REVIEW ARTICLE

A REVIEW OF LITERATURE ON MODERN PARENTERAL NUTRITION

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DOI: 10.5455/ijmsph.2013.030920131 **Received Date: 02.09.2013** **Accepted Date: 03.09.2013**

ABSTRACT

Appropriate nutritional support is the standard of care for hospitalized patients. Total parenteral nutrition has evolved as a distinct therapeutic reality within the past decade for patients with appropriate indications including but not limited to non/dysfunction of the gastrointestinal tract. Starvation/malnutrition historically associated with prolonged hospital stay and protracted illness course can be somewhat addressed successfully. Though it is a well-established fact that current TPN techniques can be both safe and effective if used with due caution, the prevention and awareness of potential complications must be considered. Changes in technique are to be anticipated as advancement of knowledge and improvement and innovation in materials ensues. The current effectiveness and safety of TPN, particularly in comparison to enteral feeding and the clinical situations most appropriate for nutrition support have been the topic of ongoing discussion. Innovative strategies such as supplementation of TPN with medium-chain triglycerides, glutamine or branched-chain amino acids have been compared with standard treatments. Increasing efforts are being made to mitigate the adverse effects associated with TPN such as hyperglycaemia, central venous catheter infection, and hepatic dysfunction. This review focuses on these issues as addressed by the recent literature.

Key-Words: Malnourished; Hyperglycaemia; Hepatic Dysfunction; Refeeding Syndrome

Introduction

The incidence of malnutrition in hospitalized patients is common and is associated with increased morbidity and mortality. It is estimated that greater than 40% of all patients are seriously malnourished at the time of admission[1] and are at risk (up to 65%) of becoming malnourished during their hospitalization[2]. In particular, critically ill patients admitted to the intensive care unit (ICU) are more prone to suffer from the adverse effects of malnutrition such as diminished ventilatory drive, reduction in immune function and increased length of stay.[3-5] Additionally, the delay at onset of nutritional therapy can impede the regenerative capacity of the patient and ultimately increase the risk of adverse outcomes. Research suggests that initiating early nutritional support within the first 48 hours of hospital admission is advantageous for improving wound healing, reducing sepsis and preventing progression on the SIRS index, and decreasing the catabolic response to injury or illness.[3-6]

The route of nutritional support facilitates varying medical circumstance and the decision has direct outcome influence on clinical prognosis in medical and surgical patients with multiple comorbid factors. For those patients who cannot safely consume an oral diet and/or who do not have a functional gastrointestinal tract, parenteral nutrition (PN) therapies should be considered as an adjunctive therapy to prevent prolonged starvation. Parenteral nutrition is well considered in post-surgical with Nil Per Os status, as well as a variety of medical conditions including gastrointestinal inflammation or dysfunction, amongst a host of other indications for initiation of parenteral nutritional therapy.[2,7,8]

Parenteral Nutrition

Parenteral nutrition entails infusion of intravenous nutrients (macronutrients and micronutrients) to patients who have contraindications to an oral dietary approach. Though the concept of parenteral nutritional may significantly predate, a modern concept of PN was developed in the 1960's, developed as intravenous hyperalimentation and often infused centrally into

internal jugular or subclavian veins, and was called Total Parenteral Nutrition (TPN). PN administered into a peripheral vein is called Peripheral Parenteral Nutrition (PPN). An assortment of PN solutions can be compounded to contain specialized mixtures of amino acids, dextrose, lipid emulsions, electrolytes, vitamins and minerals and administered intravenously to provide a source of total and complete nutrition. Hemodynamic stability is a major consideration, just as the ability to compensate for the fluid volume necessary to provide macro and micronutrient intake in patients with central or peripheral vascular access.[9]

Mechanism

An electronic, computerized mechanical pump is employed in the governance of the fluid dispensation into the central line. For use at home, pumps are available that allow TPN administration, usually with the preparation which operate on an external dispensing line (part of a single-use dispensing cassette) which is in turn connected to the patient via a valve on a semi-permanent attached venous port. Because access is open to the central venous system, standards of sterility need close attention and a high index of suspicion required for onset of fever, tachycardia, drop in blood pressure, or other clinical indications towards progression up the SIRS scale. Patients on TPN may frequently have multiple comorbidities and have indwelling catheters, and other sources for sepsis. The use of a rechargeable battery and a portable component pack allows a convenient household mobility for many patients during administration periods which may be as high as twelve to sixteen hours daily.[10]

