Review Article

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Total Parenteral Nutrition

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Abstract

Total parenteral nutrition is a medication used to manage and treat malnourishment. It is in the nutrition class of drugs. Parenteral nutrition (TPN) is when the intravenous administered nutrition can serve as the main source of nutrition and also as a supplementary nutrition if the patient is not having adequate nutrition. This articlehighlights the composition, initiation, indications, contraindications, complicationsof total parenteral nutrition as a valuable agent in managing malnourishment.

Keywords: Total Parenteral Nutrition, Initiation, Composition, Indication, Monitoring, Complication.

INTRODUCTION

Parenteral nutrition support refers to the provision of calories, amino acids, electrolytes,vitamins, minerals, trace elements, and fluids via a parenteral route. Access, prescribing,monitoring, and complications of parenteral nutrition are discussed. Parenteral nutrition is a mixture of solutions that contain dextrose, amino acids,electrolytes, vitamins, minerals and trace elements.[1,2] The initiation, composition, indications, contraindications, monitoring, complications ofparenteral nutrition are discussed in this review article.

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MATERIALS AND METHODS

This study was conducted in the Department of Plastic Surgery in a tertiary care institute. It is a review article based on the study of literature available in Scopus, PubMed, Google scholar & open sources. Inclusion criteria for selecting articles was to include only articles published at least in peer reviewed indexed journals about Parenteral Nutrition.

RESULTS

Based on the inclusion criteria 38 articles were studied to discuss Total Parenteral nutrition under following headings:

1. Initiation of Parenteral Nutrition
2. Composition of Parenteral Nutrition
3. Indications and Contraindications
4. Vitamins and Trace elements
5. Monitoring
6. Complications

DISCUSSION

Initiation of Parenteral Nutrition

In order to initiate parenteral nutrition, appropriate access must be obtained and the prescription (i.e., composition and infusion rate) must be determined. Guidelines suggest that when tolerance to enteral nutrition is evident, parenteral nutrition should be weaned and discontinued when >60 percent of the patient needs are met enterally.[1]

Our practice is to wean parenteral nutrition proportionate to the amount of enteral nutrition being delivered, thus meeting but not exceeding the daily goals. For ease of calculation, most standard Parenteral Nutrition solutions contain approximately 1 kcal/ml.

Venous Access

Parenteral nutrition given for more than a few days must be delivered via a central venous catheter, so called central parenteral nutrition (CPN) because its high osmotic load is not tolerated by peripheral veins.[2,3] Parenteral nutrition may be given via a peripheral vein if it is significantly more dilute (<900 mOsm), so called peripheral parenteral nutrition(PPN). Because of the ease of obtaining central access in the hospital, the large volume usually required to administer PPN, and the lack of benefit from short-term parenteral nutrition, PPN is rarely indicated.

Choosing among a peripherally inserted central catheter (PICC) or a tunnelled central venous catheter ([TCVC]; also referred to as TICC, eg, Hickman catheter, Groshong catheter, or implanted infusion port) should be individualized and depend upon duration of need for Parenteral Nutrition, local expertise, ability of the facility or individual to take care of the device, and presence of other risk factors for catheter-related blood stream infections (CRBSI)

The American Society for Parenteral and Enteral Nutrition (ASPEN) has issued clinical guidelines to describe best practices in the selection and care of central venous access devices (CVADs) for the infusion of home parenteral nutrition in adult patients.[4] ASPEN guidelines use an arbitrary cutoff of 30 days to distinguish short-term from long-term Parenteral Nutrition use.

- The patients in whom short-term administration of PN is desirable or intended that PN be delivered through a PICC. Alternatively, while not preferable, PN may be administered through a subclavian, internal jugular, or femoral central venous catheter if PN is only needed for very short periods (eg, a few days) or if a PICC is not feasible or reasonable. Tradition teaches that the femoral site is least desirable due to an increased risk of CRBSIs [5], and is usually not preferred.
- For long term administration of PN, A.S.P.E.N. guidelines indicated a preference for atunnelled central venous catheter (TCVC). The rationale for this choice is based upon expert opinion and observational studies that suggest infection rates may be lower with TCVC.[6-9] In fact, one systematic review suggested that rates were no different between PN delivered through a PICC compared with a TCVC.[6,7]
- When possible, a single lumen central venous catheter should be used for the infusion of parenteral nutrition. If a multiple lumen central venous catheter is used it should have one port dedicated solely for the infusion of parenteral nutrition. In addition, catheter manipulations should be minimized. These precautions may decrease the infectious complications associated with parenteral nutrition.[10,11] For patients who have an existing CVC, a new CVC is not typically required unless there has been septicaemia during the life of the existing line.
- The Institute for Safe Medication Practices (ISMP) has listed Parenteral nutrition as a "high alert medication," in the same category of complexity and potential for error or harm as chemotherapy. Guidelines that describe safe practices for parenteral nutrition have been published by professional organizations.[11-15] These recommend that parenteral nutrition be prescribed by a multidisciplinary team of physicians, nutritionists, pharmacists, and nurses.

