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OPTIMIZING NUTRITIONAL SUPPORT: ENTERAL AND PARENTERAL NUTRITION IN CLINICAL CARE

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Abstract

Nutritional support is one of the pillars of treatment for patients who are unable to meet their nutritional needs by consuming food orally alone. Enteral and parenteral nutrition provide essential energy, macronutrients, micronutrients, and fluids that are required to promote recovery, prevent malnutrition, and improve clinical outcomes in a wide range of medical and surgical conditions. This review outlines the principles of nutritional support, with a focus on enteral and parenteral feeding modalities, formula composition, route of administration, and indicators of its use. The most important characteristics of enteral formulas, including energy density, nutrient composition, osmolality, and fiber element, are elaborated with disease-specific formulations. The methods of feeding tube placement, methods of administration, pharmacology, and the most common complications are also reviewed. Parenteral nutrition, such as peripheral and total, is discussed in greater detail regarding formulation components, access routes, and clinical monitoring. Expertise in choosing and administering optimal nutritional support solutions is essential for enhancing patient outcomes and minimizing adverse effects.

1. Introduction

Proper nutrition is one of the foundations of human health, such as recovering from illnesses and preventing complications that malnutrition provokes. In most clinical settings, patients can no longer be able to take in adequate amounts of nutrition orally due to dysphagia, loss of appetite, gastrointestinal (GI) dysfunction, critical illness, or postoperative conditions. In this case, nutritional support is an essential treatment procedure that may be provided by mouth using oral nutritional supplements (ONS), enterally via the gastrointestinal tract (GIT), or parenterally via intravenous (IV) routes when the gut is non-functional or inaccessible (NCCAC, 2017).

Enteral nutrition (EN) is mostly used when the GIT is intact because it allows preservation of gut integrity and the immune system, and is linked to a lower rate of infectious complications compared to parenteral nutrition (PN). There is a wide range of enteral formulas that allow clinicians to customize nutrition support based on the digestive capacity, metabolic needs, and disease-specific demands (Doley, 2022). PN offers a life-saving option when the enteral route of feeding is not feasible or sufficient, as it provides nutrients directly into the bloodstream. The selection of the two feeding routes is illustrated in Figure 1.

The current review will seek to provide an outline of enteral and parenteral nutrition with a focus on the characteristics of the formula, feeding route, administration pathway, and clinical

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implications. With an understanding of the principles underlying nutritional support, healthcare workers can be able to make appropriate decisions to optimize nutritional status and enhance patient outcomes.

