TPN in children with small bowel syndrome has yielded remarkable benefits. Other issues include developing ways to minimise catheter-related sepsis, cholestasis, and osteopenia [14].

- TPN IN CANCER PATIENTS

TPN's relevance in cancer patients is still debatable [6], and initial enthusiasm for supplementary nutritional support in cancer patients has diminished in recent years. Malnutrition is linked to a loss of immunocompetence and energy, and it is a major cause of mortality and morbidity in patients with cancer. TPN, on the other hand, should only be utilised when malnutrition threatens the successful delivery of a therapeutic choice, such as chemo- or radiation [4]. It should not be administered to a terminally ill patient whose

death is a certain conclusion. The question of whether supplementing micronutrients will feed or repress the tumour remains unsolved [15].

- TPN IN THE INDIAN SETTING

In India, TPN has been utilised "from the year 1980[16], however, there are few published articles on its application. It's been used as a supplement to other treatments for people who are sick "Management of enter cutaneous fistulas in adults and children [16, 17]. Despite Indians' ingenuity for modification, the cost of TPN in India is too high. Though one day's TPN in India might cost as little as Rs. 275 [16], a more realistic number is over Rs. 1500 per day. In India, the backbone of TPN is still 25% glucose, hermin, and intralipid.

DEMONSTRATED EFFICACY OF TPN IN SOME COMMON DISORDERS

Patients with entercutaneous fistulae have showed a significant drop in mortality and an increase in healing rate [18,19]. Patients with surgically associated renal failure treated with TPN had lower urea appearance, earlier diuresis, and a statistically significant improvement in survival [20], Patients with small bowel syndrome can now live for years or more on home. TPN, despite the fact that they would have perished otherwise[21]. There has been no randomization, but these patients have no other option. In children with serious burns receiving high protein parenteral diet, a prospective randomised trial found better survival, improved immunologic protein synthesis, and improved neutrophil function [22]. Patients with hepatic failure who received extensive parenteral nutritional assistance lived longer [23]. Although no compelling evidence for the administration of TPN before to major procedures has been found [24], a Veterans administration multicentre trial found that preoperative TPN reduced septic complications and mortality in a subgroup of malnourished patients with greater than 15% body weight loss [25].

CONCLUSION

TPN is being used in a range of clinical conditions as a primary or supplementary therapy. Because of advancements in catheter delivery methods, it is now a relatively safe treatment. Nutritional assistance is rapidly becoming a part of clinical biochemistry practice. In some patients, home TPN is now an option. It has recently been discovered that specifically prepared amino acid solutions can stop and reverse atherosclerosis. TPN-related difficulties would be reduced even more, and customised treatments for specific clinical situations would be developed. Parenteral nutrition is not a benign therapy. Appropriate patient selection, assessment, and monitoring are key to successful nutritional therapy, helping in prevention of unnecessary complications or harm to the patient. Standardized order forms and monitoring protocols are useful tools to ensure appropriate administration and monitoring of parenteral nutrition therapy. Pharmacists have been involved in the provision of parenteral nutrition at many levels including direct patient care, education, and research. The field of pharmacy nutrition support has grown into a well-defined area of pharmacy practice with formally defined standards of practice. The use of parenteral nutrition therapy and the role of the nutrition support pharmacist will be affected primarily by new insights from clinical research and economic challenges in the health care environment.

DECLARATIONS

Acknowledgements:

Nil

Conflict of Interest:

NO

REFERENCES

[1]. Dudrick, S.J. and Wilmore, D.W. Long term parenteral nutrition with growth, development, and positive nitrogen balance. Surgery 1968; 64: 134-42.

[2]. Rossi, T. and Morrison-Willard, E.Total Parenteral Nutrition: Indication, utilization, complications and pathophysiological considerations. New York: Raven Press, 1986; 252-7.

[3]. Dudrick, S.J., Latifi, R., and Adams, P.R. Arrest and reversal of atherosclerosis with parenteral nutrition. Surg Clin North Am 1991; 71: 665-76.

[4]. Smith, L.C., and Mullen, J.L. Nutritional assessment and indications for nutritional support. Surg Clin North Am 1991; 71: 449-58.

