NUTRITIONAL SUPPORT IN PEDIATRIC SURGERY

Clinical Indications of Parenteral and Enteral Nutrition Support in Pediatric Patients

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INTRODUCTION

Modern nutritional support not only signifies the supply of nutrients by parenteral or enteral route sufficient to meet daily requirements for health by an appropriate means but also has more positive connotations of a strong wish to improve the nutritional and metabolic condition, to prevent various sequelae of malnutrition, and provide therapy to help patients with various disorders take a turn for the better. For nutritional support to accomplish these purposes, it is important to evaluate accurately the current nutritional and metabolic status of the patient using properly selected sensitive parameters, and determine, on the basis of the results thus obtained, the most appropriate method of nutritional support for the existing pathologic condition. This came into being as a consequence of the remarkable progress of total parenteral nutrition (TPN) during the last few years. With the subsequent technical refinements and development of highly sophisticated nutrient solutions consisting of optimal combinations of macro- and micronutrients and adjunctive drugs for the individual patient's situation, TPN is now playing an important role in patient management. In fact, attempts have been made since the beginning of this century to give as high-calorie nutrition as possible intravenously to malnourished patients and to those in whom there is a definite anatomic or functional loss of intestine. Unfortunately, however, none of these attempts proved successful in the clinical application of intravenous infusion of a mixture of mainly glucose, fat, and amino acid. Moreover, with regard to the use of low calorie electrolyte solution alone, the limitations of TPN's capacity to maintain homeostasis and life were increasingly felt as the duration of its use became longer and malnutrition worsened. Difficulties with traditional peripheral parenteral nutrition were overcome in the late 1960s through experiments on growth in puppies and subsequent clinical trials in pediatric patients with multiple intestinal atresia.[1] A generally applicable TPN protocol was developed, thus making a dramatic breakthrough in the treatment of malnutrition. It was not until the advent of TPN that it was established that highly concentrated carbohydrates could be administered through a central venous line, that use of coadministered amino acid mixture as a protein source was verified, and that clinical evidence was obtained that nutritional status can be maintained and even improved by TPN alone. With this as a turning point, there was an abrupt increase in the number of nutrition support teams worldwide who began to use TPN in the nutritional management of critically ill and postoperative patients. However, it became obvious soon after the advent of TPN that, contrary to expectation, its use was attended by a great many adverse reactions and complications that had never been noted with hitherto employed techniques for nutrition, the safety of TPN thus being seriously in doubt. Intensive studies were conducted in an effort to improve the material of intravenous catheters, secure aseptic control of the infusion line, prevent metabolic complications, and develop effective measures to prevent, circumvent, or relieve adverse events.[2] Through these strenuous research efforts, the safety of TPN gradually was established.

On the other hand, attempts to introduce nutrient solutions via a tube inserted into the gastrointestinal tract in patients incapable of oral intake of foodstuffs were made even earlier. Thus, as long ago as the 19th century, tube feeding was used in the treatment of malnourished patients. Later on, after the turn of the century, it was demonstrated that proteins are absorbed from the intestines upon being hydrolyzed to their constituent amino acids. This finding led to the establishment of the concept of essential and nonessential amino acids, on the basis of which enteral nutrition solutions that contain an amino acid mixture and bear more and more resemblance to the present-day TPN solution were prepared and proven to be of therapeutic benefit in the nutritional treatment of the patients. In current clinical practice, parenteral and enteral nutrition are being used either alone or in combination and have demonstrated great therapeutic benefit in debilitated patients with various disorders.

INDICATIONS FOR PARENTERAL AND ENTERAL NUTRITION

The basic principle of nutritional support is to make an estimate of the functioning gut and on the basis thereof to continue oral (or enteral) nutrition as much as possible. Strictly speaking, there is only one method of nutrition best suited for a given pathologic condition, with no alternative, and thus physicians can not make a choice according to their own preferences. In making the decision, one also should take into account the concept of cost

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TABLE I.