Indications and Duration of Utility

Total parenteral nutrition has multiple indications. It is indicated in comatose patients lacking the mental or cognitive capacity for oral nutritional intake. It is also for use in patients without adequately functioning gastrointestinal tract or for those requiring complete bowel rest including bowel obstruction, short bowel syndrome, gastroschisis, prolonged diarrhea regardless of its cause, high output fistula, severe Crohn's disease or ulcerative colitis, and paediatric disorders including congenital anomalies and necrotizing enterocolitis.[9,10] Short-term PN is considered less than 1 week and is generally recommended in individuals with gastrointestinal pathologies necessitating parenteral feeds, for instance obliterative or sclerosing peritonitis. Long-term parenteral nutrition entails greater than two weeks, and is used to sustain patients with extended or protracted health conditions including but not limited to trauma, surgery, or in paediatric instances of underdeveloped or deformed organogenesis.[10]

Potential Complications

Parenteral nutrition has benefited from considerable advancement over the past fifty years when clinical data demonstrated that glucose infusions with amino acid in postsurgical patients minimized protein loss and muscle degeneration.[12] In consideration of this knowledge and general medical and technological advancement, the surgical community frequently practiced parenteral feeding techniques in patients, oftentimes with the sole intention of boosting nutritional status and replenishment or maintenance of macro and micronutrient levels to encourage physiological homeostatic mechanisms. Ease of administration facilitated its use, assuming adherence to specific criteria and evidence based practice guidelines. The overuse of parenteral feeding became apparent when newer data demonstrated minimal nutritional benefit in well-nourished patients, which sharply contrasted with potentially high risks of adverse outcomes and therapeutic misadventure involved with patients receiving hyperalimentation.[12] Adverse complications of parenteral nutrition were discovered to include incidence of infections, postoperative wound complications, gastrointestinal bleeding, immune compromise, fluid/electrolyte imbalances and lack of research to support initiating early parenteral nutrition.[8]

Potential Risks

Bacterial Translocation

Multiple animal studies have shown that underuse

of the gastrointestinal tract can facilitate villous atrophy and bacterial translocation. Xu et al. demonstrated that TPN administration promoted bacterial translocation to the mesenteric lymph nodes and reduced immune cell circulation in animal models. Suppressed numbers of T and B cells which in turn result in diminished immune response has also been reported with use of total parenteral nutrition.[13] Similar studies with animal models have been repeated multiple times suggesting that in patients with functional gastrointestinal tracts, enteral routes of nutrition which retain the element of gastrointestinal stimulation should be preferred over parenteral nutrition support. However, controlled human trials documenting the veracity of this phenomenon in human physiology are needed.[14]

Nosocomial Infections

Over 200,000 nosocomial bloodstream infections are reported annually in the United States and approximately 35% of those are associated with central venous access devices, such as those used to deliver parenteral nutrition.[15] Mortality rates from catheter sepsis reach 15% in many cases.[2,15] Additionally, metabolic complications induced by the administration of parenteral nutrition can allow bacterial proliferation and progression to sepsis. Parenteral nutrition management requires thorough assessment and close monitoring of lab investigation values and clinical signs prior to initiation of, and during PN administration. Despite the fact that many of these infections could be attributed to other factors such as hand-washing compliance, catheter materials, catheter placement, and infection control programs, the tendency to prefer therapies utilizing non central, non-venous access usage is in progress.[15] In a randomized prospective study comparing the effects of early enteral versus early parenteral approaches in trauma patients during the first 15 days of hospitalization, Kudsk et al. found parenteral administration was associated with a staggering eleven-fold increase in the risk of infection (15% infections in EN group versus 66.7% in the PN group). The enteral group experienced less septic morbidity, defined as pneumonia, intra-abdominal abscess, and empyema or line sepsis. Only three of 15 enterally fed patients developed more than one infection, whereas fourteen of fifteen parenterally fed patients developed more than one infection. Additionally, those with blunt injuries had a higher infection rate if fed parenterally (60% versus 18.8% in the EN group). EN patients with penetrating wounds developed significantly fewer septic complications than did PN patients where the risk of infection increased 3.6 times in the PN group.[16]

