

Current concepts on preoperative nutritional support: how, when and why?

Conceptos actuales sobre el soporte nutricional preoperatorio: ¿cómo, cuándo y por qué?

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Abstract

Malnutrition is associated with several complications during hospital stay, including patients who will undergo major surgery. Therefore, it is important to optimize nutritional status in the preoperative period being the main objective restoring metabolic and immunological abnormalities. Preoperative fasting is a common practice in clinical settings, although it has been shown to induce insulin resistance. One intervention to avoid this practice is the implementation of the ERAS (Enhanced Recovery After Surgery) protocol. Proper nutritional assessment in hospitalized patients is the cornerstone to identify patients at nutritional risk, or those in malnutrition who may benefit from early nutritional interventions. The feeding route should be chosen according to the patient's condition, either orally with the use of nutritional supplements and in those where calorie requirements cannot be achieved by oral, enteral nutrition is the next logical step, reserving parenteral nutritional support in patients with non-functional gastrointestinal tracts in order to improve postoperative morbidity and mortality.

Keywords: Preoperative period. Nutritional support. Nutritional assessment. Enteral nutrition. Parenteral nutrition.

Resumen

La desnutrición se asocia con una larga lista de complicaciones intrahospitalarias, incluidos aquellos pacientes que se someterán a cirugía mayor. Por lo tanto, es importante optimizar el estado nutricional en el periodo preoperatorio, siendo el objetivo principal la restauración de anomalías metabólicas e inmunitarias. El ayuno preoperatorio es una práctica sistemática en el ámbito clínico, a pesar de que se ha demostrado que induce resistencia a la insulina. Una de las intervenciones para evitar dicha práctica es la implementación del protocolo ERAS (Enhanced Recovery After Surgery). Una correcta valoración nutricional en los pacientes hospitalizados es de vital importancia para identificar aquellos con riesgo nutricional, o bien aquellos en desnutrición que pudieran beneficiarse de intervenciones nutricionales tempranas. La ruta de alimentación debe elegirse

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de acuerdo con el estado del paciente, por vía oral con el uso de suplementos nutricionales o con nutrición enteral en aquellos cuyos requerimientos calóricos no logran ser alcanzados por dicha vía, y reservando el apoyo nutricional parenteral para aquellos con tracto gastrointestinal no funcional, con el objetivo de mejorar la morbilidad y la mortalidad posoperatorias.

Palabras clave: Periodo preoperatorio. Soporte nutricional. Valoración nutricional. Nutrición enteral. Nutrición parenteral.

Introduction

In the last two decades, the prevalence rate of malnutrition and nutritional risk has ranged from 10% to 50% among hospitalized patients worldwide¹. However, a recent study establishes that this prevalence is as high as 65%². In surgical patients, preoperative malnutrition is common and has been associated with poor clinical outcomes³, with a rate ranging from 23% to 33% depending on the type of surgery and the nutritional assessment tool used⁴.

The primary goals of nutrition are to assess the patient for pre-existing malnutrition, treat malnutrition to optimize surgical preparation, minimize starvation, prevent postoperative malnutrition, and support anabolism for recovery⁵. However, the administration of adequate preoperative nutritional support leads to postponing the surgical procedure and to additional costs generated by artificial nutrition³. In order to adequately implement perioperative nutritional support programs in patients undergoing surgery, it is essential to understand the basic changes that occur in metabolism as a result of injury/trauma, and that compromised nutritional status is a clear risk factor for the development of postoperative complications⁶.

Metabolic changes in surgical patients

Surgical trauma causes physiologic stress, which in turn causes increased sympathetic activity and catecholamine secretion (such changes are transient). Subsequently, a prolonged hypermetabolic state follows, associated with a negative nitrogen balance⁷. For several decades it has been known that the metabolic response in the post-traumatic period depends on the type and extent of the injury and the patient's previous health, as well as nutritional status⁸.

The initial post-injury state in severely injured patients, caused by tissue damage, is characterized by an acute phase response and increased energy expenditure. The cytokines released (for example, interleukins and tumor necrosis factor alpha), along with the hormones released after injury (including adrenaline, cortisol, and glucagon), act as catabolic stimulants^{9,10}.

