World J. Surg. 23, 545–552, 1999

WORLD Journal of SURGERY

Postoperative Protein Sparing

Douglas W. Wilmore, M.D.

Laboratories for Surgical Metabolism and Nutrition, Department of Surgery, Harvard Medical School, Brigham and Women's Hospital, 75 Francis Street, Boston, Massachusetts 02115, USA

Abstract. Postoperative nitrogen sparing refers to a therapy that decreases net nitrogen loss from the body following an operation. Protein sparing has long been regarded as a surrogate marker for improved outcome, but a critical review of the evidence indicates that this relation is difficult to establish, especially in the short term. Thus, specific endpoints that evaluate outcome are needed to determine the efficacy of a specific therapy that spares protein. Cost effectiveness must also be considered. A variety of therapies were evaluated using protein-sparing, efficiency, and cost criteria. Evidence was reviewed for glucose, amino acids, parenteral nutrition, enteral nutrition, growth hormone, and glutamine administered during the perioperative period. Only three areas could be identified that spared nitrogen and provided efficacy: (1) preoperative total parenteral nutrition (TPN) for 7 to 10 days before operation in a depleted patient (≤15% body weight loss); (2) the use of growth hormone with nutritional support to promote wound healing (especially in burns) and possibly to enhance muscle strength (particularly in the elderly); and (3) the use of glutamine-supplemented TPN in severely ill surgical patients to decrease mortality. The issue of early tube feeding in trauma patients is still confusing. This therapy must be evaluated by an appropriate study in trauma patients that compares a tube-fed group with an unfed control group. Only by demonstrating improved outcomes and enhanced cost saving with our protein-sparing therapy can we continue to enhance the care of our surgical patients.

Following an operative procedure there is increased loss of nitrogen in the urine. The nitrogen appears primarily as urea, and this increased rate of ureagenesis reflects the enhanced net breakdown of body protein that is initiated and propagated by anesthesia and the surgical procedure. The extent of the nitrogen loss depends on a variety of factors: nutritional status of the host, underlying disease process, type of anesthesia administered, and duration and extent of the surgical procedure. In addition, the type of intravenous solutions infused and in some cases the drugs and hormones administered during the perioperative period often significantly decrease the cumulative nitrogen loss.

This postoperative negative nitrogen balance has been so predictable and reproducible that investigators have carefully selected patients and standardized the operative procedure and the anesthesia administered to evaluate the impact of a specific nutritional substrate on postoperative nitrogen balance. Although these studies have often been described as occurring in patients with mild to moderate injury or trauma, our knowledge has progressed so rapidly over the past 40 years that we now know that controlled elective operations rarely simulate accidental injury. This is because, in the elective surgical setting, we have learned to modulate the body's response to an operative procedure through the use of modern pharmacologic agents, regional and epidural anesthesia, minimally invasive procedures, and rapid rehabilatory techniques. Before these modern developments, there was an extensive effort to spare nitrogen during the postoperative period through the administration of nutrients, the use of anabolic agents, or both. The purpose of this article is to review this evidence and place this body of knowledge within the context of modern surgical care.

This paper was presented at a postgraduate course arranged by the International Association for Surgical Metabolism and Nutrition (IASMEN) in Acapulco, Mexico, August 24, 1997.

Definitions

Postoperative nitrogen sparing is the term often used to refer to a therapy that decreases net nitrogen loss from the body following an operation. This sparing can occur by two mechanisms. The first is a reduction in the rate of ureagenesis and a *decrease* in nitrogen excretion. This effect is usually observed following administration of glucose and its simultaneous stimulation of endogenous insulin [1]. The second mechanism occurs through the administration of amino acids (or their protein equivalent). The infusion of amino acids actually *increases* the excretion of urinary nitrogen. A proportion of the nitrogen administered is retained, and so nitrogen balance becomes more positive and thus protein is spared. (Balance is defined as the sum of the intake of nitrogen minus all nitrogen lost in urine and stool and via other routes). The latter mechanism appears to be related to an innate property of the amino acids themselves and occurs despite the hormonal milieu or extent of ketosis [2]. By providing parenteral nutrition (which combines calories with amino acids) both of these mechanisms are stimulated; and in some cases even a positive nitrogen balance is achieved.

Protein sparing has long been regarded as a surrogate marker for improved outcome. This is understandable, as protein represents the structural and functional component of the body. Body protein stores do not exist per se, and therefore loss of body protein should represent some loss of optimal body function. It has been argued that attenuating this loss or improving the retention of body protein should improve body function and restore and maintain health. Although this is probably the case in the long term, it is difficult to establish it in the short term. In fact, a select committee recently reviewed the evidence and failed to find a metabolic marker such as nitrogen balance or protein sparing that correlated with patient outcome [3]. Thus specific measures of outcome are the endpoints needed to evaluate the efficacy of nutritional support.