Parenteral nutrition should not be prescribed by clinicians nor compounded by pharmacists without specific training because it is complicated and requires advanced knowledge about issues such as nutrient metabolism and solute compatibility.[14,15]
Composition of Parenteral nutrition

Parenteral nutrition is an admixture of solutions containing dextrose, amino acids,electrolytes, vitamins, minerals, and trace elements. Lipid emulsion may be infused separately or added to the mixture. However, mixing all three, a so-called total nutrient admixture, or 3-in-1 parenteral nutrition, is favoured by most experts.[16] The exact composition and infusion rate are tailored to the nutritional and

fluid needs of each patient.

Dextrose

Dextrose-containing stock solutions are available in a variety of concentrations, most commonly 40, 50, and 70 percent. The percentage of calories that is contributed by dextrose is titrated according to individual factors, such as severity of illness, the caloric needs of the patient, and the patient's ability to tolerate fluid volume.The caloric contribution of dextrose in medical solutions is 3.4 kcal/gm, which differs from dietary carbohydrate (4 kcal/gm). The reason for the difference is that water contributes to the weight of the dextrose-hydrate that is used to prepare parenteral nutrition.

Amino Acids and Electrolytes

- Amino acid solutions contain most essential and nonessential amino acids. The exceptions are arginine and glutamine. While these are thought to be conditionally essential in critical illness, due to blockade of their metabolic pathways in catabolism, research does not support their supplementation. The caloric contribution of amino acids is approximately 4 kcal/gm. The buffer used in amino acid solution contains electrolytes, usually in small quantities.
- Amino acid solutions with large amounts of electrolytes have been used infrequently. Premixedparenteral nutrition with a variety of available electrolyte content are available. It is occasionally necessary to use amino acid solutions with further electrolyterestriction (usually these are 15 percent amino acid solutions), particularly in patients withrenal failure when electrolytes, particularly phosphate levels, are difficult to control.
- The amino acid stock solutions come in concentrations ranging from 5.5 to 15 percent. Higher concentrations are useful for minimizing volume and electrolytes delivered to patients.
- Branched chain amino acid-enriched parenteral nutrition to standard parenteral nutrition found a trend toward decreased mortality among patients who received branched chain amino acids.[17]

Lipids

Lipids are provided as an emulsion that may be infused separately or added to the mixture (total nutrient admixture [TNA] or three-in-one). Most lipid emulsion consists of long-chain omega-6 triglycerides derived from soybean and safflower oils and then emulsified using egg phospholipids and glycerine. Mixtures of several types of lipids like refined olive, soybean, and fish oil emulsionshave been approved and are also available for use.[18-22]

- Omega-6 fatty acids, omega-3 fatty acids are metabolized to mediators that are noninflammatory and anti-inflammatory. Manipulation of the inflammatory process has been of strong interest in the nutrition support, as it is the cause of disease-related wasting. omega-3 fatty acid-enriched parenteral nutrition was associated with a 40 percent lower risk of infection and 56 percent lower risk of sepsis compared with patients receiving standard parenteral nutrition without omega-3 fatty acid enrichment.[23] Hospital and ICU length of stay was also lower in the fatty-acid enriched group.
- The caloric contribution of a typical lipid emulsion is 10 kcal/g or 2 kcal/mL in 20 percent emulsion and 11 kcal/g or 1.1 kcal/mL in 10 percent emulsion. Dietary fat provides 9 kcal/g, but there is a contribution of calories from the emulsifiers used to create the lipid suspension for intravenous administration. Intravenous fat emulsions should be given with care to patients with prior allergy to eggs. Egg phospholipid is used to emulsify the triglycerides in intravenous fat emulsions and allergic cross-reactions have been rarely reported.
- Cautious initiation of Intravenous lipid emulsions (ILE) has been recommended when serum triglycerides exceed 200mg/dL (eg, infuse lipid emulsion three times weekly). Severe hypertriglyceridemia and other severe disorders of lipid metabolism are a contraindication to lipid emulsion infusion(eg, serum triglycerides >1000 mg/dL due to pathologic hypertriglyceridemia, lipoid necrosis, acute pancreatitis accompanied by hypertriglyceridemia, disorders of fat metabolism).