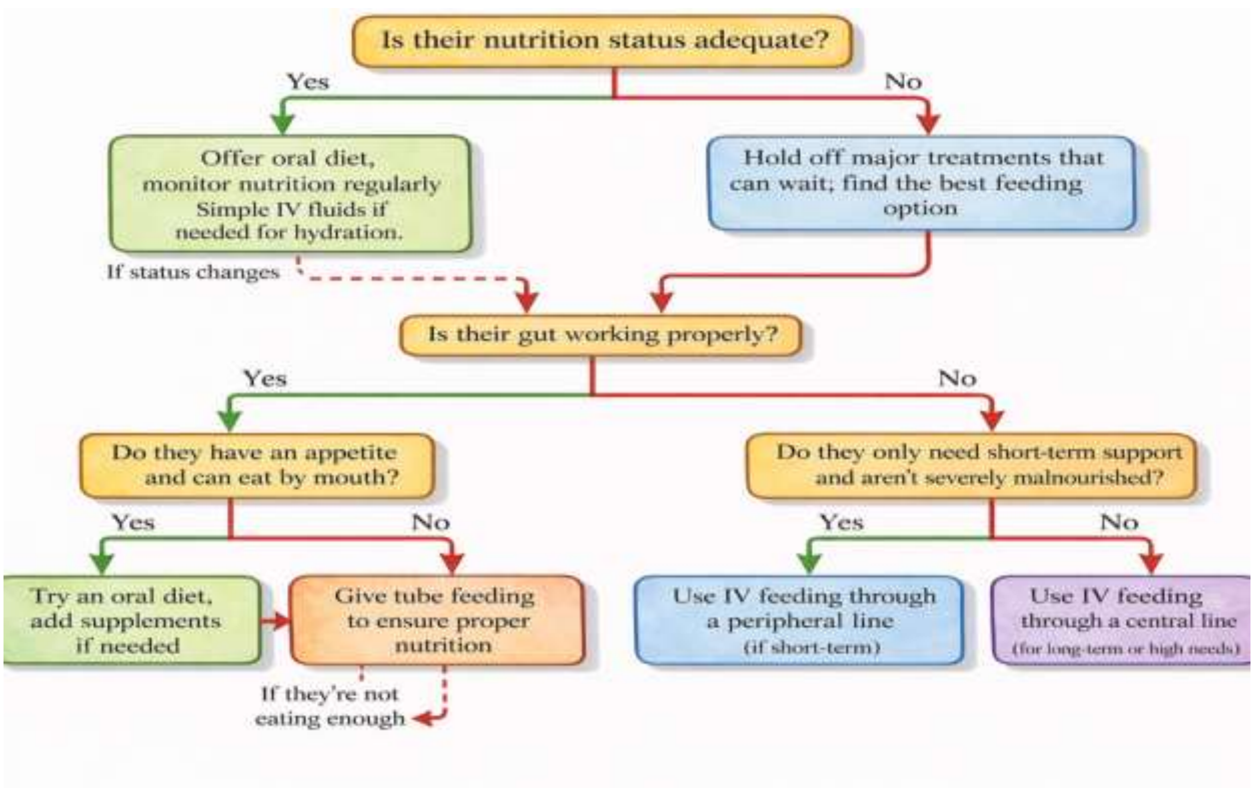

Figure 1: Nutritional assessment decision flowchart

2. Enteral Nutrition

EN feed supplies nutrients through the GIT. It includes oral food or supplements, but is better known in the context of tube feedings that provide nutrients to the stomach or the intestine via a long, slim tube, thus maintaining the functioning of the gut and reducing the risk of infections as compared to IV feeding. EN is recommended in the following cases: severe dysphagia (e.g., after a stroke), insufficient oral nutrition, or acute health problem (Adeyinka et al., 2022).

Types of Enteral Formula

Enteral formulas are often categorized according to their macronutrient composition.

2.1.1. Standard Formula

Standard formulas usually contain intact proteins that are extracted from milk or soybean, or are combinations of protein isolates and polysaccharides, with the sources including modified starches, glucose polymers like maltodextrin, or other sugars. These recipes are prescribed to people who do not have problems with digesting and absorbing nutrients. There is also a range of limited products, called blenderized formulas, which are made of whole foods and contain mostly pureed meat or poultry as a source of their protein (Ojo et al., 2020).

2.1.2. Hydrolyzed Formula

Hydrolyzed formulas, however, on the other side, are often provided to patients who have compromised digestive or absorptive functions. These preparations include macronutrients that have been in part or totally hydrolyzed to fragments that need less or no additional enzymatic action before absorption. They are usually designed to contain a lower amount of fat and can include the use of medium-chain triglycerides (MCTs) to aid in their digestion and absorption. Regular hydrolyzed formulas are mostly lactose-free and result in decreased fecal output (Li et al., 2022).

2.1.3. Modular Formula

Modular formulas generally include one or two of the macronutrients and are used to supplement other formulations. Their use meets the nutritional needs of the patients with specific deficiencies; e.g., a high-carbohydrate formulation can be used to supplement the caloric intake in patients under protein limitation. Various modular preparations can also be used to add liquid vitamins and mineral adjuvants to create personalized regimens depending on the individual nutrient needs of the patients (Hudson et al., 2022).

Certain formulations that are disease-specific are also being sold in the market, but these are mostly expensive, and their effectiveness is also a point of contention.

2.2. Formula Characteristics

2.2.1. Energy Density

Enteral preparations have a high degree of variability in energy density, with a range of between 0.5 and 2.0 kcal/ml of fluid. The standardised formulations generally provide 1.0 to 1.2 kcal/ml, which makes them appropriate with patients who have average fluid needs (Ruperto et al., 2022).

2.2.2. Nutrient Density

Nutritional density of the enteral formula has a marked variability with regard to the proportion of protein, carbohydrate, and fat. Carbohydrate and fat provide most of the energy in enteral formulas, and as with protein, the content of each varies among formulas. The protein needs are increased in patients with high metabolic stress, and have to be reduced in patients with renal failure. Protein usually represents 15-25% of all calories, whereas according to the standard formulas, 40-50% of all calories are carbohydrate, and 30-50% are fat (Ruperto et al., 2022).

2.2.3. Osmolality

Enteral formulations come in various osmolality such as the isotonic and hypertonic preparations. The majority of enteral formulas have osmolalities ranging between 300 and 700 milliosmoles per kilogram (Santos et al., 2022). However, Hydrolysed and nutrient-dense formulations tend to have higher osmolalities than the normal formulations. Hypertonic preparations can slow down nutrient absorption rates as well as increase diarrhea risks, however most patients can tolerate hypertonic and isotonic feeds with no complex challenges. Enteral feeding in the presence of concomitant medication administration raises the osmotic load significantly and could be a cause of diarrhea that is common in most tube-fed patients (Cakir et al., 2025).

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2.2.4. Fiber Content

Moreover, enteral formulations also vary significantly in the content of fibre. It includes dietary fibre to restore intestinal motility, treat diarrhea and constipation, and manage glycaemic control. It is also recommended to avoid fibrous preparations in patients with some GI diseases, including pancreatitis, or in those who are undergoing intestinal tests and operations (Lionetti et al., 2023). Dietary fibre-enriched tube feedings contain both soluble and insoluble components, with the soluble components, such as guar, pectin, and fructo-oligosaccharides (FOS), acting as prebiotics. While insoluble fibre increases fecal volume and enteral peristalsis, thereby decreasing fecal transit time (Salvatore et al., 2023).

2.3. Main Characteristics of Different Feeds

2.3.1. Renal Feeds

Special feeds are usually created to include limited levels of sodium, potassium, and phosphorus to meet the needs of renal patients. They have different protein levels: low protein diets are used in the initial stages of chronic kidney disease (CKD), and higher protein diets are used in patients with end-stage CKD, e.g., those who are on haemodialysis or on peritoneal dialysis. CKD feeds used at the end-stage are typically high in energy, which helps with the fluid restriction required by such patients (Doley, 2022).

2.3.2. Pulmonary Feeds

These feeds usually contain a greater percentage of total energy consumption of fats and a lower percentage of carbohydrates to reduce carbon dioxide generation during metabolism and consequently reduce respiratory workload in patients with respiratory diseases by lowering the production of carbon dioxide by the feed metabolism (Ohbe et al., 2024).

