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Review On Total Parenteral Nutrition

Miss. Dhonde Apeksha, Miss. Khade Shubhangi ,Mr. Purbe Sir, Mr. Dr. Kolhe S.D.

ANAND CHARITABLE SANSTHAS'S COLLEGE OF PHARMACEUTICAL SCIENCE AND RESEARCH, ASHTI.

Tal-Ashti, Dist- Beed, Maharashtra.

ABSTRACT:

Home parenteral nutrition (HPN) support has been an advancing therapy in the past 30 yearsAbout 25 years ago it became apparent that TPN had value in the management of critically ill patients who were not being normally nourished because they either had gastrointestinal failure or could not tolerate the enteral preparations offered. Total parenteral nutrition (TPN) is a type of medication that provides nutrition to critically ill patients for whom enteral feeding is not possible. 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. TPN administered protein, fats, carbohydrates, vitamins and minerals. TPN plays a vital role in the growth and development of preterm neonates in NICU to provide micro nutrients, macro nutrients and electrolytes. TPN has extended the life of a small number of children born with non-existent or severely birth-deformed guts. Parenteral nutrition plays a major role in treating COVID-19 infection-related malnutrition in patients across the globe. 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.

KEYWORDS:

TPN; PPN; Malnourishment; PN; NICU; COVID-19

1. Introduction:-

Definition:- It is pharmacological theraphy where nutrients, vitamins, electrolyte and medications are delivered via the venous route to those patients whose GIT is not functioning and are unable to tolerate enteral nutrition.

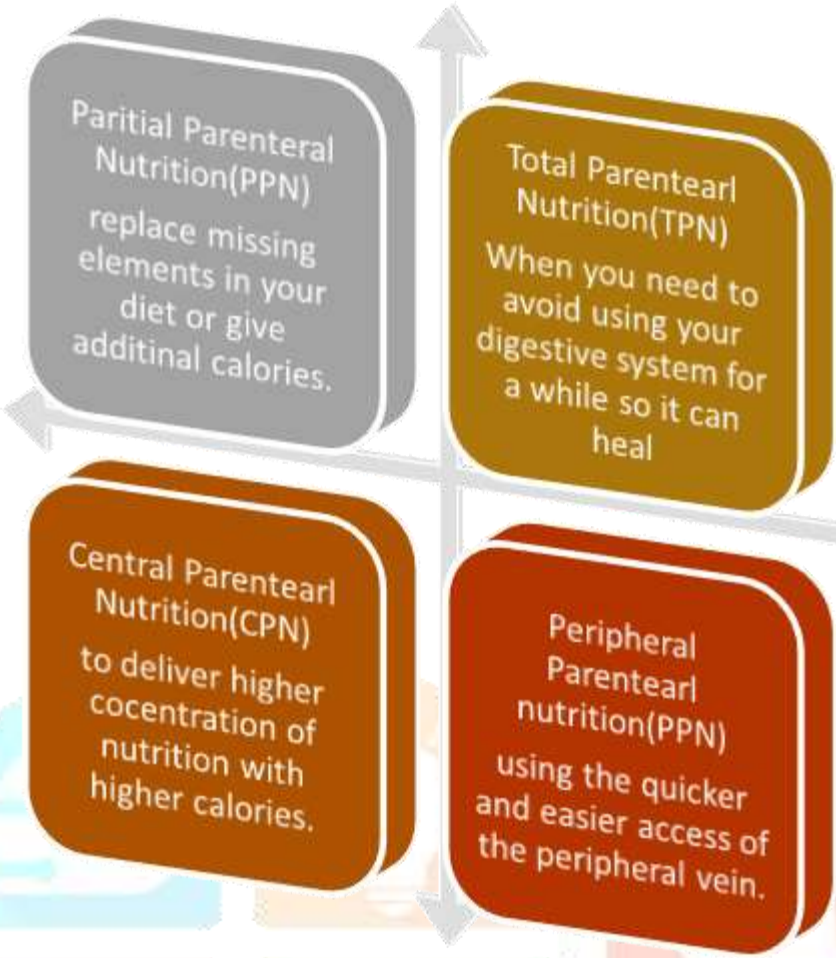
Total parenteral nutrition (TPN) is a medication used in the management and treatment of malnourishment[1]. TPN is the intravenous administration of nutrition outside of the gastrointestinal tract. TPN is given when the I.V administered nutrition is the only source of nutrition[2]. It is indicated when there is an inadequate gastrointestinal function and contraindications to enteral nutrition. Enteral diet intake is preferred over parenteral as it is more expensive and associated with fewer complications such as infection and blood clots but requires a functional GI system[3,4]. It is a special formula given through a vein that provides most of the nutrients the body needs. The method is used when someone can't or shouldn't receive feedings or fluids by mouth[5]. TPN is normally used following surgery, when feeding by mouth or using the gut is not possible, when a person's digestive system cannot absorb nutrients due to chronic disease, or, alternatively, if a person's nutrient requirement cannot be met by enteral feeding (tube feeding) and supplementation[6,7].