This review evaluates the effect of various approaches to protein sparing and relates this metabolic response to the outcome of the patient (if the data are available). A therapy may be efficacious but not cost-effective. Therefore the cost-benefit ratio of a particular approach is reviewed and reported when available.

Dextrose

Dextrose, or D-glucose, has long been a component of medical therapy. Discovered as a chemical element during the seventeenth century, the biochemistry of dextrose and other simple sugars was most extensively described by Emil Fischer during the late 1800s. Fischer continued his work on the structure and metabolism of sugars and established such a renown reputation in this field that he is now regarded as the "father of carbohydrate chemistry."

Two important discoveries during the early twentieth century allowed application of the basic science of carbohydrates to clinical care [4]. The first discovery was a simple method for determining the concentration of glucose in the bloodstream. The second finding was the isolation of insulin from the pancreas, which allowed future investigators to study and understand the regulation of glucose metabolism. As a result of these and other developments, dextrose was utilized for a variety of treatments during the first part of the twentieth century [4]. Dextrose was added to intravenous solutions to resuscitate soldiers during World War I and was later used in various concentrations to treat cardiac failure, neonatal hypoglycemia, liver failure, a variety of infectious diseases, and other catabolic illnesses.

It was not until World War II that the protein-sparing effects of dextrose were carefully evaluated by James Gamble, who was commissioned by the government to develop the optimal ration to be provided on life rafts for survivors of German U-boat attacks [5]. Gamble was not as concerned with the protein-sparing effects of dextrose as he was fascinated by the salt-retaining capacity of a glucose load. Because of the need to optimize water balance in individuals adrift at sea, he determined that dextrose would reduce the urea load and conserve sodium (Fig. 1). As urea was the main solute that required water for renal excretion, such an effect would minimize fluid requirements. Gamble demonstrated that 100 g of dextrose per day provided near-optimal "protein sparing." [Little more was achieved in reducing nitrogen excretion by providing larger doses (200 g) of dextrose.] This concept was studied and confirmed by others. Elman concluded that "this minimum of 100 grams of carbohydrate applies to the adult under normal conditions, and is probably also true for the patient during an uncomplicated operative period. . . . Less than 100 grams will provoke unnecessary utilization of tissue protein to provide energy and lead to excessive production of ketone bodies with the potential danger of inducing acidosis" [6].

Dextrose was inexpensive, relatively safe and provided a diffusible utilizable molecule that would provide an active isosmotic material in intravenous solutions. However, is dextrose necessary? Is it efficacious? No studies are available to answer these ques-

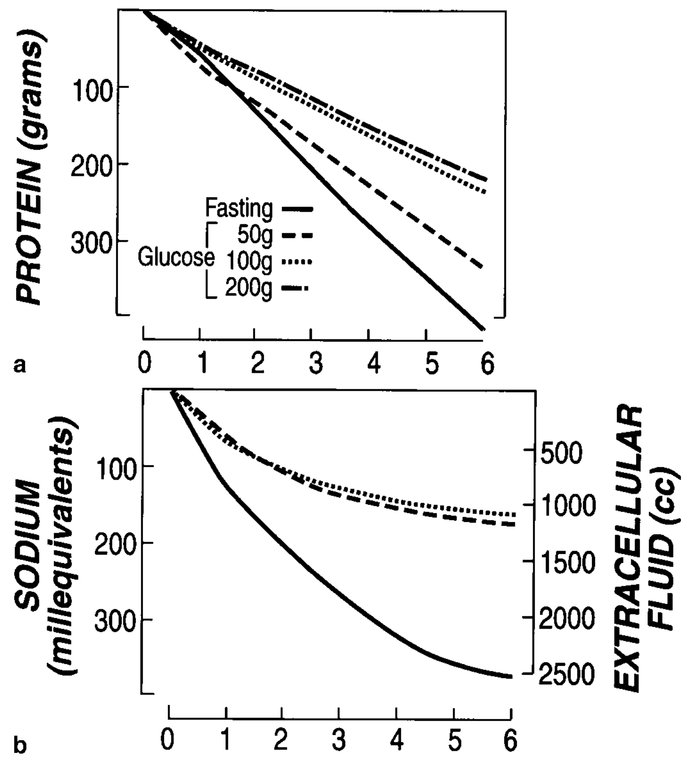


Fig. 1. Repeated studies in a single, fasted subject demonstrate the dose-response effect of oral glucose on protein (**a**) and sodium (**b**) sparing. Data are plotted as cumulative loss and are adapted from Gamble [5], with permission of Academic Press.

tions. As Moore pointed out, "there is no objective evidence in the literature that the 200 to 500 calories a day provided by 5 percent dextrose in water makes any material difference in the postoperative welfare of the patient after elective surgery. One must consider that the best step is to give the glucose; it apparently does no harm" [7].