Refeeding Syndrome

One of the dreaded complications of parenteral modalities involves introduction of refeeding. Refeeding of moderate to severely malnourished patients may result in “refeeding syndrome” which presents as a clinical constellation of fluid, micronutrient, electrolyte and vitamin imbalances. It is potentially life threatening and can affect nearly every organ system, specifically causing cardiac arrhythmias, heart failure, acute respiratory failure, coma, paralysis, nephropathy and liver dysfunction. The underlying mechanism of refeeding syndrome is the metabolic shift from stored body fat to exogenous carbohydrate as the primary fuel source. As serum insulin levels rise with carbohydrate feeding, a rapid shift of electrolytes from the extracellular to the intracellular spaces can result in potentially fatal hypophosphatemia, hypomagnesaemia and hypokalemia. Risk factors for refeeding syndrome include alcoholism, anorexia nervosa, marasmus, overaggressive parenteral feed advancement, excessive dextrose infusion, and notably recent malnutrition status clinically indexed by recent history of weight loss or cachexia.[2]

Many recent reviews have indicated that the use of parenteral modalities in earlier years was detrimental secondary to the risks of overfeeding rather than due to any risk inherent in the parenteral route itself.[12,19] The adage that "if some nutrition is good, then more must be better," resulted in excessive peripheral infusion of macronutrients, which is easy to accomplish in comparison to enteral or oral nutrition. One study found that the total energy intake equated to approximately 46 calories per kilogram body weight (kcal/kg) when infused peripherally. This was deemed excessive in comparison to similar patient populations who orally consumed food

without restriction, and only consumed approximately 20 kcal/kg in a twenty-four hour period.[19] Overfeeding the critically ill patients can be harmful by producing metabolic disturbances such as hyperglycaemia, hypertriglyceridemia (a rise of > 50 mg/dL) and hypernatremia.[12] Therefore, concentrations of macronutrients in PN solutions need formulaic calculation in order to avoid overfeeding and increase risks of refeeding syndrome when advanced too rapidly.

Hyperglycaemia is common in the stressed state and is associated with adverse outcomes in critically ill patients. Patients with elevated blood glucose levels show higher mortality rates than those with normal blood glucose levels, particularly in stroke and myocardial infarction.[20] Cheung et al (2005) found that even a relatively modest level of hyperglycemia (>140 mg/dL) is associated with adverse outcomes despite a history of diabetes mellitus prior to hospitalization. Frequently observed adverse outcomes noted include cardiac complications, infections, systemic sepsis, renal failure and death. Patients with serum glucose levels in the highest quartile (>163 mg/dL) had 10.9 times greater risk of mortality than those in the lowest quartile of glucose range. Prolonged durations of TPN employment resulted in protracted hospitalization courses and augmentation of risk of adverse outcome. In cognizance of the fact that even one incidence of hyperglycemia might be detrimental to clinical outcomes, insulin regulation and close attention to dextrose in TPN must be closely monitored so as not to overestimate dextrose infusion rates in the critically ill patient.[20]

ASPEN Guidelines for Parenteral Nutrition

The American Society for Parenteral and Enteral Nutrition (ASPEN) has published widely accepted clinical practice guidelines regarding pre and postoperative patients and use of parenteral support. The following three guidelines have been endorsed by ASPEN regarding parenteral nutrition: "preoperative nutrition support should be given for 7 to 14 days to patients with moderate to severe protein calorie malnutrition who are undergoing major gastrointestinal surgery; TPN should not be given during the immediate postoperative period to patients who have undergone major gastrointestinal surgery; nutrition support should be given to patients who will be unable to eat 7 to 10 days postoperatively."[2,7]

Conclusion

Because of associated risks, overfeeding of PN can be mitigated by guidelines, and standardized calculation guidelines, stepwise progression of macronutrients and close observation and rapid response to daily laboratory data to avoid unfavorable complications. Parenteral techniques can be used to deliver adequate nutrition safely to critically ill patients, especially in the presence of malnutrition.[11,14,17,18] PN is still considered superior than prolonged NPO status.[4] Parenteral nutrition is not recommended for critically ill patients with intact gastrointestinal tracts, representing greater than 90% of the ICU population. In such case, enteral feeding is deemed preferable over parenteral nutrition.[12]

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Cite this article as: Arya IN, Shah B, Arya S, Dronavalli S, Karthikeyan N. A review of literature on modern parenteral nutrition. Int J Med Sci Public Health 2013; 2:801-805.
Source of Support: None
Conflict of interest: None declared