Nutritional issues in the surgical patient

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In surgical patients, the clinical implications of "malnutrition" (in the broadest sense of the term) include impaired wound healing, immunocompromise, diminished cardiac and respiratory function, and a host of other complications that can lead to longer hospitalizations and higher mortality rates. Studies have shown that the consequences of malnourishment—protein calorie malnutrition (PCM) in particular—might be avoided by the administration of pre-, peri-, and postoperative nutrition support, delivered either parenterally or enterally.

This article reviews evidence on the utility of perioperative nutrition support, provides guidance on patient selection for this support, and outlines calorie and protein requirements.

STUDIES OF PARENTERAL NUTRITION

Preoperative and perioperative TPN: Mixed results

Evidence that pre- and perioperative total parenteral nutrition (TPN) contributes somewhat to better postoperative outcomes has been reported in several studies and meta-analyses. Other reports, however, have indicated that TPN has little effect.

The value of preoperative TPN in preventing serious complications in malnourished patients following major abdominal or thoracic surgery was addressed in a 1991 report by a Veterans Affairs study group.[1] The authors followed 395 patients (99% men) who had undergone nonemergent laparotomy or noncardiac thoracotomy. PCM was assessed by calculating the nutrition-risk index from the following formula, with a score of less than 100 indicating PCM:

$$1.519 \times \text{serum albumin level (g/L)} + 0.417 \times (\text{current weight/usual weight}) \times 100$$

Patients were randomized to receive either TPN for 7 to 15 days preoperatively and 3 days postoperatively (TPN group) or no perioperative TPN (control group). Postoperative follow-up lasted for 90 days, with an interim assessment at 30 days. Patients in both groups were subclassified according to whether or not they had been operated on for cancer (65% of the TPN group and 68% of the controls had cancer). TPN was delivered to a daily caloric goal of 1,000 kcal greater than the resting metabolic expenditure.

The rates of major complications at 30 days were similar: 25.5% in the TPN group and 24.6% in the control group. Likewise, mortality rates at 90 days were comparable: 13.4% and 10.5%, respectively. One of the few statistically significant differences between the two groups was in the incidence of postoperative infection. Infection rates were 14.1% among the treated patients and 6.4% among the controls ($P = .01$; relative risk [RR]: 2.2). The postoperative infections in the TPN group occurred primarily in those patients who had only mild or borderline PCM; overall, TPN provided no demonstrable benefit to these patients.

There was a trend toward a higher incidence of noninfectious complications in the control group as a whole (22.2% vs 16.7%), but the difference was not significant ($P = .20$; RR: 0.75). Again, one significant difference was observed when subgroups were analyzed according to the degree of PCM; TPN recipients with severe PCM had a significantly lower incidence of noninfectious complications than did controls with severe PCM (5% vs 43%; $P = .03$; RR: 0.12).

Hyperglycemia was more common in patients who received nutrition support, but it is possible that the study's designers simply provided too many calories in the TPN doses. If so, this would perhaps explain why so few patients derived any benefit from TPN.

The authors concluded that the use of perioperative TPN should be limited to patients who are

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severely malnourished unless other specific indications are present. Indeed, this is one of the reports that we point to when we argue that perioperative nutrition support is of benefit for a small subgroup of patients.

In 1997, Klein et al combined data from 13 randomized clinical trials involving more than 1,250 patients.[2] They found that 7 to 10 days of preoperative TPN led to a 10% reduction in postoperative complications with no significant effect on postoperative mortality.

In 2001, Koretz et al, under the auspices of the American Gastroenterological Association, published a meta-analysis of 61 randomized clinical trials of perioperative TPN for hospitalized surgical patients.[3] The authors concluded that perioperative TPN failed to improve outcomes in the cohort as a whole, although a few subgroups did receive some benefit. Overall, TPN was associated with a 6% decrease in postoperative complications, but this difference was not statistically significant. They calculated that 17 patients would have to be treated for 7 days in order to achieve a reduction of just one complication. One finding that was not consistent with the previously mentioned VA study[1] was that TPN was more effective in patients who did not have severe PCM. Also, TPN was more beneficial in patients with upper gastrointestinal (GI) malignancies. Finally, Koretz et al concluded that although TPN did not provide any benefit, neither did it cause any harm.