2.3.3. Hepatic Feeds

These formulations are usually deficient in aromatic amino acids (AAA) and methionine, with an increase in the branched-chain amino acids (BCAA). These are commonly hypercaloric, have a high calorie-to-nitrogen ratio, and have dietary fibre to stimulate bowel movements. Moreover, they tend to be deficient in sodium, copper, iron, and manganese, as well as being fortified with fat-soluble vitamins, folic acid, and B-complex vitamins (Kappus, 2020).

2.3.4. Diabetic Feeds

Diabetic feeds are characterized by reduced carbohydrate levels and include carbohydrate moieties different from those in normal formulations. They usually include oligosaccharides, fructose, and corn starch, with a greater fibre content. These compounds are expected to enhance glycemic regulation by slowing down gastric emptying and decreasing the intestinal transit time (Church & Zoeller, 2023).

2.4. Tube Feeding & Feeding Routes

The tube feeding routes are chosen depending on the clinical condition of a patient, the expected time of EN, and the possible complications of a particular route. For instance, GI motility can be temporarily inhibited after a severe stress event, like abdominal or intestinal surgery. The normal restoration of intestinal function usually takes a few hours or a day, but gastric recovery can take up to three or four days. Therefore, enteral formulas may be introduced earlier than gastric feeds into the small intestine (Xie et al., 2024). Gastric feeds can also be dangerous in patients having a

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high risk of aspiration, which is also a common complication of formula feeding (Miao et al., 2023). Various placements of tube feedings are shown in Figure 2.

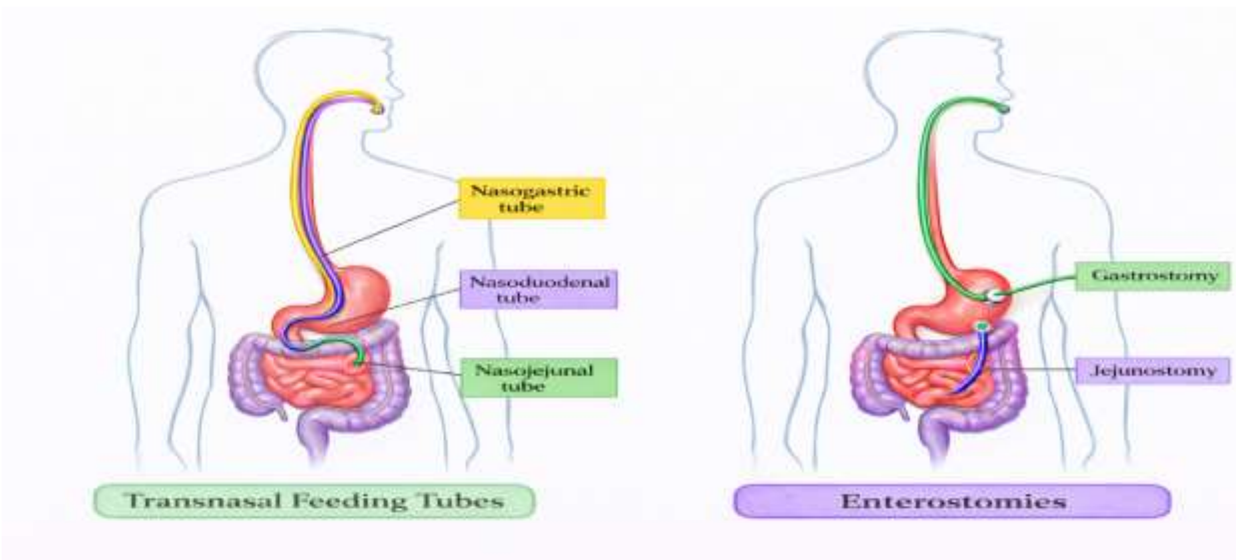

Figure 2. Enteral feeding tubes placement

2.4.1. Transnasal

The nasoenteric method is usually preferable in patients who are expected to be fed through the enteral tube for not more than four weeks. The tube is passed through the nasal cavity into the GIT (Bowling, 2023). The patient is frequently awake during transnasal (through the nose) placement of a feeding tube. While the patient is in a slightly upright position with head tilted, the tube is inserted into a nostril and passed into the stomach (nasogastric), duodenum (nasoduodenal), or jejunum (nasojejunal). The alert patient can be advised to swallow water to ease the passage of the tube. The position of the distal tip is regularly confirmed with the help of abdominal X-ray or other evaluation tools (Taylor & Manara, 2021). In the case of neonates and infants, orogastric placement (i.e., insertion of the tube into the stomach via the oral cavity) is the preferred mode of installation, as this mode of tube insertion allows the infants to breathe in a more normal manner during feeding (Chen et al., 2024).

2.4.2. Enterostomy

In cases where the enteral feeding is expected to last more than four weeks, or the nasoenteric channel is not possible due to obstruction or other clinical conditions, it is advised to gain direct access to the stomach or small intestine through an enterostomy. An enterostomy is a medical procedure that creates an opening in the stomach (gastrostomy) or in the jejunum (jejunostomy), as shown in Figure 2. The establishment of the enterostomy can be achieved either surgically or non-surgically using local anesthesia (Han, 2022).

