

NUTRITIONAL MANAGEMENT OF OBESITY IN CLINICAL AND CRITICAL CARE: A COMPREHENSIVE REVIEW OF PARENTERAL NUTRITION AND METABOLIC RISKS

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ABSTRACT

Obesity has become a pervasive global health concern, closely linked with a spectrum of chronic diseases and complications. In both acute and long-term care settings, managing the nutritional needs of individuals with obesity is a complex task requiring evidence-based, multidisciplinary strategies. Total parenteral nutrition (TPN) offers life-saving support for patients with impaired gastrointestinal function but presents significant clinical risks, particularly in critically ill or obese populations.

KEYWORDS: Obesity, Total Parenteral Nutrition, Critical Care Nutrition, Hyperglycemia, Weight Management, Nutritional Therapy, Socioeconomic Determinants.

INTRODUCTION

The World Health Organization classifies obesity ($BMI \geq 30$ kg/m²) as a distinct disease and describes it as a global pandemic that may surpass traditional health challenges such as

undernutrition and infectious diseases. Since 2000, several professional societies have also endorsed obesity as a disease. Obesity is defined as excessive or abnormal accumulation of body fat that increases health risks. It significantly contributes to morbidity and mortality through its association with conditions including hypertension, dyslipidemia, type 2 diabetes, coronary heart disease, stroke, certain cancers, and other chronic disorders. Additionally, The

Obesity Society characterizes obesity as a multifactorial, chronic disease involving structural abnormalities, physiological disturbances, and functional impairment, which collectively elevate the risk of morbidity and premature mortality. Despite this, nutritional deficiencies and malnutrition in individuals with overweight or obesity are often underdiagnosed due to the limited availability of sensitive assessment tools and well-defined diagnostic criteria.^[3]

Total parenteral nutrition (TPN) is an intravenous nutritional therapy used for the management of malnutrition when the gastrointestinal (GI) tract cannot be utilized. It involves the administration of nutrients directly into the bloodstream, serving as the sole source of nutrition when oral or enteral feeding is not feasible. TPN is indicated in conditions involving impaired gastrointestinal function or contraindications to enteral nutrition. Although enteral feeding is generally preferred due to its lower cost and reduced risk of complications such as infections and thrombosis, it requires a functional GI tract. TPN provides essential nutrients through a specialized intravenous formulation and is commonly used after surgery, in patients with severe digestive disorders that impair nutrient absorption, or when nutritional requirements cannot be met through enteral feeding.^[2]

Parenteral nutrition can be classified based on the route of venous access.

- 1) **Central parenteral nutrition (CPN)** is delivered through a central vein, typically the superior vena cava, allowing administration of highly concentrated nutrient solutions and higher caloric loads; therefore, it is commonly used for total parenteral nutrition.
- 2) **peripheral parenteral nutrition (PPN)** is administered through peripheral veins, usually in the limbs or neck, and is generally used for short-term nutritional support because the solutions provide lower caloric concentrations compared with central administration.^[2]

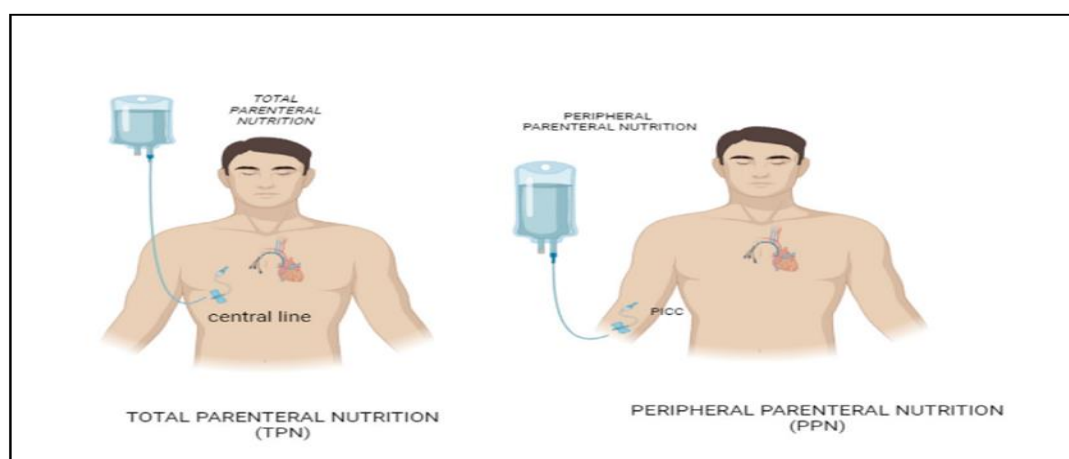


Fig. 1: The Route of Administration of PPN and TPN from different veins.[2]