Total parenteral nutrition is when IV –administered nutrition is the only source of nutrition the patient is receiving. Total parenteral nutrition is indicated when there is impaired gastrointestinal function and contraindication to enteral nutrition. Various technique have been adopted for nutritional support in recent clinical studies, such as total parenteral nutrition(TPN), dual parenteral and enteral nutritional support, nasojejunal feeding nasogastric feeding, and others. The optimal route of administering nutritional support is controversial. It is long term therapy . TPN can be given to a persons who has a digestive disorder, accident, or has critical surgery. TPN is causative as it has minerals ,glucose ,and electrolytes. TPN can only be administered in larger veins near the chest or neck of the patient. TPN must be administered through a central line. The products are made by pharmaceutical compounding companies. TPN is also called central parenteral nutrition (CPN) or ‘hyperal’ (hyperalimentation). The term ‘hyperalimentation’ is misnomer because it incorrectly implies that nutrient are supplied in excess of needs. Large amounts of nutrients in hypertonic solution can be supplied via TPN . The catheter is surgically placed into the superior vena cava. The reason that larger amounts of nutrient in a hypertonic solution can be supplied via the superior vena cava than peripheral parenteral nutrition is that the superior vena cava has much diameter and a higher blood flow rate, both of which quickly dilute the TPN solution.

HISTORY

Dr. Dudrick was a 32 year-old surgical resident at the hospital of the University of Pennsylvania when the he invented TPN in 1967 alongside preeminent surgeon and then chair of the Department of surgery**, Jonathan E. Rhoads,GRM’40,HON’60**. Known as the “father of intravenous feeding”, Dr. Dudrick has been hailed as one of the most impactful physician in the history of medicine ,having invented total parenteral nutrition (TPN)- Which has been credited with saving the lives of countless millions.

2. Types of Parenteral Nutrition:-



3. Daily Basic Requirements For TPN

TPN is a mixture of separate components which contain lipid emulsion, dextrose, amino acids, vitamins, electrolytes, minerals, and trace elements[21]. The basic adult daily requirement for Total Parenteral Nutrition contains water (kg/body weight/day) 30–40 ml Energy (kg/body weight/day) 30–45 kcal as per medical, Post-operative, hypercatabolic patient condition. Amino acids (kg/body weight/day) 01–03 g[22]. Lipid emulsions are an TPN is a mixture of separate components which contain lipid emulsions, dextrose, amino acids, vitamins, electrolytes, minerals, and trace elements[21]. The basic adult daily requirement for Total Parenteral Nutrition contains water (kg/body weight/day) 30–40 ml , Energy (kg/body weight/day) 30–45 kcal as per medical, Post-operative, hypercatabolic patient condition. Amino acids (kg/body weight/day) 01–03 g. Lipid emulsions are an important component of TPN because they supply essential fatty acids and minimize the dependence on glucose as a major source of non-protein energy. Lipids provide 20–30 % of total calories. Protein requirement varies from 1.5 to 2.5 g (kg/body weight/day)[23]. The ratio of nitrogen to calories should be 1: 100–150. Branched-chain amino acids have been recommended as an integral part of TPN. Electrolytes required 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. 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[24]. different lipid

emulsion and amino acid containing TPN are generallat prepaired by many pharmaceutical companies like Fresenius Kabi, B.baun, Baxter and Eurolife healthcare, some of their TPN containing lipid (Table 1) and amino acid composition are listed in table.

Table 1. Different companies preparing Lipid emulsion containing TPN with their composition

Company Name	**FRESENIUS KABI**	**FRESENIUS KABI**	**FRESENIUS KABI**	**B.BRAUN LABORATORIES**
Product	**INTRALIPID10%(100ml)**	**Omegaven(100ml)**	**SMO Flipid20%(100ml contains)**	**Lipidem/Lipoplus (1000ml)**
Total Energy	1100kcal	112kcal	200kcal	1910kcal
Linoleic acid(omega-6)	-	0.31g	-	48.0-58.0g
Alpha linolenic acid(omega-3)	-	0.13g	-	5.0-11.0g
Soyabean oil	40.0g	-	6.0g	80.0g
Olive oil	-	-	5.0g	-
Medium chain triglycride(MCT)	-	-	6.0g	100.0g
Glycerol	22.g	-	-	-
Highly refined fish oil(omega-3 fatty acid)	-	10.0g	3.0g	-
osmolality	300(mOsm/kg)	308-376(mOsm/kg)	380(mOsm/kg)	Approx410(mOsm/kg)
osmolarity	260(mOsmol/L)	273(mOsmol/L)	290(mOsmol/L)	-