2.4.3. Percutaneous Endoscopic Gastrostomy or Jejunostomy

The percutaneous endoscopic gastrostomy (PEG) is a non-surgical procedure of tube insertion directly into the stomach, through the abdominal wall, using an endoscope, and under local

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anesthesia (Liu et al., 2021). It is inserted endoscopically through the oral cavity into the stomach or distal small bowel, and then exteriorized through the abdominal wall under local anesthesia, creating a channel through which EN would be delivered, as shown in Figure 3. The PEG is the preferred access route for patients requiring tube feeding for more than 3 to 4 weeks because of its ease in providing feeding while causing the patient less anxiety and self-consciousness. Also, the short duration of the procedure, the minimal need for anesthesia, and the minor wound-related issues make it beneficial to clinicians (Sharif et al., 2018). PEG to gastrojejunostomy conversion is also possible by passing a small-bore catheter through the already placed PEG tube into the jejunum using fluoroscopic or endoscopic imaging.

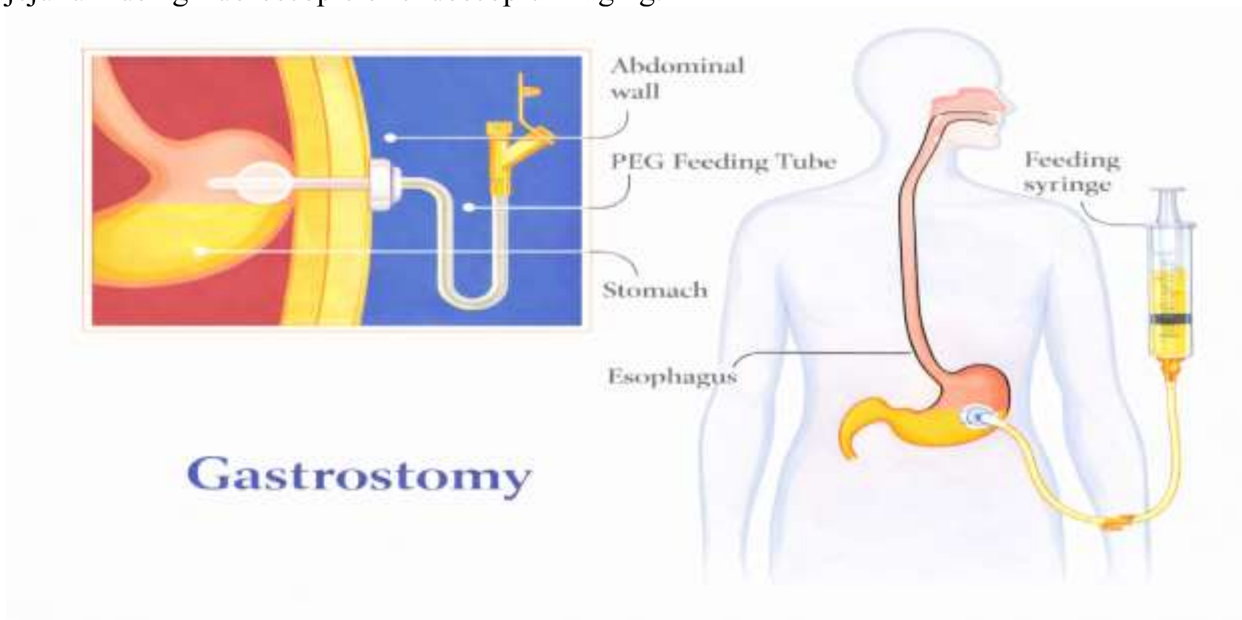

Figure 3. PEG feeding tube placement

2.4.4. Surgically Placed Enterostomies

Surgical gastrostomies and jejunostomies are used in patients who need EN and are undergoing surgical operations or in cases where endoscopy cannot be performed and is contraindicated (Gong, 2021). The Stamm and Witzel procedures are the most frequently used methods of operative insertion of gastrostomy tubes, with the Janeway procedure being a more permanent and robust technique. Surgical gastrostomy tubes have virtually the same use as PEGs. Short-term access routes to the small intestine include the Witzel jejunostomy and needle-catheter jejunostomy, which are normally used to provide EN at early postoperative phases along with gastric decompression. The small lumen size of the needle-catheter jejunostomy may be a challenge, since it is easily dislodged and may hinder the flow of some nutrient formulations (Murray-Ramcharan et al., 2022; Brendel & Gauderer, 2023).

2.5. Administration

The three methods of administration of enteral tube-feed, mainly used, are bolus feeding, intermittent drip, and continuous drip; the choice of a certain method mainly depends on the clinical condition and quality of life factors of the patient. Furthermore, there may be a transitional regimen from one approach to another as the condition of the patient gets better.

2.5.1. Bolus Feeding

The syringe bolus method is the preferred feeding modality of the patient who is clinically stable and who has a functional stomach. Syringe bolus feedings, given in 5-20 minutes, are typically more convenient and less expensive than pump or gravity bolus feedings; as such, they ought to be encouraged when tolerated. The formula is infused with the help of a 60-ml syringe (Epp et al., 2023). In case of bloating or stomach-ache, the patient should wait 10 to 15 minutes before consuming the rest of the recommended formula in the feeding period. Physiologically stable gastric patients normally digest 500 ml of formula at a time. The normal daily nutritional requirements of most patients can be met with three or four bolus feedings per day (Nutricia UK).