Despite its clinical benefits, total parenteral nutrition (TPN) can cause metabolic complications, with hyperglycemia being one of the most common. According to the American Society for Parenteral and Enteral Nutrition, hyperglycemia is defined as a blood glucose level above 180 mg/dL and occurs in approximately 17–67% of adults receiving TPN. Elevated blood glucose levels are associated with adverse outcomes, including increased risk of infections, cardiac complications, organ failure, and higher in-hospital mortality. TPN-induced hyperglycemia primarily results from the high glucose content of TPN formulations and the physiological stress response in critically ill patients, which increases counter-regulatory hormones and reduces glucose utilization. This study aims to determine the prevalence of TPN-induced hyperglycemia in hospitalized non-diabetic adults and identify associated risk factors.^[3]

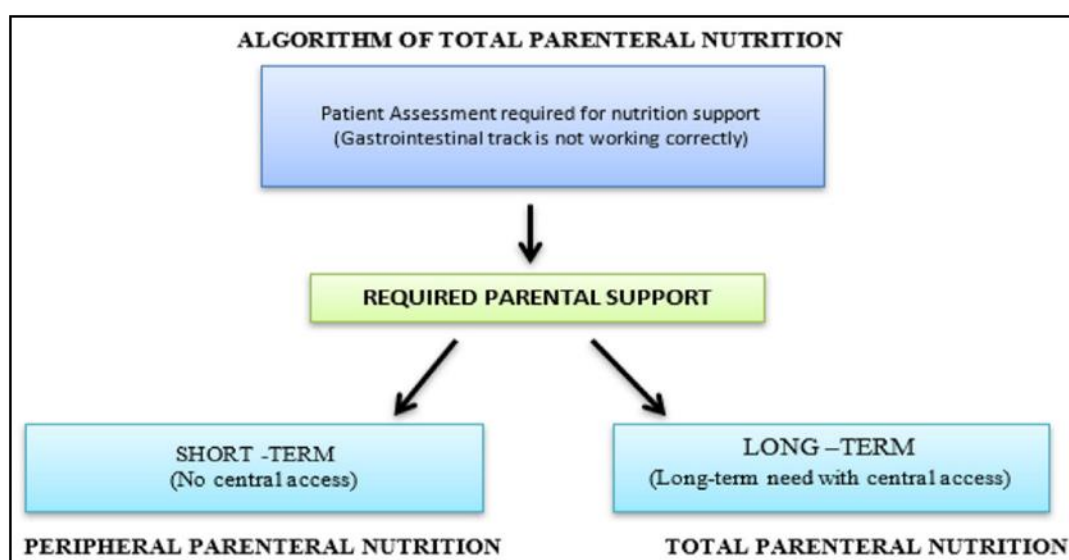


Fig. 2: The algorithm of total parenteral nutrition.^[2]

Total parenteral nutrition (TPN) is contraindicated in certain clinical conditions. It should not be used when the gastrointestinal tract is functional and enteral feeding is feasible, as enteral nutrition is the preferred and safer route. TPN is also contraindicated in patients with severe cardiovascular or metabolic instability until these conditions are corrected. Additionally, it is not recommended in patients with irreversible decerebrate states or in individuals with adequate nutritional status when only short-term nutritional support is required. In infants with extremely short bowel length (less than 8 cm) who cannot tolerate enteral feeding, TPN may also be inappropriate or ineffective.^[2]