Depending on the severity of the injury, energy expenditure increases by 20-50% in trauma patients compared to patients after elective surgery¹⁰.

The combination of this acute phase response and the increase in energy expenditure after trauma leads to a first hypermetabolic state, characterized by increased mobilization of muscle proteins for energy and a decrease in their synthesis that ends in catabolism. In addition, patients with severe trauma develop a second hypermetabolic state, with increased lipid metabolism, insulin resistance, and hyperglycemia^{10,11}. Leukocytosis, changes in glucose metabolism, and sodium and water retention are also seen. These biochemical adaptations are distinctive for severely injured patients and increase the susceptibility of trauma patients to develop malnutrition^{10,12}.

The better understanding of the pathophysiological response to damage has allowed the development of nutritional supplementation protocols that support recovery, while reducing the effects of muscle catabolism, which is the main contributor to post-surgical or traumatic adverse outcomes. Nutritional supplementation is necessary to counteract dietary deficiencies, augment reduced function of the alimentary tract, and support healing and recovery¹³.

Preoperative fasting

Preoperative fasting is routinely performed in clinical practice (due to the risk of pulmonary aspiration from gastric contents), despite the fact that it has been shown to induce insulin resistance, mitochondrial dysfunction, and metabolic stress. Insulin resistance is characterized by a decrease in its sensitivity in tissues and has been associated with increased postoperative mortality and morbidity, as well as a longer hospital stay¹⁴.

According to the European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines on clinical nutrition in surgery, there is insufficient evidence that patients who receive clear liquids up to 2 hours before elective surgery are at increased risk of aspiration or regurgitation compared with those who fast for the traditional 12 hours or more, since gastric emptying of clear fluids occurs in 60 to 90 minutes⁶.

Carbohydrate load in the preoperative period

A simple method has been described to achieve an increase in tissue insulin sensitivity, thus improving its resistance, with the intake of beverages rich in carbohydrates (12.6%) in a dose of 800 ml before midnight and 400 ml 2-3 hours before surgery. This strategy produces an insulin release similar to that induced by a balanced meal and, consequently, a reduction in tissue resistance associated with surgical stress, which may be 50% lower compared to patients who do not receive this regimen during the preoperative period^{15,16}, in addition to reducing preoperative thirst, hunger and anxiety¹⁶. A 2016 meta-analysis by Amer et al.¹⁷ compared the normal dose (> 45 g) against the lowest dose (10-44 g) of carbohydrate loading, and found a significant reduction in hospital stay of 0.4 days for the normal dose and 0.2 days for the lower dose compared to fasting; however, there was no difference when carbohydrate loading was compared to water or placebo.

One of the most applied programs in the world to improve the recovery of operated patients is the protocol for accelerated recovery after surgery (ERAS, *Enhanced Recovery After Surgery*), which represents a paradigm shift in perioperative care, since it has shown reduce both recovery time and postoperative complication rates¹⁸, in addition to reducing anxiety, hunger, thirst and fatigue, with a greater feeling of perioperative comfort¹⁹.

Preoperative nutritional evaluation

The benefits of preoperative nutritional therapy are generally observed in malnourished surgical patients, so nutritional status should be assessed in all patients before major surgery⁶. The most common criteria or tools for the diagnosis of malnutrition are low levels of preoperative serum albumin (< 30 g/l, without evidence of liver or renal dysfunction), low body mass index (< 18.5 kg/m²), unintentional weight loss > 10-15% in 6 months, assessment global subjective grade C, nutritional risk screening > 5 (nutritional risk screening [NRS]€-2002), prealbumin, total lymphocyte count, mean arm circumference, and triceps skinfold^{5,20}.

Wang et al.²¹ performed a retrospective analysis of 120 patients with colorectal cancer divided into two groups: those without nutritional risk (NRS-2002 < 3) and those with nutritional risk (NRS-2002 ≥ 3). They analyzed the impacts of preoperative nutritional status on postoperative complications and short-term

outcomes, and concluded that the rate of postoperative complications increased in the group that presented nutritional risk in the preoperative period, and had more days of hospital stay, compared to those who were admitted without nutritional risk.