2.5.2. Intermittent Drip

The quality-of-life factors are often the reason to implement intermittent drip-feeding protocols, which provide more flexibility and independence to mobile patients compared to continuous drip feeds. Such feedings can be provided through a pump or a gravity drip. The plan is organized in accordance with four to six feedings per day, in which the feeding session is 20 to 60 minutes long (O'Connor et al., 2023). The administration of formula is initiated at 100 to 150ml per feeding and raised gradually based on tolerance. The effectiveness of this feeding plan will be mainly dictated by the level of mobility, alertness, and motivation of the patient. Patients with high risks of pulmonary aspiration should not receive intermittent and bolus feedings (Adeyinka et al., 2022).

2.5.3. Continuous Drip

This method needs continual drip infusion via a pump. It should be used with patients who are unable to tolerate a large volume of infusion within one feeding session, such as those under bolus or intermittent infusion. Patients who cannot be given oral liquid nutrition because of the disease, surgery, antineoplastic therapy, or other physiologic inhibitors are relevant to continuous drip infusion. The target feeding rate is determined by dividing the total daily volume by the number of hours per day in which the infusion would be given (18-24 hours per day). Feeding is initiated at one-quarter to one-half the goal rate and advanced every 8 to 12 hours to the final volume. Formulas with osmolarities between 300 and 500 mOsm/kg can be started at full strength, hyperosmolar formulas, however, should be advanced conservatively to ensure tolerance. Formulas do not usually need to be diluted (Walshe, 2022; Hardy & Majid, 2023).

2.6. Medication through Tube Feeding

Clients undergoing enteral tube feedings need one or more drugs that have to be given through the feeding tube. To reduce possible complications, it is necessary to administer it correctly. Enteral formulas may interact with pharmacologic agents in a similar manner to how oral foods interact with medicines; therefore, the time of drug delivery needs to be carefully planned. Feedings might need to be postponed, or the feeding schedule should be rearranged so that medication and formula can be administered independently. Some drugs require acidic GI conditions and are therefore not administrable via a distal intestinal feeding tube. Also, certain medications can trigger the blockage of tubes (Klang, 2023).

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Clinical guidelines typically suggest the use of drugs in the form of oral administration whenever possible because of the reduction of complications. In cases where the oral administration cannot be used, liquid formulations should be used; viscous or hypertonic liquids need to be diluted with 10-30ml of water before being given through the tube. In cases where liquid forms are not available, there should be the use of agents that can be administered by injection or intravenously. Before and after the drug administration, the feeding tube should be flushed with 15-30mL of warm (physiological) water, or with 5mL of water between each drug given (Bischoff et al., 2023). In situations where tablets are required, it is advisable to consult pharmacists. They should ascertain if the specific tablet can be crushed. If so, it can be reduced to a fine powder, mixed with warm water, and then consumed. Enteric-coated or sustained-release tablets should never be crushed because of possible adverse effects, and alternative formulations are to be obtained. Drugs that are known to interact with the enteral formulas should be avoided. The precautionary measure is to halt feeding 15 minutes preceding and 15 minutes subsequent to drug delivery, but certain agents might necessitate a longer duration without formula. When this happens, it is necessary to increase the rate of infusion so that the required volume of formula can be delivered (Alodat et al., 2026).

3. Parenteral Nutrition

PN is the administration of nutrients directly to the bloodstream by IV infusion, thus bypassing the GIT. The modality is recommended to patients who are unable to take into the body the necessary carbohydrates, proteins, lipids, vitamins, and minerals orally or enterally. In turn, PN allows the digestive system to rest and rejuvenate, at the same time meeting the metabolic needs, a factor that is especially important when the patient is in critical condition or in severe malnutrition. Clinical signs of PN include the inability to digest and absorb nutrients, short bowel syndrome (SBS) that occurs after the resection of part of the intestine, severe pancreatitis, obstruction of the intestine or the appearance of fistulas, extensive trauma or burns, critical systemic diseases or wasting syndromes, bone marrow transplantation, and severe malnutrition with an increased risk of aspiration (Berlana, 2022).

After it is established that PN is requisite, there is a need to select an access site. The conventional classification of IV feeding access sites is into two categories: peripheral venous access, most often found in the arms and legs, and central venous access, found in large central veins before the heart chambers. PN administration has a similar approach to enteral tube feeding in that the risk of developing complications is alleviated by paying close attention to the preparation and management of the nutrient solution. To prevent bacterial contamination and maintain the stability of the nutrition formulation, parenteral solutions are made under an aseptic pharmaceutical setting, out of direct light, and refrigerated. Before the start of infusion, the solutions are removed from the refrigerator and allowed to cool down to ambient temperature. During the infusion period, the nutrient solution as well as the catheter placed into the body should be checked periodically to identify any signs of contamination. (Berlana, 2022).

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3.1. Feeding Routes

3.1.1. Peripheral Parenteral Nutrition (PPN)

In peripheral parenteral nutrition (PPN), nutrient requirements could be addressed by the use of peripheral veins. However, with concentrated solutions, peripheral veins may be damaged, and thus, only limited amounts of energy and protein can be provided by PPN. Solutions applied in PPN also have a restricted osmolarity of 900 milliosmoles/liter. It is typically applied in patients requiring short-term nutritional assistance (approximately 7 to 10 days) and who do not have excessive nutrient requirements or fluid limitations. PPN cannot be practiced in cases where the peripheral veins of a patient are so weak that the procedure may not be tolerated. Venous access sites also need to be rotated in most instances to avoid inflammation (Khan et al., 2023).