Picture				

TPN CONTENT VALUE		
Basic Adults Daily Requirements For Total Parenteral Nutrition		
Nutrient		**Amount**
Water (/kg body wt/day)	→	**30-40 ml.**
Energy* (/kg body wt/day)		
Medical patient	→	**30 kcal**
Postoperative patient	→	**30-45 kcal**
Hypercatabolic patient	→	**45-60 kcal**
Amino acids (/kg body wt/day)		
Medical patient	→	**1.0 g**
Postoperative patient	→	**2.0 g**
Hypercatabolic patient	→	**3.0 g**
Minerals		
Vitamins		
***Requirements for energy increase by 12%per 1℃ of fever.**		

ELECTROLYTE	ESTIMATED ADULT REQUIREMENT FOR PARENTEARL NITRITION (mmol)
1. Sodium	45-145
2. Potassium	30-40
3. Calcium	5-7.5
4. Magnesium	5-10
5. Chloride	Varies with acid base balance

4. Indication of TPN

TPN is indicated in situations where enteral or oral nutrition is not possible or is insufficient. The main indications for TPN in adult subjects are intestinal failure due to disease or treatment like (short bowel syndrome, inflammatory bowel diseases, intestinal pseudo-obstruction and radiation enteritis), high-output fistulas, severe intestinal obstruction, or an inaccessible gastrointestinal tract[25].

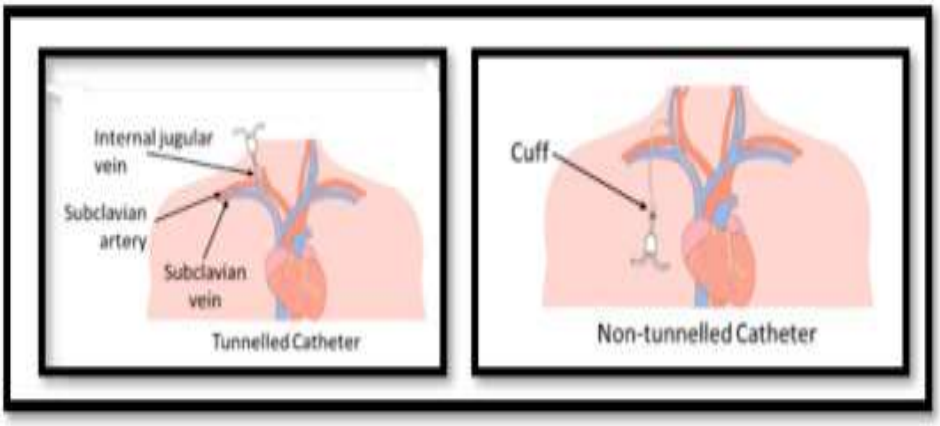
TPN has several indication. These include:

- Bowel obstruction.
- Certain paediatric GI disorders (eg , congenital GI anomalies, prolonged diarrhoea regardless of its cause)
- Short bowel syndrome due to surgery
- Crohn's Disease
- Cystic Fibrosis
- GI Tract Cancer
- Ulcerative Colitis
- Pancreatitis
- Other condition severely limiting intestinal function