Choice of preoperative feeding route

The first line of intervention is the oral route, with strengthening through oral nutritional supplements; however, in case of inability to carry it out, the choice of the form of nutritional administration in patients before surgery can represent a clinical challenge. The choice of the feeding route in the operating rooms is affected, in addition to the general indications (Fig. 1), by a series of factors that arise from the clinical situation of the patient (for example, the severity of malnutrition, the type of surgery planned or the presence of other medical conditions), from organizational capabilities (for example, availability of the method and experience of the clinician) and others (for example, the will of the patient). All of the above factors are the reason for the different measures that are carried out within the different health institutions. For this reason, during daily hospital practice there is a need to choose between enteral nutrition (EN) and parenteral nutrition (PN)²² (Table 1).

Enteral nutrition in the preoperative period

NE helps activate the gastrointestinal neuroendocrine system, promotes peristalsis, improves physiology and ecological balance, and protects the intestinal mucosa by preventing its atrophy and bacterial translocation²³, since the intestinal mucosa plays a key role in defending the intestinal mucosa. intestinal barrier, in addition to the digestion, absorption and metabolism of nutrients²⁴. A systematic review on the effect of NE and NP on the gastrointestinal microbiota found that seven studies (n = 237 patients) reported higher abundance of *Proteobacteria* with NP compared with NE, six studies (n = 172) reported lower *Firmicutes* and five studies (n = 155) less *Bacteroidetes*. In seven studies (n = 282), microbial diversity was lower with the provision of PN than with NE²⁵.

Shen et al.²⁶ in 2020, conducted a retrospective study in 56 patients with NRS-2002 ≥ 3 and apparent difficulty swallowing. Patients received preoperative EN (n = 27) or PN (n = 27). Both groups received nutritional support for 7 days prior to radical esophagectomy with extended, two-field lymph node dissection.

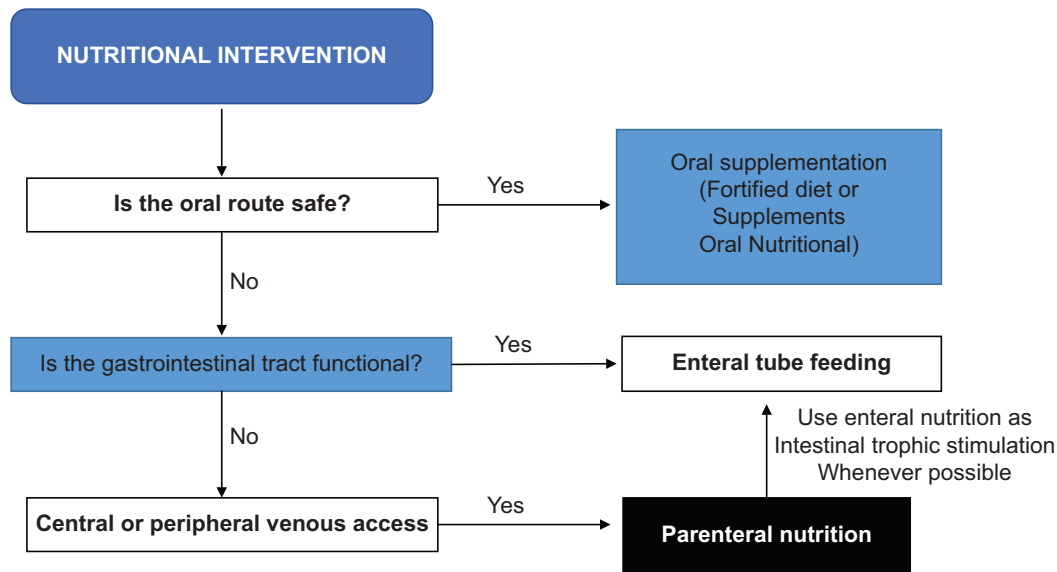


Figure 1. General indications for nutritional intervention.