Amino Acids

Amino acids (and other protein equivalent substrates) are essential for achieving nitrogen balance and maintaining optimal protein nutrition; but most consider the infusion of amino acids within the context of supplying all or at least some of the nonprotein calories. Therefore it was provocative when Blackburn and his colleagues reported that they could obtain near-positive nitrogen balance in a variety of surgical patients by the infusion of amino acids via a peripheral vein [8, 9]. The basis for this nitrogen-sparing effect was said to be related to the complete *withdrawal* of dextrose, which allowed insulin levels to fall, fatty acids to be mobilized, and ketosis to occur. The ketones thus served as a fuel source and as a signal to promote protein conservation.

A flurry of reports followed [2, 10–15]. In general, the results can be summarized as follows.

1. When compared to saline, often isocaloric quantities of glucose, and lipid infusions, amino acids provided superior nitrogen balance in postoperative patients (Fig. 2).
2. The mechanism by which protein sparing occurred was not

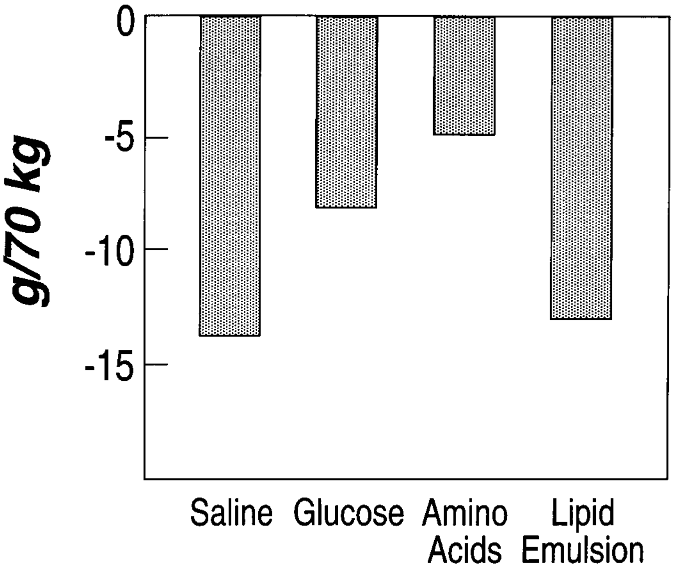


Fig. 2. Nitrogen balance in patients following elective pyloroplasty and vagotomy and after receiving one of four infusions during the postoperative period. The glucose, amino acids, and lipid emulsion were isocaloric infusions. (Adapted from Craig et al. [14], with permission of The Lancet Ltd., © *The Lancet* 1977.)

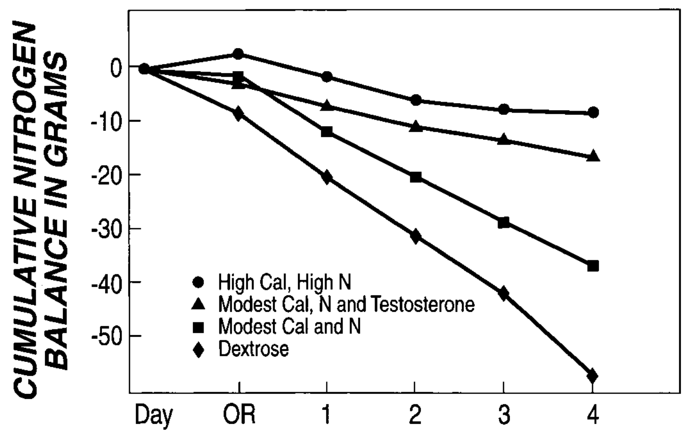


Fig. 3. Cumulative postoperative nitrogen balance improves with the addition of nitrogen and calories to parenteral nutrition in patients following gastric operations. The high caloric, high nitrogen infusions contained about 1.2 g protein/kg and about 30 calories/kg and approached nitrogen equilibrium during the postoperative period. (From Holden et al. [18], with permission of Lippincott-Raven Publishers.)

through the effects of ketosis, as manipulating the endocrine environment by adding glucose or lipid emulsion to the infusate and thus manipulating the insulin and ketone concentrations had no effect on the protein-sparing response [2].

3. No improvement in outcome has been demonstrated with the infusion of amino acids alone.
4. Mixtures of crystalline amino acids are expressive; and with no clinical benefit derived from their infusion during the postoperative period, the cost of these solutions does not justify their use.
5. In starved, nonhypermetabolic patients who cannot take enteral feedings, nitrogen equilibrium or even a slight positive balance may be achieved with amino acid infusions [6, 16]. Using this approach, successful clinical outcomes have also been noted in a highly select patient group.