In a meta-analysis published in 2001, Heyland et al combined data on 2,907 patients who had participated in 27 randomized clinical trials.[4] Patients who received TPN preoperatively had a lower rate of postoperative complications than did patients who received standard care with an oral diet and intravenous dextrose. TPN was most effective in patients who had experienced significant (> 10%) weight loss. No difference in postoperative mortality was observed between the two groups.

Postoperative TPN: Often more harmful than helpful

A very limited number of studies of postoperative TPN has shown that administering it without regard to patients' nutritional status does more harm than good. In a meta-analysis of eight studies, Torosian found that postoperative TPN actually increased the incidence of complications by 10%.[5] Similar findings were reported by Klein et al in a meta-analysis of nine trials.[2] Other studies[6] have shown that postoperative TPN improved wound healing and decreased morbidity and mortality.

The take-home message is that postoperative TPN should be reserved for patients who have a prolonged postoperative ileus, which is generally regarded as greater than 7 to 10 days, and for those who are severely malnourished and whose diet cannot be advanced in 3 to 5 days.

STUDIES OF ENTERAL NUTRITION

A literature search uncovered only three comparative studies of enteral nutrition support, and all of them are relatively old.[7–9]

In a randomized study of 24 patients published in 1981, Lim et al found that TPN was superior to gastrostomy feeding—but not significantly so—in terms of achieving a positive nitrogen balance and weight gain during a 4-week period.[7] The authors preferred gastrostomy in view of its lower cost, ease of administration, and safety and because it does not restrict freedom of movement.

The same year, Sako et al reported a randomized study of 69 patients who had undergone radical resection for head and neck cancer.[8] They found no difference between TPN and enteral nutrition administered for at least 14 days postoperatively in terms of immune status, wound healing, complications, and survival.

Finally, Campos and Meguid reported in 1992 that enteral nutrition was equal to both TPN and ad libitum oral nutrition in improving postoperative clinical outcome.[9]

In sum, there were no statistically significant differences in morbidity and mortality between patients who received enteral nutrition or TPN in any of these studies. The take-home message is one that we teach medical students on their first day of rounds: if the gut works, use it.

CLINICAL PRACTICE GUIDELINES

The American Society for Parenteral and Enteral Nutrition (ASPEN) published its practice guidelines in 2002.[6] Several of the ASPEN's main recommendations echo some already cited:

- Preoperative nutrition support should be given for 7 to 14 days to patients with moderate to severe PCM who are undergoing major GI surgery (level A recommendation).
- TPN should not be given during the immediate postoperative period to patients who have undergone major GI surgery (level A recommendation).
- Nutrition support should be given to patients who will be unable to eat for 7 to 10 days postoperatively (level B recommendation).

TABLE 1
Standards for laboratory studies relevant to nutrition status

	Normal	Mildly depleted	Moderately depleted	Severely depleted
Albumin (g/dL)	3.5–5.0	3.0–3.4	2.1–2.9	< 2.1
Transferrin (mg/dL)	176–315	134–175	117–133	< 117
Prealbumin (mg/dL)	18–45	10–17	5–9	< 5
Total lymphocyte count (cells/mm^3)	1,801–3,500	1,501–1,800	900–1,500	< 900

PATIENT SELECTION

Routine investigations

In addition to the medical history, physical examination, and laboratory results, two important factors to consider when deciding whether a patient is a candidate for nutrition support are weight history and anthropometry.