Table 1. Enteral access route according to duration and risk of bronchial aspiration

	No risk of bronchial aspiration	With risk of bronchial aspiration
Duration < 4 weeks	Nasogastric	Nasojejunal
Duration > 4 weeks	Gastrostomy	Jejunostomy

When comparing the effects of the two routes of nutritional support, a significant improvement ($p = 0.000$) was found in the reduction of postoperative hospital stay and a lower cost of nutritional support in the EN group compared to the PN group. Gas channeling and first bowel movement occurred earlier in the EN group than in the PN group ($p = 0.001$), and the incidence of gastrointestinal tract complications was also lower in the EN group compared to the PN group. ($p = 0.039$). It is concluded that preoperative EN can shorten the recovery time of gastrointestinal function, as well as reduce the incidence of gastrointestinal complications and finally speed up postoperative recovery.

Parenteral nutrition in the preoperative period: dose and duration

PN should only be considered in preoperative patients who are severely malnourished, or who are

unable to tolerate EN, or to maintain more than 50% oral intake for more than 7 days, therefore nutritional status should be assessed in all patients. before major surgery²⁷. The goal of preoperative PN is not to regain weight, but rather to acutely increase storage of energy, protein, micronutrients, and glycogen stores⁴.

Energy and protein requirements are of the order of 25-30 kcal/kg/day and 1.5 g/kg/day, respectively^{6,28}. Micronutrients should be administered daily according to the recommended daily intake⁴. Micronutrient deficiencies have been called “hidden hunger”, since they are determinants and aggravating factors of health status and quality of life. The deficiencies with the greatest risk are those of iron, zinc, thiamine, vitamin B12 and vitamin C^{29,30}. Recovery of physiological function and body protein can be achieved with 7 days of PN. Furthermore, there are no controlled studies comparing 7 days with 10-14 days of PN. However, in the opinion of the working group of the ESPEN guidelines, in patients with severe nutritional risk, the potential increase in benefit would justify the preoperative extension of PN to 10-14 days⁶.

Figure 2 summarizes the indications, doses, duration, and monitoring of preoperative PN.

Benefits of the use of preoperative parenteral nutrition

Most studies evaluate the benefits of preoperative PN on three main aspects: postoperative complications,