Parenteral Nutrition

During the 1940s Elman reported that nitrogen equilibrium could be achieved in malnourished patients receiving infusions of protein hydrolysates and isotonic glucose [17]. Later Abbott and colleagues in the United States [18] and Hallberg et al. in Sweden [19] greatly attenuated the nitrogen loss following intraabdominal operations by infusing various mixtures of protein hydrolysates, glucose, and lipid emulsion. With the demonstration in 1967 that positive nitrogen balance, wound healing, and growth could be achieved with the infusion of all essential nutrients via a central venous catheter [20], investigators around the world embarked on studies that would further optimize parenteral nutrition. In general, most moderately to well nourished patients undergoing elective or semielective operations could achieve near nitrogen equilibrium by receiving 30 to 35 kcal/kg and 1.5 g protein/kg (Fig. 3). The proportion of fat and dextrose (as the caloric source) varied, with fat emulsion contributing 15% to 50% of the nonprotein calories; the remaining nonprotein calories were infused as concentrated dextrose. Rarely were glucose concentrations greater than 15% necessary to provide the dextrose requirement of 4 mg/kg/min (<6 g/kg/day) [21].

The interaction between calories, nitrogen, and minerals required additional carefully designed balance studies. Johnson and Clark demonstrated that as the calories were increased the nitrogen balance improved (became more positive) and that this relation was linear [22]. Similar studies were performed by Rudman and colleagues, who fixed calorie intake and varied the quantity of nitrogen administered [23]. They also demonstrated that protein excretion would not occur if potassium or phosphorus were omitted from the nutrient mix. Similar studies of nutrient interaction have been performed in more catabolic patients [24]; all of these investigations demonstrated the general concept articulated by Calloway and Spector: increasing the quantity of energy in the diet improved the nitrogen balance. The collollary to the rule was that with a fixed energy intake the quantity of nitrogen in the diet became the limiting determinant of the nitrogen balance (Fig. 4) [25]. A detailed study of the effects of parenteral substrate, administered alone or in combination to normal volunteers, has also been carried out by Wolfe and associates [1]. These data and the studies previously performed in patients confirms that a similar relation between calories and nitrogen accounts for predictable effects on protein retention when these substrates are administered by the parenteral route. This relation is generally optimized when the parenteral solution contains nitrogen and calories in a ratio of approximately 1:150.

The development of the central venous infusion technique allowed infusion of the optimal or near-optimal parenteral nutritional requirements for postoperative patients. During the past 20 years a variety of prospective randomized trials were undertaken to evaluate the influence of perioperative parenteral nutrition on *outcome.* These trials have been reviewed in detail [3]. Thirteen studies involving 1250 surgical patients provided total parenteral nutrition (TPN) for at least 7 to 10 days *before* an elective surgical procedure. Most patients were considered by the authors to be "moderately malnourished." Nine of the thirteen studies found that the patients

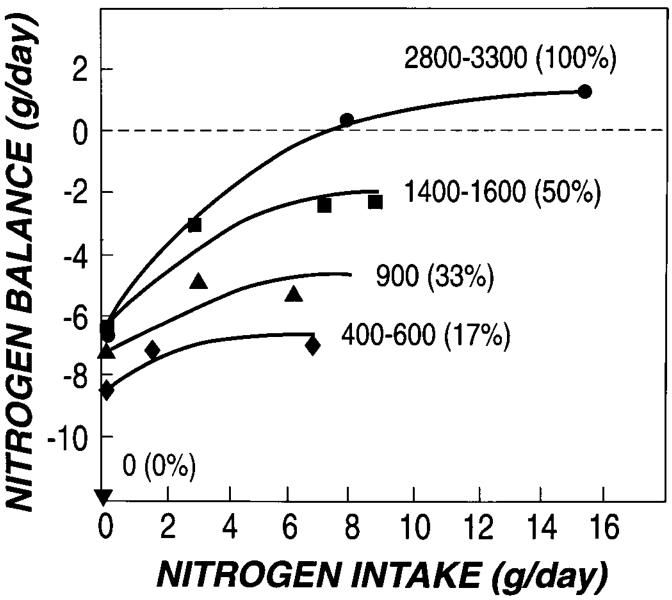


Fig. 4. Relation between nitrogen intake, caloric intake, and nitrogen balance. These studies were performed in normal exercising young men. The curves shifted downward and to the right in catabolic patients and upward and to the left in malnourished nonhypermetabolic subjects. (Adapted from Calloway and Spector [25], with permission. © Am. J. Clin. Nutr., American Society for Clinical Nutrition.)

