Review

TOTAL PARENTERAL NUTRITION

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ABSTRACT

Total parenteral nutrition has been used in clinical practice for over a quarter of a century. It has revolutionized the management of potentially fatal condition like the short bowel syndrome in infants as well as adults. Refinements in techniques have led to development of sophisticated catheters and delivery systems. Better understanding of human nutrition and metabolic processes has lead to formulation of scientific parenteral solutions to suit specific situations. This article addresses the role of total parenteral nutrition in modern surgical practice.

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Introduction

Total parenteral nutrition (TPN) was introduced in clinical practice over 25 years ago by Dudrick et al who demonstrated the beneficial effects of long-term TPN on the growth and development in children [1]. Since then it has come a long way, and it is now a standard tool in the armamentarium of the physicians in their quest for delivery of comprehensive health care to patients. The indications of TPN are now fairly well defined, as is the knowledge about its limitations, side effects, and complications. Advances in technology have now made it possible for TPN to be delivered at the patients own residence, thus reducing hospital costs [2]. New areas of research include the possible use of TPN in arresting and possibly reversing atherosclerotic disease processes [3]. This review article discusses the place of TPN in modern surgical practice.

Indications

The principal indication for TPN is a seriously ill patient where enteral feeding is not possible. It may also be used to supplement inadequate oral intake. The successful use of TPN requires proper selection of patients, adequate experience with the technique, and

awareness of its complications. Some of the more important indications of TPN are listed below [4].

1. Newborns with gastrointestinal anomalies such as tracheoesophageal fistula, massive intestinal atresia, complicated meconium ileus, massive diaphragmatic hernia, gastroschisis, omphalocele or cloacal exostrophy, and neglected pyloric stenosis.
2. Failure to thrive in infants with short bowel syndrome, malabsorption, inflammatory bowel disease, enzyme deficiencies and chronic idiopathic diarrhea.
3. Other paediatric indications include necrotizing enterocolitis, intestinal fistulae, severe trauma, burns, postoperative infections and malignancies.
4. Adults with short bowel syndrome secondary to massive small-bowel resection or internal or external enteric fistulae.
5. Malnutrition secondary to high intestinal obstruction for example achalasia, oesophageal strictures and neoplasms, pyloric obstruction and gastric neoplasms.
6. Prolonged ileus due to medical or surgical causes (for example post-operative,

following abdominal trauma or polytrauma).

7. Malabsorption secondary to sprue, enzyme & pancreatic deficiencies, regional enteritis, ulcerative colitis, granulomatous colitis, and tuberculous enteritis.
8. Functional gastrointestinal disorders like idiopathic diarrhoea, psychogenic vomiting, anorexia nervosa.
9. Patients with depressed sensorium (for example following head injury or intracranial surgery) in whom tube feeding is not possible.
10. Hypercatabolic states secondary to severe sepsis, extensive full thickness burns, major fractures, polytrauma, major abdominal operations etc.
11. Patients with malignancies in whom malnutrition may jeopardize successful delivery of a therapeutic option (surgery, chemo- or radiotherapy).
12. Paraplegics/quadruplegics with pressure sores in pelvic or perineal regions where fecal soiling is a problem.

Contraindications

Treating a patient with TPN when it is not indicated is not only frustrating for the doctor as well as the patient but is also an unnecessary drain on scarce resources. Definite contraindications to TPN include the following :

1. Where gastrointestinal feeding is possible. Almost always this is the best route to provide nutrition to the patient [5].
2. Patients with good nutritional status in whom only short term TPN support is anticipated.
3. Irreversibly decerebrate patients.
4. Lack of specific therapeutic goal : TPN should NOT be used to prolong life if death is inevitable [6].
5. Severe cardiovascular instability or metabolic derangements. These should be corrected before attempting intravenous hyperalimentation.
6. Infants with less than 8 cm of small bowel

as it has been conclusively proved that they cannot adapt to enteral feeding despite prolonged periods of TPN.