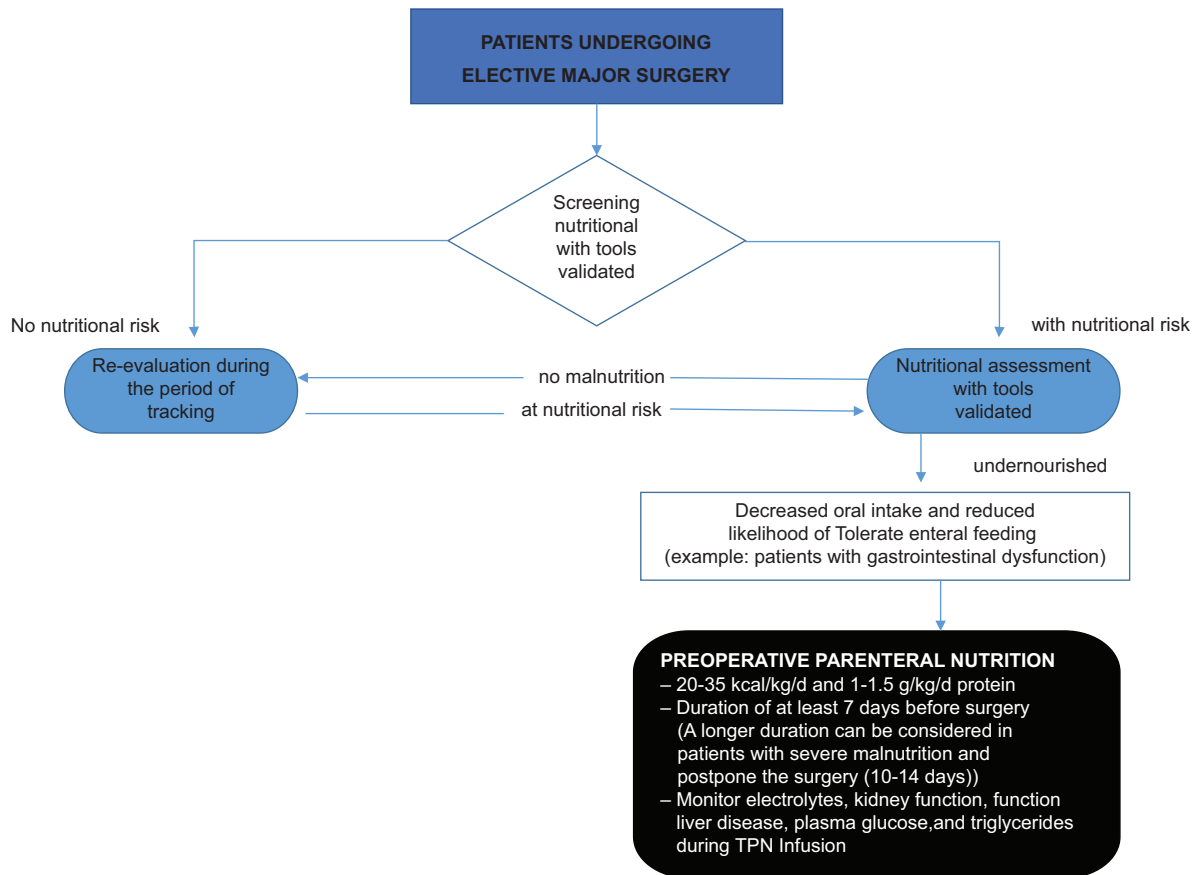


Figure 2. Parenteral nutrition: indication, dose, duration and follow-up.

mortality, and length of hospital stay⁴. Administration of PN via central venous catheters can rapidly improve nitrogen balance, allowing faster recovery of lymphocytes and better wound healing, as well as reducing postoperative complications, but has not been shown to decrease the morbidity or mortality³¹. A 2001 meta-analysis of 27 studies (2907 patients) showed that PN was associated with a reduced complication rate in surgical patients (relative risk [RR]: 0.81; 95% confidence interval [95% CI]: 0.65-1.01; $p = 0.06$) and a significant reduction was only demonstrated when studies in malnourished patients were analyzed (RR = 0.52; 95% CI: 0.30 to 0.91)³². Another meta-analysis carried out in 2012 demonstrated a significant reduction in major complications associated with the use of preoperative PN in patients with gastrointestinal surgery (RR: 0.64; 95% CI: 0.46-0.87)³³. In addition, in a meta-analysis of patients with Crohn's disease, preoperative PN showed a trend toward reducing complications, but without reaching statistical significance (odds ratio [OR]: 0.65; IC95%: 0.23-1.88; $p = 0.43$)³⁴.

Risks and complications of parenteral nutrition

Hyperglycemia, along with its metabolic consequences, can lead to adverse outcomes if not addressed. Additionally, volume overload can cause respiratory compromise. Refeeding syndrome is another concern with PN use, which can cause azotemia and metabolic acidosis. Excessive infusion of carbohydrates causes hyperglycemia, hypertriglyceridemia, and hepatic steatosis. High lipid infusions can cause hypertriglyceridemia. Hypercapnia and refeeding syndrome can also be the result of abrupt introduction of feeding³⁵. In addition, special attention should be paid to the duration of PN, since its prolonged use is one of the most important predictors of nosocomial infections, as shown by a study carried out by Yang et al.³⁶ with 259 patients with intestinal failure, in which found a prevalence of nosocomial infections of 25.5%, pneumonia being the most common (14.3%). The multivariate analysis revealed that

Table 2. Recommendations for initiation and nutritional progress in patients at risk of refeeding syndrome (RS)