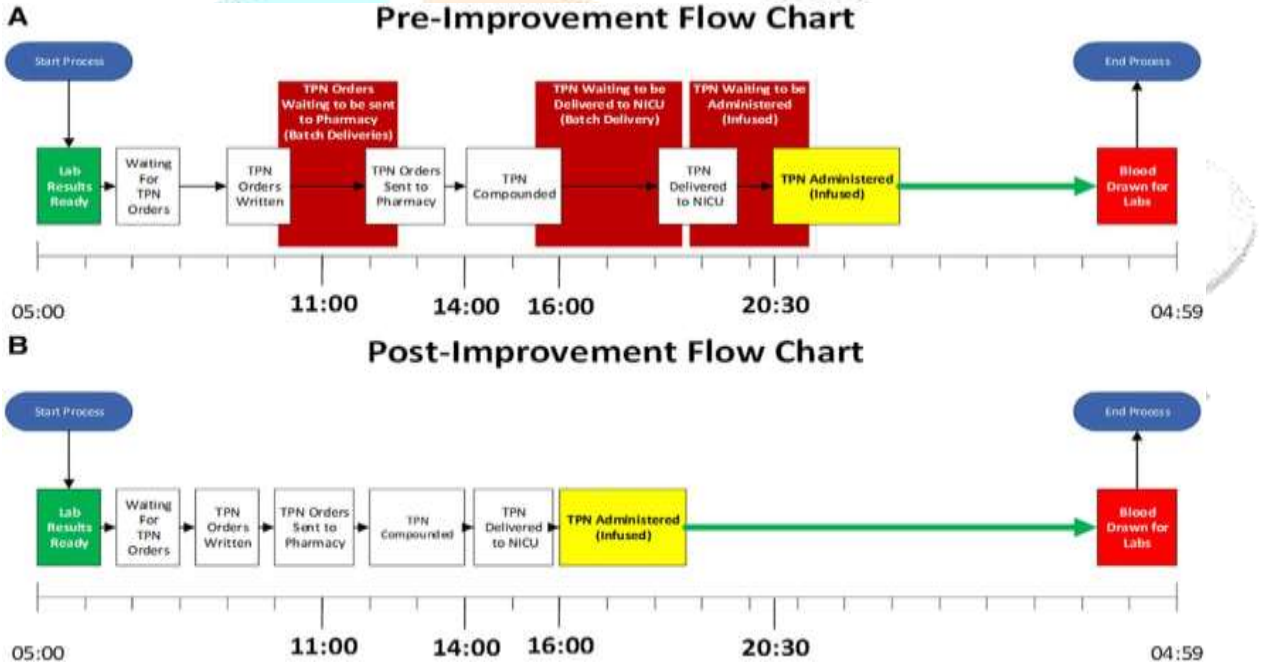
5 . Administration Procedures For TPN

Total parenteral nutrition (TPN) is delivered through a flexible tube (catheter) connected through a Huber needle directly into a vein called the superior vena cava that goes directly into the heart and the external end in attached to I.V bag containing the required nutrition[35]. During this process the patient is under heavy sedation or anesthesia is given[36]. For the temporary need for nutrition PPN, Peripheral intravenous is used instead of central line (superior vena cava). TPN is administered in a clean and sterile environment to prevent complications and lower the risk of catheter infection. TPN total time of infusion takes approx. 10 to 12 Hrs. To fully transfer from I.V bag to the human body and can be given 5–7 times a week[38]. Different types of catheters can be used for the administration of TPN are:

A tunnelled catheter such as a Hickman catheter has a segment of the tube outside the skin and another portion tunnelled under the skin before it enters the vein (see below figure). In terms of their design and structure, tunnelled catheters consist of a piece of long, thin tubing. They may have one or more lumens, or channels, via which fluids like blood and medications can flow. They also usually have a cuff, which is a small antimicrobial attachment near the entry site that helps to hold the catheter in position and reduces the risk of infection[39,40].



[39,40]



6. Monitoring required during administration of TPN

A patient who is on TPN has more chance of metabolic complication than patient receiving eternal nutrition[41]. Therefore close monitoring required comprising of the treating physician, intensives, nutritional therapist and critical care nurse should monitor the patient's nutritional status regularly on a day-to-day basis for the prevention and early detection of complications. Progress of the patient receiving TPN should be documented in flow chart in terms of bodyweight, blood counts, serum electrolytes and BUN levels, every 24 hr Patients on long-term TPN need monthly monitoring of vitamin, mineral and trace element status[42]. Monitoring should be highly individualised to the existing needs and co-morbidities of the patient. To minimize complications and ensure safety during TPN, all hospitals should have proper guidelines and standardized procedures[43,44].

Table : Monitoring required during administration of TPN:-[41,42]

Fluid balance	**At least every 24 h for the first 2-3 days**
Blood Test	Sodium ,potassium, chloride, Carbon dioxide, creatinine, blood sugar, calcium, magnesium, phosphorus,haemoglobin,and WBCs.
Body Weight	Twice a week
Daily Temperature	Every 6 hourly
Pulse and Blood Pressure	Daily (4 hourly)
Urine Glucose	Every 8-12 hours for the first 2-3 days
Blood Glucose	Every 12 hours for the first 2-3 days
LFT(Liver function test)	2 times a week.

7.Partial parenteral nutrition vs. Total parenteral nutrition:-

A comparison of TPN and PPN shows in on the basis of their hypertonicity and route of administration[15,16]. Table . A comparison of total parenteral nutrition and partial parenteral nutrition[15,16].