Nutritional Assessment

While the indication for TPN may be self-evident in the majority of the patients, it is recommended to have some form of assessment of the nutritional status of the patient prior to institution of TPN in order to plan the treatment and to formulate clear-cut therapeutic goals [4]. Traditional methods include historical, anthropometric, biochemical and immunological parameters. Pre-existing illness, a weight loss of 10%, weakness and oedema are important features in a thorough history-taking [7]. Besides obvious signs of malnutrition, triceps skinfold thickness is the most important part of physical assessment. Anthropometric assessment in the form of height-weight ratio and total body surface area gives a rather crude assessment. Serum albumin and transferrin levels are readily assessable biochemical parameters and have been extensively used in clinical practice. Retinol-binding protein and thyroxine-binding globulin also reflect visceral reserves but are rarely available clinically. Total lymphocytic count not only assesses the immunological status but is also reflective of visceral protein reserves. Immunological status can be further assessed by delayed cutaneous hypersensitivity to PPD and candida antigens. A combination of these factors is highly predictive of outcome in terms of morbidity and mortality or survival. The Prognostic Nutritional Index (PNI) is useful in predicting risk of septic complications and death :

$$\text{PNI}(\%) = 158 - 16.6 (\text{ALB}) - 0.78 (\text{TSF}) - 0.20 (\text{TFN}) - 5.8 (\text{DH})$$

Where ALB is the serum albumin in gm/dL, TSF is triceps fold thickness in mm, TFN is serum transferrin level in mg/dL, and DH is delayed cutaneous hypersensitivity. A PNI of less than 40% is associated with a low risk of complication and death in critically ill patients, while a PNI of 50% or more

is associated with a mortality of 33% [8].

Nutritional Requirements and Delivery of TPN

The delivery of TPN is via a large bore central venous catheter placed in the superior vena cava through the subclavian or the internal jugular vein. This can be done by a "cut-down", but it is much better to use one of the modern percutaneous catheter-systems, as the incidence of infection is much lower by the use of the latter technique. Strict asepsis is to be observed during the placement of the catheter. A chest radiograph should be taken prior to the commencement of feeding to confirm the position of the catheter-tip and to exclude traumatic pneumothorax, the commonest complication related to catheter placement. The catheter should be flushed with dilute heparin daily, to avoid catheter thrombosis. With proper care, a central catheter can be maintained for several days or even weeks for the delivery of TPN.

While energy requirements can be calculated by the Harris-Benedict equation or the Long's modification of the same [9], in practice the institution of TPN is not so complicated. The therapy is now well standardized, yet it allows a fair deal of freedom to the treating physician. However, certain basic principles must be adhered to. The ratio of calories to nitrogen must be adequate (at least 100 to 150 kcal/g nitrogen) and the two materials must be infused simultaneously as there is significant decrease in nitrogen utilization if they are infused at different times. The entire TPN requirement for the day should be constituted in the hospital pharmacy under strict aseptic conditions. The basic solution should contain 20% to 25% dextrose and 3% to 5% crystalline amino acids from the commercially available kits/solutions. Lipid emulsions are not only an important source of energy, but also prevent development of essential fatty acid deficiency. While there are several special formulations available for specific clinical situations, an outline of basic TPN solution is given below [10].

Fluid requirements : 100 mL/kg body

weight for the first 10 kg, 50 mL/kg for next 10 kg and 20 mL/kg for each additional kg of body weight. Compensations should be made for additional losses e.g., from a fistula.

Calories : Glucose is the major carbohydrate which supplies calories, and this is administered in the form of 25% or 50% solution. Total energy requirement may vary considerably between 2000 to 4500 or more calories daily.

Fats : In order to avoid essential fatty acid deficiency at least 4% of calories should be supplied as fats.

Proteins : Protein requirement varies from 1.5 to 2.5 g/kg of body weight per day. The ratio of nitrogen to calories should be 1 : 100-150. Branched-chain amino acids have been recommended as an integral part of TPN. However their benefits have so far not been conclusively proved.

Electrolytes : Daily maintenance requirements of sodium are 1-1.5 mEq/kg; potassium 1 mEq/kg; chloride 1.5 - 2 mEq/kg; calcium 0.2 mEq/kg and magnesium 0.35 - 0.45 mEq/kg.

Micronutrients : Trace elements are an important component of TPN. Zinc 5 mg, copper 1 mg, chromium 10 mcg, manganese 0.5 mg and iron 1-2 mg are required daily.

Vitamins : Vit K-1 10 mg and folic acid 5 mg should be administered intramuscularly once a week. Vit B-12 1 mg is given once a month. Water soluble vitamins should be given daily.