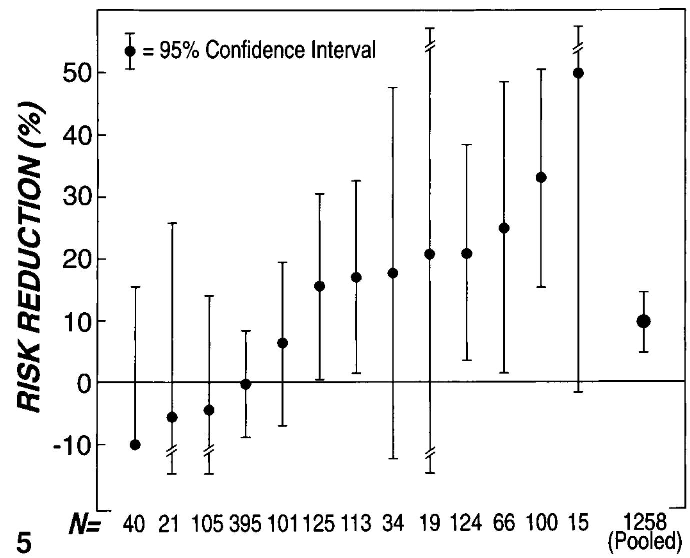
who received TPN had fewer postoperative complications. The pooled result demonstrated that preoperative TPN reduced the overall risk for complications in those patients by 10% (Fig. 5). Similar pooled analysis of eight prospective trials in more than 700 postoperative patients suggested that TPN *increased* the overall risk of complications approximately 10% (Fig. 6). No statistical differences for mortality between treated and control groups were found in either pooled sample.

Thus in malnourished patients with approximately ≥15% body weight loss, a week or more of parenteral nutritional support seems indicated from these trials. However, no comparable economic data are available for analysis at this time, and it is not known if preoperative intravenous nutritional therapy is more expensive than treatment of the complications that might occur without this nutritional therapy.

Enteral Nutrition

The role of enteral nutrition in nitrogen sparing was established in postoperative patients approximately 50 years ago. Nasointestinal feeding tubes were utilized in a group of patients who had undergone intercranial or upper abdominal surgical procedures [26]. Some patients were supported by standard postoperative fluids, and others received tube feedings, which provided 0.3 g nitrogen/kg and 30 kcal/kg. Most of the tube-fed patients achieved nitrogen equilibrium during the immediate postoperative period, whereas the controls continued to be in negative nitrogen balance throughout the duration of the study.

Two technologic developments prompted the widespread application of this technique to a variety of postoperative patients. First, a complete nutrient formula of low viscosity was developed (e.g., the elemental diet). Next, a fine-bore Silastic catheter was tailored



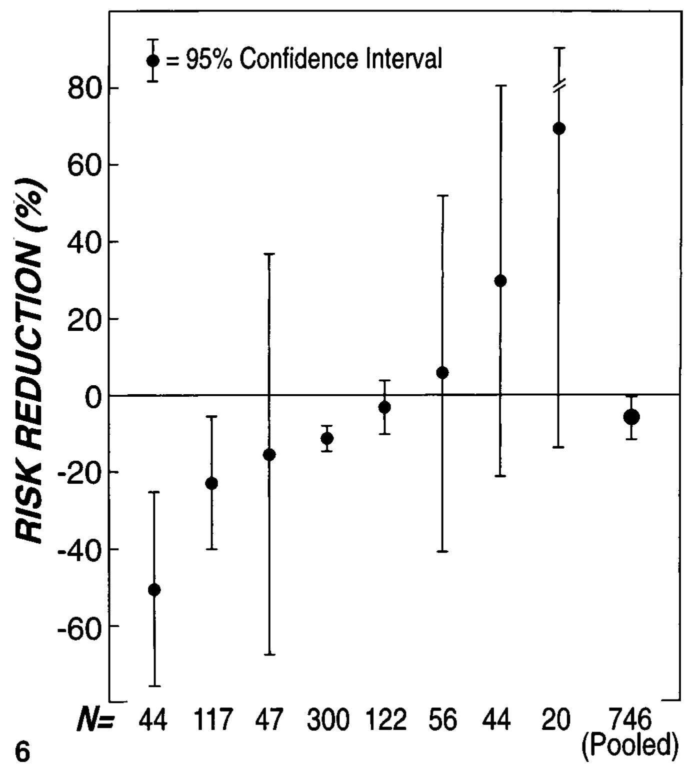


Fig. 5. Relation between preoperative TPN and postoperative risk reduction from 13 randomized trials. Each point represents the mean and the bars the 95% confidence interval for each trial. Numbers on the baseline indicate the number of patients entered in the trial. Values above the zero line indicate a decrease in complications. The pooled analysis, shown on the right, demonstrates a 10% reduction in complications. (From Klein et al. [3], with permission of the publisher and author.)

Fig. 6. Relation between postoperative TPN and morbidity. The data from eight prospective randomized trials are plotted in a similar fashion to those displayed in Fig. 5. Points below the zero line show an *increase* in complications. The pooled data at the far right shows a 10% increase in complications in the TPN group. (From Klein et al. [3], with permission of the publisher and author.)

specifically for use as a jejunostomy tube. Thus, the technique of needle catheter jejunostomy was developed and refined [27]. More recently, a variety of nasoenteral tube or gastrostomy tube with extensions have become commercially available, along with techniques to promote safe intubation of the duodenum and jejunum.