INDICATIONS OF TOTAL CASES RECEIVING TOTAL PARENTERAL NUTRITION DURING THE PAST 26 YEARS (1971–1996) IN OSAKA UNIVERSITY MEDICAL SCHOOL

	Adult	Pediatric	Total Number
Pre- and postoperative management	804	834	1638 (38.3%)
Postoperative complications	206	77	283 (6.6%)
Gastrointestinal symptoms (ileus, diarrhea, bleeding, etc.)	207	139	346 (8.1%)
Inadequate oral intake including cancer cachexia	453	99	552 (12.9%)
Anticancer treatment	538	377	915 (21.4%)
Liver or renal failure (multiorgan failure)	101	29	130 (3.0%)
Respiratory management	87	68	155 (3.6%)
Intestinal failure	63	65	128 (3.0%)
Others	137	47	184 (4.3%)
Total	2557	1717	4274 (100%)

benefit and data concerning the incidence of complications and/or adverse events are related at least partly to the management skills of the physician. In cases where there is a lesion of the digestive tract and stimuli induced by ingestion of food are considered likely to adversely influence the healing process, the physician should reduce stimuli to the lesion while maintaining nutritional status. With regard to oral feeding, it is not uncommon to encounter cases in which intake of food, though apparently increasing at a normal pace, is in actual fact considerably less than needed.

Table I gives indications of total cases of 2557 adults and 1717 children receiving TPN at our institution during the past 26 y (1971–1996). Overall, TPN is used in perioperative management in about 45% of cases (routine pre- and postoperative management, postoperative complications) and as part of cancer treatment (treatment of cancer cachexia and as an adjunct to anticancer therapy). When comparing the first 13-year period of TPN use with the second 13-year period, we found that there was an increase in the number of cases receiving TPN as a means of perioperative management in the latter, with a concomitant decrease in the frequency with which TPN was used to combat postoperative complications. This suggested the possibility that routine pre- and postoperative management reduced the incidence of postoperative complications. This is of great significance especially to critically ill newborn infants, and in fact, TPN has been demonstrated to be effective in supplying nutrients and improving nutritional deficiencies in newborn cases of gastrointestinal diseases, e.g., intestinal obstruction, midgut volvulus, necrotizing enterocolitis, giant omphalocele, and gastroschisis, in which the newborn infant is very much likely to be malnourished over a prolonged period of time.[4] The fact that cases in which TPN was administered as an adjuvant therapy to control adverse effects of cancer chemotherapy have increased markedly in number during recent years clearly indicates that TPN, with its proven effectiveness in maintaining nutritional status, is becoming an essential part of treatment for pediatric cancer patients. Recently, there is also an increased number of instances in which TPN has been used in the management of respiratory distress associated with multiple organ failure. In addition, a pathologic condition that logically and tentatively could be termed intestinal failure, though quite limited in incidence in our own experience, is shown to be an indication for TPN. Thanks to the great technical advances made in recent years, TPN now offers the possibility that even a complete functional loss of the gut, which formerly would have certainly proved fatal, is compatible with life and the patient can return home and be rehabilitated[5] for many years.