Total Parenteral Nutrition	**Partial Parenteral Nutrition**
Marked hypertonicity (850–2,000 mOsm/L)	Mild hypertonicity (500–600 mOsm/L)
Supplies total patient energy needs	Does not usually supply all patient energy needs
The central venous administration required	Peripheral venous administration is possible
May be deficient in total vitamin and mineral needs, depending on the formulation	Typically deficient in vitamin and mineral needs

8. Complications may occur during the administration of TPN

Poor aseptic techniques and poor maintenance of TPN central lines can lead to severe TPN complications[27]. It has been reported that about 5 %–10 % of patients receiving total parenteral nutrition (TPN) have experienced adverse side effects and long-term complications associated with central venous access (central lines) or TPN itself[28].

Possible complication associated with total parenteral nutrition includes:

- Hypoglycemia (low blood sugar)
- Hyperglycemia (high blood sugar)
- Thrombosis (blood clots)
- Dehydration and electrolyte imbalance.
- Hypertriglyceridemia.
- Hypokalemia (low potassium).

9. Contraindication of TPN:-

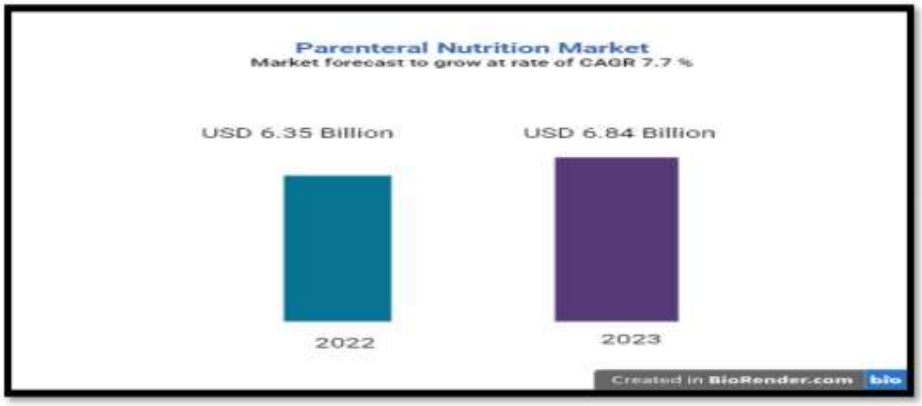
TPN is generally contraindicated when the following condition occurs.

1. Infants with less than 8 cm of small bowel who cannot adopt enteral feeding.
2. Patients having cardiovascular or metabolic instability they should be corrected before administration of TPN[32].
3. Patients having irreversibly decerebrate.
4. When G.I route is possible for the administration of nutrition. Because it is a best route to provide nutrition with no complications[33].
5. When the nutritional status is good and, only short-term TPN is needed[34].
6. When only short-term TPN is needed.

9. Parenteral nutrition market trend analysis:-

The global parenteral nutrition market grew from USD 6.35 billion in 2022 to USD 6.84 billion in 2023 at a compound annual growth rate (CAGR) of 7.7 %[44,45]. The rapid increase in the elderly population and the growing rate of premature birth (NEONATES) of babies across the globe has stimulated the demand for parenteral nutrition[46,47]. As per WHO updates of 2021, the rate of preterm birth ranged from 5 % to 18 % of babies born across 14 countries in 2021. In India, over 3 million babies are born premature accounting for 13 % of birth every year[48]. Thus due to high numbers of preterm births in various countries demand growth

of parenteral nutrition. But in some developing countries due to lack of awareness, slows the growth rate of the market. TPN serves as a primary treatment for IBD inflammatory bowel disease by restoring the nutritional deficiency caused due to resultant intestinal failure. Parenteral nutrition therapy is gaining wide recognition in the medical sector since it helps treat gastrointestinal disorders and cancer. The global parenteral nutrition market is experiencing a demand upsurge owing to the rising malnourished population[49].



[44]

10. Storage of TPN:-

Store the TPN solution in the refrigerator when you are not using it. Let the solution warm to room temperature before you use it[50].

11. Conclusion:-

TPN should be used for fully balanced nutrition in critically ill patients for whom ethereal feeding is not possible or contraindicated. It is observed that proper guidance and administration procedures make it less complicated and advances in catheters lower the risk of infection. (I-Nutrimon) a web-based application as per ASPEN/ESPEN makes it easy to calculate the nutrition requirement in critical care. The success of TPN therapy depends on the preparation and administration of a nutritional mixture. Diabetic patients need hyperglycemia control during TPN administration through continuous infusion of insulin. Patients suffering from electrolyte imbalance need more care to avoid the development of refeeding syndrome.

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