During the past 10 years, a variety of studies have been reported using immediate postoperative enteral feedings and comparing this approach with parenteral feedings. Differing views have emerged. In patients undergoing elective surgical procedures, little difference between the route of feeding and outcome, intestinal permeability, nitrogen balance, or measures of immune response have been reported [28–30]. In contrast, patients receiving early enteral feeding, particularly following accidental injury, have been reported to have fewer complications than a parenterally fed control group [31, 32]. The differences between these studies may be due, in part, to the difference in the severity of injury sustained by patients undergoing elective intraabdominal procedures versus those suffering from a major accidental injury. When an independent group reviewed the data they concluded: "Trauma patients fed by enteral nutrition have fewer complications than those given TPN. However, it is not clear whether enteral nutrition support provides a specific benefit or whether TPN itself or overfeeding by TPN is associated with increased infections" [3].

Two recent studies have attempted to address this question. In the first, Heslin and associates randomized 195 patients requiring operations for upper gastrointestinal malignancy into a control group (receiving standard intravenous dextrose and electrolyte solutions) or those receiving early enteral feedings with an immune-enhancing diet via jejunostomy [33]. There were no significant differences in the number of minor, major, or infection/wound complications between groups. Hospital mortality and length of stay were comparable in the two groups. The investigators concluded that postoperative jejunostomy feeding was not helpful and should not be utilized in a routine fashion in patients with cancer of the upper gastrointestinal tract.

In the second study, 28 patients undergoing esophagectomy or pancreatectomy were randomized to receive enteral feedings via jejunostomy or no enteral feeding during the first six postoperative days [34]. Hand grip strength, measures of pulmonary function, and indices of fatigue and vigor were assessed preoperatively and during the postoperative period. Postoperative vital capacity, forced expiratory volume at 1 second (FEV_1), and postoperative mobility were *consistently reduced* in the group receiving enteral feedings when compared with controls. Hand grip strength, fatigue, and vigor were similar in the two groups. Because there was no beneficial effect demonstrated and feedings were associated with impaired respiratory mechanics and decreased postoperative mobility, the authors concluded that immediate postoperative feedings should not be routine in patients with low nutritional risk.

Thus routine use of jejunostomy feedings in most elective or semielective surgical patients has not been proven to be beneficial and in fact may be harmful. The beneficial effects of enteral feedings in trauma patients have been demonstrated when compared to comparable patients receiving TPN. Studies must be performed in this group of patients where tube feedings are compared to standard treatment to determine if there is an outcome advantage utilizing early enteral feedings.

Anabolic Agents

There has been a long-term interest in improving the efficiency of administered nutrients by using anabolic agents such as testosterone, anabolic steroids, or extracts of the anterior pituitary gland. It became apparent during the 1980s that current methods of nutritional support were relatively inefficient at replenishing the protein-rich, metabolically active cellular portion of the body's lean tissue. It was found that conventional TPN was reasonably effective for deposition of body fat and expansion of the extracellular fluid compartment. However, protein accretion was significantly limited [35–38]. Because protein is critical to body structure and function, investigators have evaluated anabolic agents, such as growth hormone, in an attempt to augment nitrogen-sparing effects. These studies have spanned more than 30 years, but it was not until the development and availability of commercially produced growth hormone (GH), expressed from genetically engineered *Escherichia coli,* that studies of significant duration that included adequate numbers of patients were possible.

Ward et al. administered GH or placebo to postoperative patients receiving approximately 400 calories from 5% dextrose solutions [39]. Nitrogen excretion over 6 days was reduced from 42.7 ± 3.1 g to 31.5 ± 2.4 g, and fat oxidation increased with GH treatment. There was also a rise in serum glucose, insulin, and insulin-like growth factor 1 (IGF-1).

Manson and Wilmore demonstrated that positive nitrogen balance could be achieved in normal volunteers by providing adequate nitrogen but only 50% of the required energy [40]. This approach was applied by Jiang and associates, who studied a group of postoperative surgical patients following gastrectomy or colectomy [41]. The patients received parenteral nutrition containing 20 kcal/kg/day and 1 g protein/kg/day and were randomized in a blinded manner to receive placebo or GH (0.06 mg/kg/day). The GH-treated subjects lost significantly less weight (1.3 vs. 3.3 kg); cumulative nitrogen loss over 8 days was only 7.1 g, versus 32.6 g in controls. Amino acid flux studies across the forearm demonstrated that the GH-treated patients had increased uptake of amino acids into forearm skeletal muscle, and the control subjects released amino acids from their forearm. In the control patients hand grip force decreased approximately 10% following operation, whereas the patients who received GH maintained their grip strength throughout the postoperative period. This maintenance of strength was the first demonstration that this anabolic therapy could effect a positive functional outcome. Similar studies have been performed by others, and enhanced hand grip and respiratory muscle strength with GH have been reported [42].