Peripheral Parenteral Nutrition

Peripheral parenteral nutrition (PPN) is prescribed when short-term parenteral nutrition is required. It is a type of parenteral nutrition that can bedelivered for short periods through a peripheral intravenous catheter because it has anosmolarity lower than that of conventional parenteral nutrition (<900 mOsm). To deliveradequate nutrients, either a

large volume and/or a high fat formulation must be used. Frequent replacement of intravenous access is usually necessary. Despite an osmolaritylower than conventional parenteral nutrition, PPN is still quite hyperosmolar and irritating tothe peripheral veins causing thrombosis and stenosis of the veins.

Indications and Contraindications

The indications and contraindications for parenteral nutrition are described.

Indications

- Chronic intestinal obstruction as in intestinal cancer
- Bowel pseudo-obstruction with food intolerance.
- TPN can also be used to rest the bowel in cases of GI fistulas with high flow
- When an infant's gastrointestinal system is immature or has a congenital gastrointestinal malformation
- When there is a post-operative bowel anastomosis leak
- When the patient is unable to maintain nutritional status due to severe diarrhoea or vomiting
- Small bowel obstruction
- Hypercatabolic states due to sepsis, polytrauma, and major fractures
- An anticipated period of nothing by mouth (NPO) status greater than seven days as in patients with inflammatory bowel disease exacerbations as well as critically ill patients

Contraindication

- Infants with less than 8 cm of the small bowel
- Irreversibly decerebrate patients
- Patients with critical cardiovascular instability or metabolic instabilities; such instabilities require correction before administering intravenous nutrition.
- When gastrointestinal feeding is possible
- When the nutritional status is good, only short-term TPN is needed
- The lack of a therapeutic goal, as TPN should not be used to prolong life when death is unescapable.

Vitamins and trace elements

Patients receiving parenteral nutrition must receiveadequate vitamins and minerals to prevent deficiencies. For most patients, a unit dose of astandard multivitamin and multi-trace element solution will suffice to provide minimum dailyrequirements.There are also concerns about clearance of some vitamins in patients. Monitorlevels of vitamins and minerals if patients are on parenteral nutrition for extended periods.[24]

Therapeutic Vitamin and Mineral Supplementation

It is not our practice to supplementvitamins and minerals above the recommended daily amounts, unless a deficiency isdocumented or strongly suspected. Rather, a deficiency occurs only when a lack of a substance causes an undesiredhealth outcome that is reversed or prevented by supplementation.

- Levels ofvitamin D, which is protein bound, drop in critical illness. But even though there is acorrelation between vitamin D levels and ICU mortality, supplementation of vitamin D has noeffect.[25,26] The decrease in vitamin D levels is due to the decrease in carrier proteinlevels, much in the same way a decrease in albumin lowers calcium levels.
- Antioxidants on critically ill patientswhen given as single nutrients (eg, selenium) or as a combination of nutrients (selenium,copper, zinc, vitamin A, vitamin C, vitamin E, and N-acetylcysteine) is beneficial. The trials administeredthe antioxidants in various ways, including as a separate intravenous infusion, as acomponent of parenteral nutrition, as a component of enteral nutrition, and orally.Critically ill patients whoreceived vitamins and trace elements, either alone or in combination, had a lower mortalityrate than patients who did not receive vitamins or trace elements.[27]
- Given their safety, it seems reasonable to provide standard doses of vitaminsand trace elements to most critically ill patients, regardless of the type of nutrition supportthat they are receiving. The optimal mixture of vitamins and trace elements is yet to bedetermined.