[5]. Heymsfield, S.B., and Bethel, R.A. Enteral hyperalimentation: an alternative to central venous hyperalimentation. Ann Intern Med 1979; 90: 63-7.

[6]. Klein, S., Simes, J., and Blackburn, G.L. Total parenteral nutrition and cancer clinical trials. Cancer 1986; 58: 1378-86.

[7]. Baker, J.P., and Detsky, A.S. Nutritional assessment: a comparison of clinical judgement and objective measurements. N Engl J Med 1982; 306: 969-72.

[8]. Buzby, G.P. Prognostic nutritional index in gastrointestinal surgery. Am J Surg 1980; 139: 160-4.

[9]. Long, C. Metabolic response to injury and illness: estimation of energy and protein needs from indirect calorimetry and nitrogen balance. J Parenteral Enteral Nutrition 1979; 3: 452-4.

[10]. McCarthy, M.C. Nutritional support in the critically ill surgical patient. Surg Clin North Am 1991; 71: 831-42.

[11]. Shires, G.T., Shires, G.T. III., and Lowry, S.F. Fluid,electrolyte and nutritional management of the surgical patient. In: Schwartz, S.I., editor. Principles of Surgery, 6th ed., New York: McGraw Hill Inc. 1994; 87-93.

[12]. Helfrick, F., and Abelson, N. Intravenous feeding of a complete diet in a child: report of a case. J Paediatr 1944; 28: 149-50.

[13]. Robertson, L., and Jaques, P. Percutaneous inferior vena cava placement of tunnelled Silastic catheters for prolonged vascular access in infants. J Paediatr Surg 1990; 2: 595-8.

[14]. Pittard, W., and Levkoff, A. Parenteral nutrition for the neonate. In: Tsang, R.,& Nichols, B., editors: Nutrition during Infancy. Philadelphia: Hanley and Belfus 1988; 323-35.

[15]. Husami, T., and Abumard, N.N. Adverse metabolic consequences of nutritional support: micronutrients. Surg Clin North Am 1986; 66: 1049-70.

[16]. Elhence, I.P., and Sharma, B.D.Role oftotal parenteral nutrition in the management of enterocutaneous fistulae following bowel surgery for peritonitis. Indian Journal Surgery 1980; 42: 528-35.

[17]. Nandkumaran, T.N., and Sreekumaran, M.I. Total parenteral nutrition - Calicut protocol. Indian Journal of Surgery 1994; 56: 241-4.

[18]. Reber, H.A., Roberts, C., Way, L.W., and Dunphy, J.E. Management of external gastrointestinal fistulas. Ann Surg 1978; 188: 460-7.

[19]. Soeters, P.B., Ebeid, A.M., and Fischer, J.E. Review of 404 patients with gastrointestinal fistulas: impact of parenteral nutrition. Ann Surg 1979; 190: 189-97.

[20]. Abel, R.M., Beck, C.H., and Abbott, W.M. Improved survival from acute renal failure following treatment with intravenous essential L-amino-acids and glucose: results of a prospective, double-blind study. N Engl J Med 1973; 288: 695-9.

[21]. Galanduik, S., O'Neil, M., McDonald, P., Fazio, V., and Steiger, E.A. century of home parenteral nutrition for Crohn's disease. Am J Surg 1990; 159: 540-4.

[22]. Alexander, H.W., Macmillan, B.G., and Stinnett JD, Beneficial effects of aggressive protein feeding in severely burned children. Ann Surg 1980; 192: 505-17.

[23]. Cerra, F.B., Cheung, N.K., Fischer, J.E., Disease specific amino-acid infusion (F080) in hepatic encephalopathy: A prospective, randomized, double-blind. Controlled trial. J Parenter Enteral Nutri 1985; 9: 288-96.

[24]. Detsky, A.S.,Baker, J.P., and O'Rourke, K. Perioperative parenteral nutrition: A meta-analysis. Ann Intern Med 1987; 107: 195-201.

[25]. Buzby, G.P. Case of preoperative nutritional support. Presented at the American College of Surgeons 1988 Clinical Congress Postgraduate Course on "pre- and post-operative care: metabolism and nutrition" Chicago Oct 25-8, 1988.

[26]. Sudheer kumar, D., Krishnaveni, J., and Manjula, P. Fundamentals of Clinical Pharmacy Practice 2010: 280 – 309.