In an effort to evaluate the clinical effects of this anabolic agent on muscle strength, Knox and associates treated a group of postoperative ventilator-dependent patients with GH and adequate nutrition [43]. Patients who satisfied the entry criteria ($n = 53$) and could not be weaned from the ventilator after 14 days of conventional treatment received GH, administered in doses ranging from 0.04 to 0.14 mg/kg/day. The average duration of therapy was 38 days, and 81% of the previously unweanable patients became independent from the ventilator; overall survival was 76%. Because the actual mortality rate of 24% was significantly less than the 42% mortality predicted from APACHE II scores derived from patient assessment, randomized blinded placebo trials were warranted and are now being performed.

Thus GH and other agents such as IGF-1 hold promise of enhancing nitrogen balance and improving outcome. In addition to improving muscle strength, GH has been shown to accelerate wound healing [44]. This anabolic hormone may be an extremely useful drug in the care of complex debilitated surgical patients.

Glutamine

Glutamine (GLN) is now thought of as a conditionally essential amino acid in patients with serious illness and necessary as a fuel for immunologic tissue and the intestinal mucosa. In addition, GLN participates in acid-base homeostasis, enhances wound healing, and provides substrate for glutathione, one of the most important intracellular antioxidants in the body.

The addition of GLN to the intravenous feedings of postoperative patients significantly attenuates the negative nitrogen balance that follows colectomy [45]. Does GLN enhance efficacy?

In one recent study of postoperative patients, individuals were randomly assigned to receive standard TPN or GLN-supplemented infusions [46]. The diets were isocaloric and isonitrogenous. After 6 days of therapy, nitrogen balance was improved and lymphocyte recovery enhanced in the GLN-supplemented group. Moreover, the hospital stay was reduced 6 days in the GLN group, a decrease in length of stay comparable to previous reports of patients receiving GLN-supplemented TPN following bone marrow transplantation [47, 48].

Griffiths and colleagues reported the results of a similar trial performed in critically ill patients, most of whom required ventilatory support and could not tolerate tube feedings because of intraabdominal sepsis [49]. One half of the group ($n = 84$) was randomized to receive GLN-containing TPN, and the others received conventional parenteral nutrition. Survival at 6 months was significantly improved in those receiving GLN (24/42 vs. 14/42; $p = 0.049$). In patients fed more than 10 days, 12 of 17 (71%) controls died vs. only 5 of 18 (28%) of the GLN fed group.

A cost analysis of the study groups demonstrated that the total intensive care unit and hospital cost per survivor were reduced by 50% in the GLN group. Thus, emerging data demonstrates that glutamine-supplemented nutritional solutions can enhance outcome and reduce costs in a critically ill patient group. Additional studies utilizing these new GLN-supplemental solutions are forthcoming.

Discussion and Conclusions

Over the past 50 years much attention has been focused on postoperative nitrogen sparing. Although this endpoint was an interesting metabolic determination to study and manipulate, in the *short term* postoperative nitrogen sparing had little relevance to outcome.

Moreover, the stress of an operative procedure has changed over time, thanks to newer anesthetic techniques, technical approaches to the procedure itself, and other aspects of perioperative care. At one time, open cholecystectomy was used as a model of surgical trauma; patients were infused, sampled, biopsied, and discharged from the hospital 7 days later. Now, with minimally invasive operations, cholecystectomy is a same-day surgical procedure. Patients are often back into their routine of daily living within 2 to 3 days of laparoscopic cholecystectomy.

Physicians interested in nutritional support must adapt to these changes. Postoperative nitrogen sparing—or other biochemical measures—are no longer important primary endpoints in clinical trials. Nutritional support must improve outcome if this therapy is to have enhanced value in today's medical marketplace. In these terms, reduced length of stay (which occurs if complications are reduced) and reduced mortality are measures that are extremely relevant to patient care. Other benefits that specifically enhance individual patient outcome should also be determined (e.g., strength, self-care, vigor, mood state, depression, anxiety), but even these endpoints by themselves are more difficult to translate into payment for nutritional support by an insurance company.

A variety of data have been reviewed that evaluate nutritional and anabolic approaches that attenuated nitrogen loss following operations, primarily elective or semielective procedures. However, when the task of identifying cost-effective therapy is added to the list of endpoints, only three general areas can be identified that spare nitrogen and provide efficacy. The evidence indicates the following.