3.1.2. Total Parenteral Nutrition (TPN)

The majority of the patients met their nutrient requirements with the aid of the larger, central veins, where the blood volume is higher, and the nutrient concentrations do not have to be restricted. Since this technique is able to supply all the nutrient needs of a person, it is referred to as total parenteral nutrition (TPN). Central veins are near the heart, where the large volume of blood quickly dilutes TPN solutions. Hence, patients who have very high nutrient requirements or fluid constraints can be provided with the nutrient-rich solutions they need. TPN also suits the patients who need long-term IV feedings (Liu and Gao, 2021).

Central veins can be accessed in a number of ways. A central venous catheter tip may either be inserted directly into a large-diameter central vein or threaded into a central vein via a peripheral vein, as shown in Figure 4. Even though the insertion of peripherally inserted central catheters is less invasive and more easily done than the direct insertion of catheters through the larger veins, research has reported higher complication rates with the insertion of catheters peripherally. (Kamata et al., 2023).

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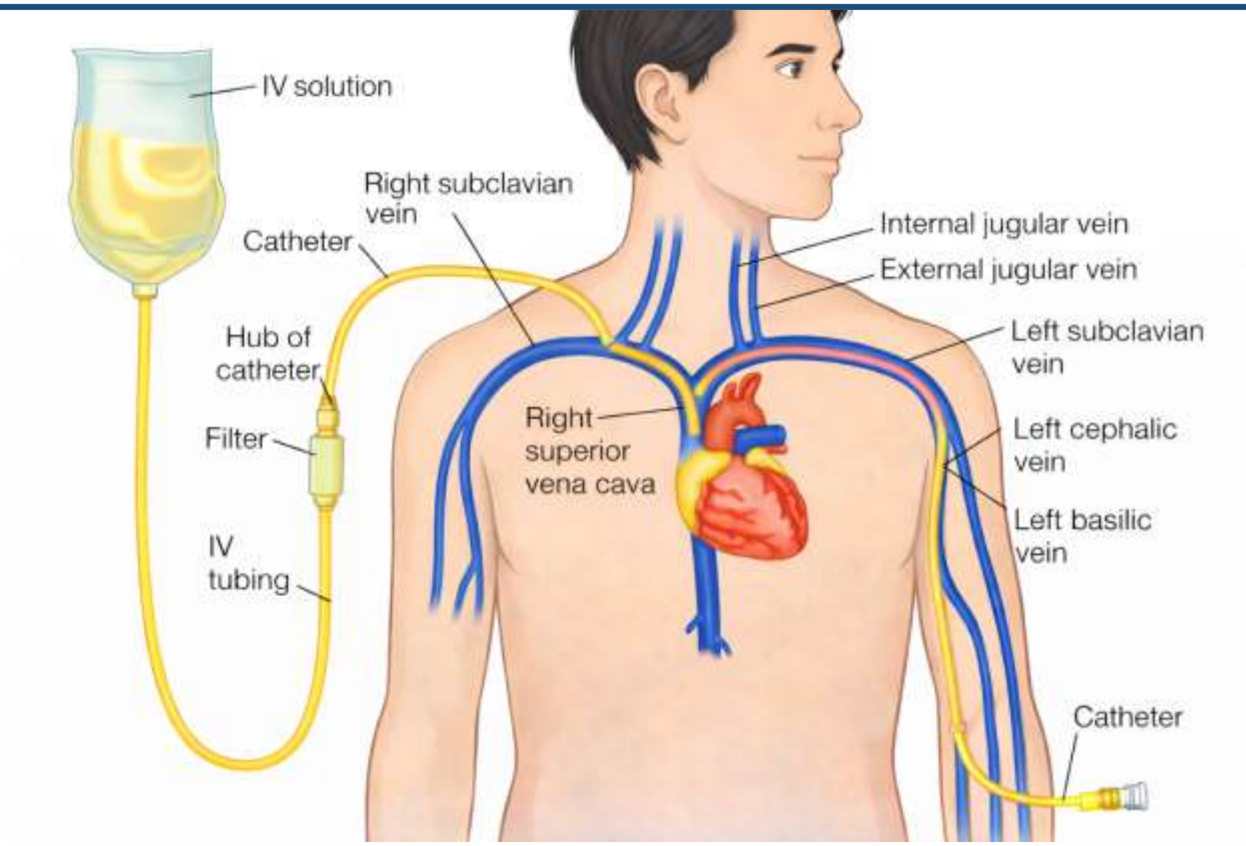

Figure 4. Intravenous catheterization and vein illustration

3.2. Formula Characteristics

IV-administered nutrients bypass the GI system and thus should be developed in a way that can be safely delivered by direct blood infusion. Parenteral solutions are meant to contain optimal content of amino acids, carbohydrates, lipids, vitamins, and minerals in such a way that they should meet the nutritional needs of the patients in an adequate manner. When dextrose, amino acids, and lipids are included in a parenteral formulation, it is known as a total nutrient admixture (TNA), a 3-in-1, or all-in-one solution. An exclusionary lipid parenteral formulation is called a 2-in-1 solution in which a lipid emulsion is administered separately, often by piggyback administration (Boullata et al., 2024). TNA solution administration is beneficial to clinical management since only one infusion pump is needed; nevertheless, the introduction of lipid emulsion may reduce solution stability, which is a significant issue in the case of TNA solution administration. Typically, a TNA that is high in lipid content is more stable than one with a low lipid content, as dilution decreases the emulsification action of the phospholipids present in that emulsion. Therefore, the infusion of lipids is often performed separately in situations where they are not a major source of energy and are administered only to provide essential fatty acids (EFAs) (Andersson et al., 2025).