Weight history. More than half the patients who present to our department are overweight, with a body mass index (BMI) of 25 or greater. Evaluating a patient's weight requires care and precision. A patient should not simply be classified as a "well-developed, well-nourished white male" without giving it some thought and inquiry. Likewise, one cannot just look at a patient, pronounce him "overweight," and automatically conclude that he does not need nutrition support. Clinicians must sit down with patients and ask them specific questions, such as, *What is your usual weight? Has there been any change in your weight? If so, what was the pattern of the weight change?* Patients who lose weight rapidly are at greater risk for postoperative complications than patients who lose weight gradually. Patients who lose weight and regain it for whatever reason are at less risk than patients who have simply lost weight.

Taking a brief dietary history can help identify any unusual features of a patient's diet that may have an impact on the postoperative outcome, such as an exclusion of or overindulgence in certain food groups.

Anthropometry. Anthropometry is the act of measuring the body as it relates to its form or shape. The simplest anthropometric measure is height and weight. These data can be used to determine the patient's BMI, a measure of body fatness. Performing upper arm anthropometry is a more sophisticated measure and provides information on both body fat stores and muscle mass. These measures help provide information on the patient's energy and protein stores.

Other investigations. The importance of the medical history is obvious. The physical examination should focus on detecting muscle wasting, skin abnormalities, cheilosis, glossitis, etc. Laboratory studies must evaluate the visceral protein deficiency (see "Laboratory-based classification" below). The chemistry panel can detect deficiency and excess of electrolytes and minerals, and a blood count can identify nutrition-associated anemias.

Classifications of malnutrition

Weight-based classification. One classification system for PCM is based on percentages of ideal and usual body weight:

- Mild PCM: 80% to 90% of ideal body weight or 90% to 95% of usual body weight
- Moderate PCM: 70% to 79% of ideal weight or 80% to 89% of usual weight
- Severe PCM: less than 70% of ideal weight or less than 80% of usual weight.

Laboratory-based classification. Measurement of any of the visceral proteins—albumin, transferrin, or prealbumin—can be used to determine the degree of protein malnutrition (**Table 1**). However, since these proteins are decreased in the systemic response to injury and sepsis, some practitioners have argued that they should not be used to assess nutrient status in hospitalized patients. While this is true, I would suggest that visceral proteins can still be used in the hospital setting, since when they are depressed, they identify patients with poor outcomes who may benefit from nutrition support. In addition, the total lymphocyte count can be used to assess a patient's immune function, which has been shown to correlate with the degree of visceral protein depletion and clinical outcome.

Albumin. There are several reasons a patient's albumin level might be low. These include protein malnutrition, redistribution from the vascular to the interstitial space as part of the injury response, and fluid excess following resuscitation. In the hospital, severity of illness and state of hydration affect albumin concentrations more than nutrient status. Because of its long half-life (18 to 21 days), albumin only improves slowly with oral nutrition and nutrition support.

Transferrin has a half-life of 7 or 8 days. Low transferrin levels can occur with the injury response and with overhydration, while it can be elevated in patients who are iron-deficient. Because of its shorter half-life it can be measured once a week to assess the response to nutritional intervention.

Prealbumin has a half-life of 2 days, allowing for a more rapid assessment of a patient's response to nutrition support. Prealbumin concentrations can be increased by renal disease and decreased by fluid status and injury response. Although some physicians find this rapid change useful in performing a nutrition assessment and might be tempted to make frequent changes to a tube feeding of parenteral nutrition formula, I suggest that changes in a nutrient prescription be made no more than once per week because so many other factors can affect these proteins.

NUTRITIONAL REQUIREMENTS

The prescription of energy and protein to the perioperative patient who cannot eat is far different from the amount required to maintain the nutrient status in normal subjects and ambulatory patients. The primary objective in this setting is to improve organ and immune function and to promote wound healing while at the same time avoiding complications of nutrition support, such as hyperglycemia, which has been associated with poor outcome and can undermine the primary objective.

Prior to surgery, total energy needs should be met to promote nitrogen balance, while in the immediate postoperative period, permissive underfeeding is accepted for a brief time, since nitrogen balance can generally never be met during the injury response. In addition, the ability to metabolize carbohydrate and fat is decreased during the injury response, especially when these substrates are provided with TPN. Once patients recover from the stress of surgery and any associated complications, energy requirements can be increased to full goal, assuming glycemic control can be maintained. The suggestions below for energy and protein requirements (see next two sections) are target amounts for most hospitalized patients and should be adjusted depending on substrate tolerance and the response to therapy as measured by visceral proteins, weight gain, wound healing, and functional status.