1. Preoperative TPN for 7 to 10 days in a depleted patient (>15% body weight loss) results in a 10% decrease in postoperative complications.
2. The use of GH during the perioperative period enhances rehabilitation (e.g., increases muscle strength and promotes wound healing) in patients with major injuries (e.g., burns) or in elderly patients following major operations.
3. GLN-supplemented parenteral nutrition in severely ill surgical patients reduces length of stay and improves survival.

The last two areas are still provisional and additional data from ongoing studies are forthcoming.

The issue of early tube feeding in the trauma patient must be addressed and early enteral feedings compared to a no-treatment control group. Moreover, this review did not evaluate the effect of parenteral nutrition in prolonged catabolic states, sepsis, or newborn infants. These conditions may require repeated operations, and long-term intensive care may be necessary, in which case parenteral nutrition is life-sustaining.

Like the hula-hoop, blue velvet shoes, and 78 RPM records, postoperative protein sparing has passed its prime. That is not to say that this metabolic endpoint cannot reappear in the future and come back onto vogue. However, those interested in metabolic support of surgical patients must move on from metabolic endpoints and demonstrate improved outcomes and enhanced cost savings with the therapy to bring added value to the care of our patients. This will be the challenge of nutritional support in the future.

Résumé

Par technique d'épargne azotée postopératoire, nous entendons une stratégie thérapeutique qui diminue les pertes totales en azote du corps après une intervention chirurgicale. On a souvent regardé l'épargne azoté comme un marqueur supplémentaire d'amélioration de l'évolution, mais une revue critique de l'évidence indique que le rapport de cause et effet est difficile à établir, surtout dans le court terme. Ainsi, on a besoin de critères de jugement évolutifs spécifiques de l'évolution pour déterminer l'efficacité d'une thérapeutique d'épargne azotée. Le cout-efficacité doit aussi être pris en compte. Une variété de thérapeutiques a été évaluée, en tenant compte de l'épargne azotée, l'efficience et les critères de cout-efficacité. L'évidence en faveur de l'administration de glucose, des acides aminés, de la nutrition parentérale, de la nutrition entérale, de l'hormone de croissance et de la glutamine dans la période périopératoire a été examinée. Trois paramètres d'efficacité ont pu être identifiés en matière d'épargne azotée: 1) nutrition parentérale totale préopératoire, 7–10 jours avant l'opération chez un patient dénutri (perte de poids </= 15% du poids corporel). 2) utilisation de l'hormone de croissance avec un soutien nutritionnel pour promouvoir la cicatrisation (surtout en cas de brûlures) et possiblement pour améliorer la puissance musculaire (surtout chez le sujet âgé) 3) utilisation d'alimentation parentérale totale supplémentée en glutamine chez le patient gravement malade pour diminuer la mortalité. L'utilité d'une ré-alimentation précoce chez le blessé grave reste discutée. Cette thérapeutique nécessite une étude contrôlée pour comparer un groupe de patients nourris par tube naso-gastrique avec un groupe de contrôle de patients non nourris par tube. C'est seulement si l'on démontre une amélioration de l'évolution ou une économie des coûts que l'épargne azotée thérapeutique mériterait d'être continuée pour améliorer les soins de nos patients en chirurgie.

Resumen

El ahorro proteico postoperatorio se refiere a la terapia que disminuye la pérdida neta de nitrógeno corporal luego de una operación. El ahorro proteico ha sido considerado como un marcador alterno de mejor resultado final de la evolución clínica, pero la revisión crítica de la evidencia indica que tal relación es difícil de establecer, especialmente en el corto plazo. Por lo tanto, se requieren parámetros específicos de resultado final para determinar la eficacia de una terapia específica de ahorro proteico. Una variedad de terapias fue evaluada mediante el análisis de criterios de ahorro proteico, eficiencia y costo. Se revisó la evidencia disponible para el uso de glucosa, aminoácidos, nutrición parenteral, nutrición enteral, hormona de crecimiento y glutamina en el período postoperatorio. Sólo pudieron ser identificadas tres áreas en la cuales apareció eficaz el ahorro proteico. Estas fueron: 1) NPT preoperatoria por 7–10 días antes de la operación en pacientes con depleción (≤15% de pérdida de peso corporal). 2) El uso de hormona de crecimiento concomitante con soporte nutricional para promover cicatrización de la herida (especialmente en quemaduras) y, posiblemente, para promover fortaleza muscular (particularmente en ancianos). 3) El uso de NPT suplementada con glutamina en pacientes quirúrgicos en estado crítico para disminuir mortalidad. El tema de la nutrición enteral precoz en pacientes traumatizados todavía es confuso, y esta modalidad terapéutica requiere ser evaluada mediante un estudio apropiado que compare un grupo de pacientes alimentados en forma precoz contra uno que no lo sea. Solamente demostrando un mejor resultado final y una disminución de costos con nuestro régimen de ahorro proteico, es que lograremos una superación en la atención de nuestros pacientes quirúrgicos.

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