METHODOLOGY

Obesity is strongly associated with metabolic and cardiovascular disorders. The chronic inflammatory state linked to obesity contributes significantly to insulin resistance, a key underlying mechanism of Type 2 Diabetes. Central obesity, typically assessed by waist circumference, is a fundamental component of the Metabolic Syndrome as defined by the International Diabetes Federation, which also includes elevated triglycerides, reduced HDL cholesterol, hypertension, and increased fasting plasma glucose.^[4]

Clinical guidelines recommend a weight reduction of 5–10% for individuals with obesity or overweight accompanied by comorbidities, as this level of weight loss significantly improves several obesity-related conditions. Greater weight loss may lead to further benefits, particularly in metabolic parameters. For conditions such as Nonalcoholic Fatty Liver Disease and Obstructive Sleep Apnea, a minimum weight loss of about 10% is typically required to achieve clinical improvement. Importantly, modest weight loss has also been associated with reduced all-cause mortality.^[4]

A retrospective review of electronic medical records was conducted for adult patients who received TPN during the study period. Patients with a history of Diabetes Mellitus or those who exhibited hyperglycemia (blood glucose >180 mg/dL) within three days prior to TPN initiation were excluded. TPN-induced hyperglycemia was defined as any blood glucose value exceeding 180 mg/dL from the start of TPN administration until one day after its discontinuation.^[3]

Patients were categorized into two groups: those who developed hyperglycemia and those who did not. Demographic characteristics, indications and duration of TPN, and TPN composition were compared between the groups to identify potential risk factors. Additional factors assessed included body mass index (BMI) categories, concurrent steroid use, prior exposure to TPN within the previous two years, and the type of hospital admission, such as intensive care unit (ICU) or general medical ward.^[3]

The key variables and concepts synthesized across the included studies include.^[5]

Variable/Concept	Role in Study
Obesity status (BMI, body fat)	Independent or moderating variable
TPN use	Primary intervention or exposure
Hyperglycemia (BG $\geq$ 180 mg/dL)	Outcome variable in studies analyzing TPN complications

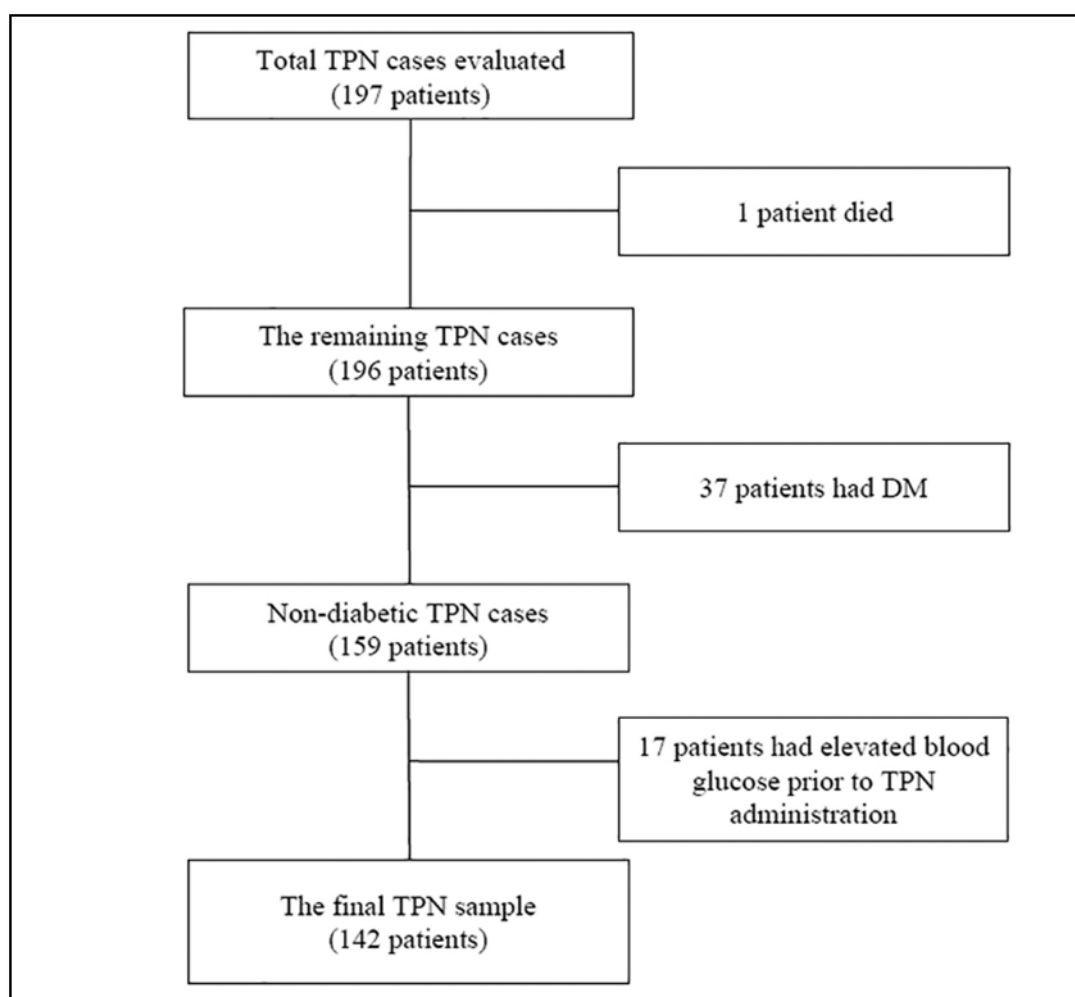
Nutritional intervention	Intervention variable (e.g., type of diet, TPN formula)
Parental/familial behaviors	Mediating variables in adolescent obesity
TPN ordering method (manual vs. electronic)	Independent variable in QI study
Health outcomes	Dependent variables (e.g., blood glucose, weight loss, complications, mortality)