Glutamine

Glutamine is a precursor for nucleotide synthesis and an important fuelsource for rapidly dividing cells, such as gastrointestinal epithelia. Despite evidence that indicates that parenteral glutamine may be beneficial to patients who

are receivingparenteral nutrition,[28-30] Glutamine supplementation in critically ill patients associated with increased 28-day mortality in those receiving glutamine-enriched enteral nutrition was reported.[31]

Monitoring

Routine monitoring of parenteral nutrition includes measurement of fluid intake and output,as well as selected laboratory studies. It is reasonable to measure serum electrolytes,glucose, calcium, magnesium, and phosphate daily until they are stable, or more frequentlywhen the patient is at high risk for or exhibiting refeeding syndrome.[32]

- Intake and output 12-hour charts
- Urine sugar monitoring every 8 hours
- Serum electrolytes: daily sodium, potassium, bicarbonate, calcium, and chloride values
- Serum creatinine and blood urea daily values
- Serum protein levels twice daily
- Liver function tests twice daily

It is similarlyreasonable to measure aminotransferases, bilirubin, and triglyceride at least once each weekduring treatment. More frequent measurements should be performed in the periodimmediately after parenteral nutrition is initiated, or after changes in the composition. Triglyceride levels should be measured at baseline and once PN has been initiated, thenmonthly or more frequently if elevated. We measure trace elements, including iron,approximately every three months, or if deficiency is suspected. Frequency of monitoringshould be adjusted to the individual patient's acuity, stability, and risks for deficiencies.

Complications

Patients who receive parenteral nutrition support are at risk for infection, adverse metaboliccomplication, and complications related to venous access.

Venous Access

Parenteral nutrition requires venous access, which is associated withpotential complicationsinclude bleeding, vascular injury, pneumothorax, venousthrombosis, arrhythmia, and air embolism.

Bloodstream Infection

Access to the central venous system is necessary when Parenteral Nutrition is given. Parenteral Nutrition is typically administered through a peripherally inserted centralvenous catheter (PICC) or a tunnelled central venous catheter (TCVC).Patients receiving parenteral nutrition are at slightly increased risk of acquiring abloodstream infection (bacterial and fungal; approximately one episode per 100 inpatient Parenteral Nutrition days.[32,33]

Among patients receiving parenteral nutrition, factors that are independently associatedwith bloodstream infection include poor patient hygiene, insertion of the central venouscatheter under emergent circumstances, and, to a lesser extent, the severity of illness andduration of central venous catheterization.[34] Conversely, proper hand hygiene andmaximal barrier precautions during insertion of the central venous catheter are associatedwith fewer bloodstream infections.[34]

Metabolic Effects

Parenteral nutrition is associated with metabolic complications,including hyperglycemia, serum electrolyte alterations, macro- or micro-nutrient excess ordeficiency, refeeding syndrome, [35] Wernicke's encephalopathy,[36] and hepaticdysfunction.

Routine monitoring of serum glucose, electrolytes, and volume status mayminimize the impact of such complications.

- Hyperglycaemia is particularly common among patients who receive parenteral nutrition. Theincidence of hyperglycaemia was approximately two times greater for patients who receivedparenteral nutrition than patients who received enteral nutrition.[37]
- Refeeding syndrome is a potentially fatal condition resulting from rapid changes in fluidsand electrolytes when malnourished patients are given oral, enteral, or parenteral feedings.38Patients with ongoing electrolyte losses likediarrhoea, vomiting, fistulasare at increased risk of refeeding syndrome. It is definedprimarily by manifestations of severe hypophosphatemia including respiratory failure, cardiovascular collapse, rhabdomyolysis, seizures, and delirium, hypokalaemia, hypomagnesemia, and Wernicke's encephalopathy also occur.
- Emergent hypertriglyceridemia or worsening of existing hypertriglyceridemiamay result from the infusion of lipid emulsion. Concentrations up to 400 mg/dL areacceptable during therapy without altering the rate of lipids during therapy. Doses oflipid emulsion should be reduced when triglyceride concentrations rise above 400 mg/dl. Levels >1000 mg/dL are a contraindication to infusion.It is also reasonable to attempt decreasing the proportion ofcalories provided

by dextrose in this hypertriglyceridemia.

CONCLUSION

Parenteral nutrition should be prescribed by a multidisciplinary team with advancedknowledge about how to tailor the composition and infusion rate to the needs of eachpatient, rather than by untrained individual clinicians. Guidelines exist that describesafe practices for parenteral nutrition. For critically ill patients receiving parenteral nutrition, we suggest the inclusion ofmultivitamins and trace elements. They are typically already included as acomponent of the parenteral nutrition, in the multivitamin, and multi-trace elementsolutions that are usually given in unit doses. The optimal mixture of nutrients has notbeen determined. Routine monitoring of parenteral nutrition includes measurement of fluid intake andoutput, as well as selected laboratory studies. Patients who receive parenteral nutrition support are at risk for infection, adversemetabolic effects, and complications related to venous access.

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