3.2.1. Amino Acids

The IV solutions include all the essential amino acids as well as a variety of non-essential amino acids. Amino acid concentrations of commercially available preparations are between 3.5 and 15%, with the more concentrated solutions used only when infusions are delivered into central veins. Similar to dietary proteins, amino acids contain about 4kcal/g, and thus a 10% amino acid solution contains 10g of amino acids/100ml of the product. Certain amino acid preparations have also been created to meet the metabolic requirements of patients with hepatic failure, renal failure, and other metabolic stress conditions (Stein et al., 2009).

3.2.2. Carbohydrate

Carbohydrate is the major energy source that is provided by IV nutrition. The carbohydrate that is used in parenteral solutions is dextrose monohydrate, which is a combination of glucose molecules that are attached to a single water molecule. Dextrose monohydrate has an energy density of 3.4 kcal/g, a little less than that of glucose in foodstuffs. Commercially available dextrose solutions are between 2.5-70% in concentration. Therefore, a 10% dextrose solution provides 10g of dextrose monohydrate per 100ml of solution. The concentrations above 10% are used only in cases of administration through central venous access (Fischer, 2012).

3.2.3. Lipids

Lipid emulsions supply EFAs and are an important source of energy. They usually include triglycerides of soybean and safflower oils, phospholipids to work as emulsifying agents, and glycerol to make the solutions isotonic. Lipid emulsions are available in 10, 20, and 30 percent solutions, which contain 1.1, 2.0, and 3.0 kcal/ml, respectively. Therefore, 500ml of a 10% lipid emulsion will provide 550kcal, but the same amount of a 20% emulsion will give 1000kcal. Lipid emulsions are often utilized on a daily basis and can constitute 20-30% of the overall caloric intake (Teitelbaum & Coran, 2006). The use of lipids as a major source of energy helps to decrease the reliance on dextrose and decrease the chances of hyperglycemia in glucose-intolerant patients. Nevertheless, lipid infusion should not be used in the case of patients with hypertriglyceridemia. There is also concern that lipid emulsions containing an excessive amount of linoleic acid may suppress some aspects of the immune response (Nanhuck et al., 2009).

3.2.4. Fluids and Electrolytes

Fluid requirements are estimated at 30 to 40 ml per kg of body weight in young adults and 30 ml per kg of body weight in older adults. Adjustments are guided by fluid losses and the findings of hydration assessment. The electrolytes added to parenteral solutions include sodium, potassium, chloride, calcium, magnesium, and phosphorus. Requirements for PN differ from dietary reference intake (DRI) values because the nutrients are infused directly into the blood and are not influenced by absorption as they are when consumed orally. Generally, blood tests are administered daily to monitor electrolyte status until patients have stabilized. Electrolyte imbalances can be lethal, and therefore electrolyte management by experienced professionals is necessary whenever IV therapies are used. The electrolyte content of parenteral solutions is expressed in milliequivalents (mEq) (McNaull & Suchar, 2020).

3.2.5. Vitamins and Trace Minerals

Parenteral solutions are regularly supplemented with commercial preparations of multivitamins and trace elements. The water-soluble vitamins are also provided together with vitamins A, D, and

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E. Nevertheless, vitamin K is not always provided and has to be included individually. Parenteral solutions are supplemented with trace minerals, which are zinc, copper, chromium, selenium, and manganese. Sometimes iron is omitted due to its ability to change the stability of other components in parenteral mixtures; hence, special forms of iron must be injected independently (Boullata et al., 2022).

3.2.6. Osmolarity

PPN solutions should not exceed 900 milliosmoles per liter of osmolarity, but TPN solutions can be as nutrient-dense as required. Amino acids, dextrose, and electrolytes contribute most to a solution's osmolarity: the higher their levels, the stronger the osmolarity. Lipids add little to osmolarity, so lipid emulsions are used to enhance energy delivery in PPN solutions. (Fessler & Rejrat, 2021).

3.2.7. Medication

Some medications are sometimes added to parenteral solutions or infused through a different port (connected with a Y-connector) to prevent the necessity of having an additional infusion site. A second solution that is administered through a separate port of a catheter is referred to as a piggyback. Piggyback insulin is also used to enhance glucose tolerance (Barsky et al., 2022). An anticoagulant such as Heparin can also be introduced via piggyback administration to avoid catheter tip clotting. Practically, fewer medications are added to parenteral solutions so that the potential drug-nutrient interactions can be avoided (Baldwin et al., 2020).

3.3. Administration of Parenteral Nutrition and Feeding Cycles

Though a competent nurse could undertake the procedures of catheterizing the peripheral venous system, the insertion of the central venous catheters would require physician intervention, as it is a complex procedure whose application has the potential of being risky. In the process, patients can be kept awake, and a local anesthetic can be used. However, hindrance of venous flow may be caused by catheter mispositioning, dislodgement, and air ingress. Some of the complications related to peripheral cannulation are phlebitis, thrombosis, and the formation of fibrous tissue surrounding the catheter tip that may lead to the reinsertion in a different location (Guanche-Sicilia et al., 2021). Catheters are also a major cause of nosocomial infection; they can be contaminated during insertion, at the catheter point, or due to contaminated solutions. Nursing personnel apply aseptic measures to prevent such risks in the course of catheter insertion, tube removal or replacement, and in modifying dressings. The clinical manifestations of unexplained bleeding, a damp dressing, excessively slow or rapid infusion rates, which may indicate obstruction, and local erythema and swelling should be taken into immediate consideration of the presence of an infection or mechanical complications, including unexplained fever. Therefore, equipment systemic inspection and close attention to the symptoms of patients are crucial in catheter-associated adverse events mitigation (Reber et al., 2021).