RESULT

The growing global prevalence of obesity highlights the importance of effective management due to its serious health consequences. Obesity induces a chronic low-grade inflammatory state that contributes to vascular dysfunction, thrombotic disorders, metabolic abnormalities, and multi-organ damage. These changes increase the risk of several diseases, including Cardiovascular Disease, Type 2 Diabetes, Obstructive Sleep Apnea, and certain cancers, ultimately contributing to increased mortality.^[4]

Even modest weight loss of 5–10% of total body weight can lead to significant improvements in health outcomes. Weight reduction can help prevent the development of type 2 diabetes in individuals with obesity and prediabetes, improve cardiovascular outcomes, and provide benefits in conditions such as obstructive sleep apnea when weight loss exceeds 10%. Additionally, weight loss is associated with reduced risk of certain cancers and improvements in several comorbidities, including asthma, Gastroesophageal Reflux Disease, liver dysfunction, urinary incontinence, infertility, joint pain, and depression.^[4]

A total of 197 patients who received TPN between January 2012 and December 2017 were initially evaluated. One patient who died within one day of TPN initiation was excluded. Among the remaining 196 patients, 37 with a history of Diabetes Mellitus were excluded. Additionally, 17 patients who had hyperglycemia (blood glucose >180 mg/dL) during the three days prior to TPN initiation were also excluded. Consequently, the final study population consisted of 142 non-diabetic patients without pre-existing hyperglycemia before receiving TPN.^[3]



CONCLUSION

Patients with obesity who develop critical illness pose significant clinical challenges due to the presence of multiple comorbidities, systemic inflammation, and limited evidence to guide optimal nutritional management. Given these complexities, expert recommendations emphasize individualized patient-centered care guided by the principle of “first, do no harm.” Nutritional strategies should therefore consider the overall health status of the patient, including psychosocial factors such as chronic stigma that may affect healthcare delivery. Furthermore, additional research is needed to evaluate the applicability of existing nutrition therapy guidelines in populations with obesity and to explore improved strategies for addressing underlying inflammation and other chronic risks, particularly in critically ill patients.^[3]

Total parenteral nutrition (TPN) provides complete nutritional support for critically ill patients when enteral feeding is not feasible or contraindicated. Proper guidance, standardized administration protocols, and advances in catheter technology reduce the risk of

complications, including infections. The effectiveness of TPN depends on careful preparation and administration of nutrient solutions. In patients with diabetes, hyperglycemia should be managed with continuous insulin infusion, while those with electrolyte imbalances require careful monitoring to prevent refeeding syndrome.^[2]

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