Nutritional monitoring : It is recommended that the following parameters be measured daily during TPN : Body weight estimation; 12-hourly intake-output chart; 8-hourly urine-sugar estimation; serum sodium, potassium, bicarbonate, calcium and chloride; blood urea and serum creatinine. Liver function tests and serum proteins should be measured twice daily.

Complications

TPN is a highly sophisticated technique and is not free from complications. These relate to the use of a central venous catheter

or to TPN itself [11].

<i>METABOLIC</i>	<i>CATHETER RELATED</i>
Hyperglycemia	Pneumothorax
Hypoglycemia	Haemothorax
Metabolic acidosis	Cardiac arrhythmia/ tamponade
Fatty acid deficiency	Haemorrhage from subclavian artery
Vitamin deficiency	Air embolism
Trace element deficiency	Line sepsis/tract abscess/septicemia
Cholestatic jaundice	Catheter thrombosis

TPN in Special Situations

TPN in Paediatric Practice

Helfrick and Abelson first reported the possibility of complete intravenous nutrition in an infant with Hirschsprung's disease in 1944 [12]. The indications of TPN in the paediatric age-group have been outlined earlier. Silicone catheters can be placed via the external or internal jugular vein, the anterior facial, cephalic or the femoral veins [13]. Use of umbilical vein for TPN is currently not recommended because of high rate of serious complications associated with its use. Remarkable results have been obtained by use of TPN in children with short bowel syndrome. Further challenges include devising techniques to reduce catheter sepsis, cholestasis and osteopenia associated with its use [14].

TPN in Cancer Patients

The role of TPN in cancer patients is still a matter of controversy [6], and the initial enthusiasm for adjunctive nutritional support in cancer patients has waned in the past decade. Malnutrition is associated with decreased immunocompetence and energy, and it constitutes a major source of mortality and morbidity in the patient with neoplastic disease. However, current recommendations state that TPN should only be used where malnutrition may jeopardize successful delivery of a therapeutic option e.g., chemo- or radiotherapy [4]. It should not be used in a terminally ill patient where death is inevita-

ble. The question of feeding or suppressing the tumor by supplementing the micronutrients remain unanswered [15].

TPN in the Indian Setting

TPN has been used in India since 1980 [16]. However there is a dearth of published articles regarding its use. It has been used as an adjunctive treatment in the management of enterocutaneous fistulae [16] and in the paediatric patients [17]. The ingenuity of Indians for improvisation notwithstanding, the cost of TPN in India is indeed prohibitive. Though it has been stated that one day's TPN in India may cost as little as Rs 275 [16], a more realistic figure is around Rs 1500 per day. 25% glucose, Hermin and Intralipid still form the backbone of TPN in India.

Demonstrated Efficacy of TPN in Some Common Disorders

A dramatic decrease in the mortality and increase in healing rate has been shown in patients with enterocutaneous fistulae [18,19]. Abel and co-workers have demonstrated decreased urea appearance, earlier diuresis and a statistically significant improvement in survival in patients with surgically related renal failure treated with TPN [20]. It is now common for patients with short bowel syndrome, who would otherwise almost certainly have died, to survive 10 years or longer on home TPN [21]. No randomization has been undertaken, but these patients have no alternative. A prospective randomized trial has shown improved survival, improved immunologic protein synthesis and improved neutrophil function in children with major burns receiving high protein parenteral nutrition [22]. Improved survival was also seen in patients with hepatic failure given aggressive parenteral nutritional support [23]. Although no conclusive case had yet been made for the use of TPN prior to major operations [24], yet the Veterans Administration multicenter trial has identified a sub-group of malnourished patients with greater than 15% body weight loss where preoperative TPN reduced the septic complications and mortality [25].

Conclusion

TPN is currently used as a primary or adjunctive therapy in a wide variety of clinical situations. Advances in catheter delivery systems have made it technically a fairly safe procedure. Nutritional support is rapidly evolving into the practice of clinical biochemistry. Home TPN is now possible in selected patients. Arresting and reversing atherosclerosis by specially formulated amino acid solutions has been recently reported. Further developments would include further reducing TPN-related complications, and formulating special solutions for specific clinical situations.

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