	Initial calories	Progress in food	Other recommendations
NICE 2019	- Maximum 10 kcal/kg/day 5 kcal/kg/day in "extreme" cases (examples: BMI < 14 kg/m² or insufficient intake for >15 days)	Slowly until caloric needs are met within 4-7 days	Restore circulatory volume
IrSPEN 2014	- Very high risk: 5 kcal/kg/day - High risk: 10/kcal/day - Moderate risk: 20 kcal/day	Initiate feeding slowly according to the risk category for SR	- Check serum electrolyte levels - Correct electrolyte deficiencies. - Monitor water balance
CNSG 2018	- Very high risk: consider providing only 5 kcal/kg/day - High risk: start nutritional support with a maximum of kcal/kg of body weight - Moderate risk: enter a maximum of 50% of caloric requirements for the first 3 days.	- Very high or high risk: slowly within 4-7 days, based on clinical and biochemical monitoring. - Moderate risk: increase caloric intake only when clinical and biochemical conditions allow it.	- Gradually introduce fluids and energy. - Check levels of potassium, magnesium and phosphorus. - Do not suspend feeding if electrolyte levels decrease. - Do not progress the feeding if the levels of phosphorus, potassium and magnesium are significantly low until they are corrected.
Cray 2016	- No more than 10 kcal/kg/day in severe cases 15-20 kcal/kg/day for the other cases.	Increase calories gradually by 200-300 kcal every 2-3 days	- Consider all sources of calories and fluids in calculations (including dextrose) - Check basal electrolyte levels (especially phosphorus, potassium and magnesium) before starting nutritional support and correct deficiencies. - Only if the patient is hemodynamically unstable, maintain sodium solutions at 1/L/d, especially in patients with severe malnutrition, anorexia nervosa, who present a component of cardiomyopathy.
Friedli 2018	Range from 5 to 25 kcal/kg/day depending on the severity of the SR	- Nutritional therapy should begin with a reduction in caloric goals and progress slowly to full calories over 5-10 days based on risk category for SR. - Avoid fluid overload by using a diet restricted in fluids and sodium within the first 7 days.	- Patients at high risk for RS, start with electrolyte replacement at levels below normal/low normal range - Prophylactic electrolyte supplementation

CNSG: clinical nutrition steering group; BMI: body mass index; IrSPEN: Irish Society for Clinical Nutrition and Metabolism; Kcal: kilocalories; Kg: kilograms; NICE: National Institute for Health and Care Excellence; RS: refeeding syndrome.

the decrease in the serum albumin level (OR: 0.884; 95%CI: 0.883-0.978; $p < 0.05$), the presence of gallbladder stones or cholestasis (OR: 3.144; 95%CI: 1.044-9.464; $p < 0.05$) and the use of prolonged PN (OR: 1.072; 95% CI: 1.039-1.105; $p < 0.001$) were independent predictors of nosocomial infection.

Refeeding syndrome in the preoperative period

Refeeding syndrome is characterized by a set of metabolic and electrolyte disturbances that arise as a result of reintroducing or increasing caloric intake after

a period of decreased or absent intake, generally in malnourished patients, and can occur with oral feeding, oral, enteral or parenteral^{37,38}. The use of carbohydrates stimulates insulin secretion, causing minerals and electrolytes to shift into the intracellular space. This change can lead to decreased serum phosphorus, magnesium, and potassium concentrations as total body stores are depleted. In addition, to maintain osmotic neutrality within the plasma, the body retains sodium and water, which can lead to the development of fluid overload and its clinical consequences (congestive heart failure, pulmonary edema, and arrhythmias), especially in critically ill patients³⁸.

Vitamin and mineral deficiencies can also be seen in this syndrome. In particular, thiamine, an important co-factor for glycolysis, can be rapidly depleted with weight loss and malnutrition, taking into account that with carbohydrate intake there will be a greater demand for it. In thiamine deficiency, pyruvate is converted to lactate, which in turn can lead to excessive formation of this compound and lead to lactic acidosis and death in patients receiving PN without thiamine supplementation³⁹.

Table 2 describes the proposed approaches to safely reintroduce energy intake in high-risk patients.

Conclusions

Perioperative malnutrition is a known independent predictor of poor postoperative outcomes. In fact, malnourished surgical patients have been found to experience higher postoperative morbidity and mortality, longer length of hospital stay, higher readmission rates, and higher hospital costs. Malnutrition is one of the main easily modifiable preoperative risk factors associated with poor surgical outcomes, including mortality. Although much attention has been paid to the physiologic and pharmacologic management of the surgical patient, the importance of perioperative nutritional optimization remains underappreciated. Likewise, it is worrying that, even if a diagnosis of malnutrition is established, this rarely leads to adequate nutritional intervention. The benefits of nutritional support have been demonstrated in patients diagnosed with severe malnutrition and who are going to undergo major surgery, so nutritional assessment using validated tools should be mandatory in these patients.

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Conflicts of interest

The authors declare no conflicts of interest.

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