INTESTINAL FAILURE

Intestinal failure is an inability of the gut to adequately perform its function or, more specifically, a condition in which there is a dependence upon oral nutrition owing to an insufficiency of the normally functioning gut. In this condition, TPN usually is indicated, though enteral nutrition (a low-residue or elemental diet) occasionally may be feasible. Intestinal failure may be divided roughly into two categories: one characterized by an absolute decrease in the volume of the gut capable of performing digestion and absorption and the other marked by extensive or widespread lesions or malfunction (malabsorption or motor dysfunction) in the absence of an anatomic loss of gut. Of all pediatric patients treated with TPN in our department during the past 26 y (1971–1996), only 27 patients were categorized as having intestinal failure. When classified according to primary disease, there were 13 patients with short bowel syndrome (5 congenital intestinal atresia, 5 extensive intestinal aganglionosis) and 14 with intestinal dysfunction (mostly infantile diarrhea). Also falling in the latter category are chronic idiopathic intestinal pseudo-obstruction (CIIPS), abnormalities of intestinal ganglia (oligoganglionosis or hypoganglionosis), and Crohn's disease. Many of these pathologic conditions are of unknown etiology and it is hoped that TPN will prove life saving in a growing number of cases. At the same time strenuous research efforts in this particular field are directed toward achieving a major breakthrough in the treatment of disease states that have so far defied all attempts to find an effective therapy. Also, these disease states pose various managerial problems in that in many instances excessive secretion from nasogastric tubes and water-electrolyte imbalance has been known to occur. On the other hand, the development and subsequent excerbation of hepatic dysfunction is a major complication of long-term parenteral nutrition. We have experienced nine cases (in adults and children) of severe hepatic dysfunction occurring in association with long-term administration of TPN and eventuating in fatal hepatic failure. In all these cases, the gross appearance of the liver on autopsy was that of fully developed cirrhosis, and the primary disease was one of those forms of enteropathy that fall under the category of so-called intestinal failure, implicating enhanced bacterial (or endotoxin) translocation due to atrophy of the intestinal mucosa, excessive proliferation of intestinal bacteria, and resulting in the exacerbation of TPN-induced hepatic fibrosis in these cases.[6–8] However, the exact pathogenic mechanism of the devastating liver disease is by no means simple, and intensive in-depth studies are needed to elucidate the mechanism whereby bacteria or endotoxin, upon reaching the liver by way of possibly the portal vein, ultimately produce irreversible changes in liver tissue. Glutamine or other intestinal growth factors, i.e., growth hormone or insulin-like growth factors, are expected to be effective in maintaining intestinal structure and function to prevent liver dysfunction in clinical practice.[9,10]

INTESTINAL TRANSPLANTATION

In many countries, organ transplantation recently has been securing a position in clinical practice as a modern therapeutic modality. The force behind the worldwide usage of organ transplantation is the availability of immunosuppressive agents, notably cyclosporin A, FK506, and several other immunosuppressive drugs that have been playing a major role in the evolution of organ transplantation.

The small intestine is believed to be the most difficult to transplant of all possible organs. However, with the introduction of cyclosporin A (Cy A) in the early 1980s, there was a marked

improvement in the outcome of organ transplantation as a whole, and, at the same time, a growing interest in small bowel transplantation. In 1985, the first successful human small bowel transplant was performed using Cy A by Cohen and associated in Toronto, Canada.[11] This was followed in succession by similar attempts by surgical teams in Chicago, Paris, Kiel, London (Canada), and Pittsburgh. As the number of successful cases of small bowel transplantation increased, further attempts were made to transplant multiple abdominal viscera using Cy A. The desire to improve the survival of patients with liver dysfunction impairment induced by long-term TPN was a strong impetus for execution of combined liver and small bowel transplantation. Interestingly, a large number of cases of graft survival were reported by the Pittsburgh group, who were strong advocates of transplantation of multiple abdominal viscera and suggested the possibility of tolerance induction by a concurrent liver transplant.[12] Later on, intestinal transplantation alone using FK506 was performed by the Pittsburgh group and successful cases of bowel graft survival were reported.[13] Small bowel transplantation in humans is still at an early stage, and the outlook for this new form of organ transplantation also has just shown great improvement. There are a multitude of clinical questions to resolve before intestinal transplantation can become a therapeutic reality. Intestinal transplantation, if technically refined to such an extent as ensures graft survival and function, will provide a new approach to the treatment of Crohn's disease of both the small and large intestines as well as of CIIPS, the etiology and pathogenesis of which are entirely unknown, and offer a unique opportunity to clarify the true causes of these intestinal disorders.

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