The strategies to be adopted in the initiation of PN should be considered individually to determine the best options that can be taken. One such method is to start with the infusion of the solution at a slow pace and then gradually increase the rate over a span of two to three days. Alternatively, it can be administered as a nutrient-dilute solution in its entire volume during the first day, and a gradual increase in the concentration of nutrients depends on the tolerance of the patient (Berlana, 2022). Some clinicians choose to start solutions at full strength unless the patient poses the risk of hyperglycemia. Blood glucose and electrolyte levels are repeatedly measured in order to determine the tolerance of the patients to the solutions. The nutrient intake should be re-evaluated regularly until a steady state has been reached. Even in some groups of patients, especially neonates, rapid changes in the infusion rate are typically avoided due to the risk of hyperglycemic or hypoglycemic (Balasundaram & Dumpa,2023).

Parenteral solutions can be given in a 24-hour loop (continuous parenteral nutrition) or limited to 10-16 hours every day (cyclic parenteral nutrition). Critically ill and malnourished patients who cannot obtain adequate nutrition within shortened time constraints are often subjected to continuous feedings. The cyclic feedings are normally administered in the nocturnal hours, thus allowing the patients to participate in normal routines during the day. This technique is especially acceptable in patients who require long parenteral nutrition or those who will conduct home-based infusions. Patients can begin therapy in the form of continuous feedings and later convert them into a cyclic feeding pattern as they improve in clinical status. (Berlana, 2022).

3.4. Discontinuing Intravenous Nutrition

The mode of transferring the patients to oral feedings relies on the health and medical state of the patient. At the beginning, small enteral feedings can be administered to check the tolerance. Enteral feedings should be administered at a slower rate in case of GI symptoms (i.e., nausea, vomiting, bloating, diarrhea) until the intestines adapt to the feedings. As soon as two-thirds to three-fourths of the nutrient requirements can be met by an enteral route, the IV feeds can be stopped (Du et al., 2024). The direct transition to an oral diet is not always easy since several weeks after the termination of PN, the appetite of a person remains depressed. Patients undergoing continuous parenteral feedings can have improved daytime appetites provided that they undergo the nocturnal cyclic feedings before the commencement of oral feedings. A patient may start taking the same formula that is being administered via tube, in most cases. Once the patients start to take more food or formula orally, they can be given less formula by tube (Ichimaru, 2018).

3.5. Complications of Tube Feeding

The complications consist of GI complications: diarrhea, constipation, vomiting, nausea, or abdominal pain. Mechanical problems include blocked feeding tubes, defective feeding pumps, and dislodged feeding tubes following insertion. Even a feeding tube may be a physical irritant. There are various side effects of nasoenteric tube insertion, namely dry mouth and mouth breathing, and reduced salivary volumes; clogged eardrums and subsequent middle ear infection, sinus infection due to sinus tract blockage (Motta et al., 2021). Cases of the leakage of GI secretions at the tube insertion point may also be found to accompany the ostomies. Fluid imbalances (dehydration or overhydration), electrolyte imbalances, and glucose intolerance are the common metabolic complications, including hyper- or hypo-glycemia, hypertriglyceridemia, and refeeding syndrome. Routine blood testing so as to monitor the potassium, phosphorus, sodium, and glucose levels may be necessary until a patient is stable. The patients may need insulin or medications to reverse hyperglycemia. PN frequently causes fatty liver, and so, liver enzyme levels are regularly monitored in serum, although the cause of liver abnormalities remains unclear (Nowak, 2020). Gallbladder problems frequently develop when the GIT is not used for long

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periods, leading to gallstones due to thickened bile. Patients who require PN for long periods may be given cholecystokinin injections (to cause gallbladder contraction and bile release) or may have their gallbladders removed surgically (Buchman, 2024). Long-term PN has been associated with decreased bone density and bone mineralization. Another hypothesis is that PN alters the function of the parathyroid gland, which may cause disruptions in bone metabolism (Park et al., 2020; Romanowska et al., 2025). Although nutrition status and bone density are carefully monitored during long-term PN, there is no satisfactory remedy for this complication at present. However, many complications of tube feeding are preventable if the most appropriate feeding route, formula, and delivery method are chosen.

4. Conclusion

EN and PN are the most crucial interventions for patients who simply cannot sustain their nutritional requirements through oral nutrition. EN is the choice when the digestive tract functions well, as it stands out as a more natural feeding method and is less likely to be followed by complications. The extensive number of formulas and feeding routes allows adjusting the nutrition plans according to the needs of the patient, their condition, and tolerance. PN offers complete nutritional support in the form of a well-thought-out IV solution when enteral feeding is contraindicated or inadequate to provide nutrition.

Nutritional support requires careful evaluation, choice of feeding modality and formula, accurate administration, and continuous monitoring to avoid complications. Therefore, both EN and PN can be used to transform clinical outcomes, recover, and improve the quality of life of diverse patients, with appropriate application.

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