Calories

Patients who are at or below their ideal weight should be provided with energy based on their current weight. Underweight patients should not be given calories based on their ideal weight, as this generally provides energy above their total requirements and may result in complications of overfeeding. Total energy expenditure in these patients ranges from 25 to 35 kcal/kg. Patients who are overweight may not tolerate full feeding, especially with TPN, since it is provided in the central circulation and first travels to the muscle and other organs for metabolism, rather than being metabolized by the liver first, as occurs with the ingestion of enteral feeding. Choban et al[10] have shown that providing energy in an amount that approximates a low-calorie diet for the treatment of obesity is adequate to allow for recovery of obese patients in the hospital setting.

We have developed an approach that uses BMI, which is calculated by dividing the patient's weight (in kg) by the square of height (in cm) and is an accepted measure of body fatness, to calculate the energy dose for overweight (BMI > 25) and obese (BMI > 30) patients that leads to the desired outcome in most patients. In overweight and obese patients, we do not advance the energy dose as they recover, as the energy deficit is made up by the utilization of the patient's excess energy stores. The method we use to calculate the initial energy dose is listed below and uses the patient's current weight:

- Normal weight/underweight (BMI < 25): 25 to 35 kcal/kg
- Overweight (BMI 25 to 29.9): 20 to 25 kcal/kg
- Obese (BMI 30 to 34.9): 15 to 20 kcal/kg
- Morbidly obese (BMI ≥ 35): 10 to 15 kcal/kg.

Proteins and amino acids

Protein is another matter. The recommended dietary intake of protein in healthy people is approximately 0.8 g/kg/day. In contrast, patients who are sick do not metabolize protein normally, and most of them require approximately 1.5 g/kg/day of protein in enteral solutions and amino acids in parenteral solutions.

Because overweight patients are provided with less energy in their nutrient solution, they must be given plenty of nitrogen to promote wound healing and fight infection. We do not generally give adults more than 2 g/kg unless they experience huge protein losses secondary to fistulas or wounds. In our department, we care for a number of people with graft-versus-host disease, which is a severe protein-losing enteropathy, and occasionally provide up to 2.5 g/kg of amino acids.

Children, however, are given as much as 3 or 4 g/kg of protein or amino acids because growth must also be promoted. Such a high dose in an adult does not lead to an improvement in nutritional status because most of the extra amount is excreted in the urine.

A guide to protein dosing based on BMI follows:

- Normal weight/underweight (BMI < 25): 1.5 g/kg of *current* weight
- Overweight/obese (BMI ≥ 25): 2.0 g/kg of *ideal* weight.

CONCLUSION

The best evidence for pre- or perioperative nutrition support is in patients who are severely malnourished. The use of postoperative TPN should also be reserved for patients with severe malnourishment or patients who are NPO beyond 7 to 10 days; broad use of postoperative TPN is not likely to be helpful and may actually increase the rate of postoperative complications.

Enteral nutrition has been shown to be equivalent to TPN in improving postoperative outcomes and should be used if the patient can eat or a feeding tube can be placed.

Height, weight, weight history, and visceral proteins can be used to assess candidates for preoperative TPN, to determine calorie and protein requirements, and to monitor response to nutrition support.

Finally, it is important to note that preoperative nutrition support should be considered only in patients who are moderately to severely malnourished in whom a major operation is planned, such as thoracoabdominal surgery, and for whom surgery can be delayed for 7 to 10 days to receive an adequate dose of this therapy. In other words, patients who require emergent or urgent surgical intervention should not be given preoperative TPN, even if they are severely malnourished. In addition, we should not expect to see an improvement in visceral proteins in patients with an ongoing injury response; nutrition support is just that—it supports, it does not cure the underlying disease.

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