EDUCATIONAL REVIEW ARTICLE

A Review of Surgical Nutrition

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Abstract

Malnutrition remains a common problem in surgical patients and is associated with significant morbidity and mortality. It is imperative that all surgical patients undergo nutritional screening on admission to highlight malnourished or at risk patients and implement a nutritional plan. Nutrition can be delivered by oral supplements, enteral or parenteral feeding, the route depending on an individual's requirements and surgical condition. Enteral feeding has largely been regarded as superior to parenteral feeding, as it is cheaper, safer and "more physiological" but studies show this is not always the case. This article reviews the basics of surgical nutrition and assesses the evidence supporting enteral versus parenteral nutrition.

Introduction

The nutritional status of patients is an important determinant of outcome after surgery and there is a strong association between malnutrition and poor clinical outcome. In 1936 Studley showed that patients undergoing gastrectomy for peptic ulcer disease who had lost <20% of their pre-illness weight had a mortality of 3%, whereas those with >20% weight loss had a mortality of 30%.[1] Malnutrition remains a common problem affecting 27-50% of surgical patients despite improvements in anaesthesia and perioperative care, and if left untreated gives rise to significant morbidity and mortality.[2,3] In order to provide nutritional support, malnourished or at risk patients must be identified and their requirements met in a timely manner, by an appropriate and safe route. An interplay exists between nutritional status and illness that makes nutritional assessment and management difficult and interpretation of studies confusing. A literature search of all relevant articles from 1966 to 2007 using MEDLINE was made with search terms "surgical nutrition", "parenteral", "enteral", "nutritional assessment", "nutritional screening" and "malnutrition". References from obtained articles were reviewed and included if appropriate. Recent guidelines from the National Institute for Clinical Excellence (NICE), the British Association for Enteral and Parenteral Nutrition (BAPEN) and NHS Quality Improvement Scotland (NHS QIS) concerning nutritional support were consulted and provide an excellent overview of malnutrition, screening tools and monitoring of nutritional support.

The consequences of malnutrition

Malnutrition disturbs cellular and organ function resulting in impaired cardiac and respiratory muscle function, atrophy of smooth muscle in the gastrointestinal tract, impaired immune function and impaired healing of wounds and anastomoses. These changes not only impair recovery after surgery but are associated with complications (wound infections, pressure sores) and increasing healthcare costs (prolonged hospital stays, recurrent hospital admissions and primary care visits).[4]

The causes of malnutrition are multifactorial and may be related to low socio-economic status or a specific disease process. The poor nutritional status of surgical patients can result from decreased oral intake due to pain, fasting or gastrointestinal pathology. Other causes include malabsorption or increased nutritional requirements in response to surgical insult, trauma or sepsis.

Nutritional requirements in health

The principal components of a normal diet are energy (carbohydrate and lipid), nitrogen, trace elements, minerals and vitamins. A healthy adult requires approximately 20-25 kcal per kilogram body weight per day. Metabolic stress associated with sepsis, trauma or surgery increases energy requirements to 35-40 kcal per kg per day. Vitamins function as coenzymes, cofactors in wound healing and antioxidants, and minerals and trace elements are required for metabolic processes and normal cellular function. It is imperative that each of these components is provided for patients requiring artificial nutritional support and this is best managed using a multidisciplinary approach with a dedicated dietitian and nutrition support team.

Nutritional assessment tools

Nutritional screening is carried out by nursing staff and is a simple process of identifying patients who may be malnourished or at risk of malnutrition. BAPEN has produced a screening tool, Malnutrition Universal Screening Tool (MUST) which is uncomplicated, reliable and reproducible.[5] These patients should then be referred to the dietetic department or nutrition team who will carry out more detailed assessment. The aim of nutritional assessment is to create a nutrition plan and monitor the adequacy and response to therapy in those identified through screening. Severe malnutrition can be assessed clinically as marked wasting of proximal limb muscles and pressure sores are easily identified. However milder degrees of malnutrition may be unrecognised and more detailed assessments of nutritional status are required. Unfortunately despite more than 50 years of research in this area, there is currently no single, simple and reliable technique for assessing nutritional status. Most methods are confounded by the fact that significant disease is often associated with malnutrition. There are a variety of techniques available which are briefly summarised.

Anthropometric measurements

Anthropometric measurements were initially used in the Third World to assess the extent of starvation. Body mass index (BMI) is defined as the body weight in kilograms divided by height in metres squared and remains a useful indicator of total body fat. A BMI of less than 18.5 implies nutritional impairment and a BMI below 15 is associated with significant mortality. Unplanned weight loss of more than 10% body weight over a six month period is a good prognostic indicator of poor clinical outcome.[6] Other measures such as triceps skinfold thickness and mid-arm muscle circumference provide rough estimates of body fat and muscle mass but their use is limited by interobserver variability.

Clinical techniques

Clinical history, in particular recent weight loss, a change in oral intake, gastrointestinal symptoms and functional capacity, combined with physical signs (muscle wasting, loss of subcutaneous fat and oedema) form the basis of the Subjective Global Assessment tool which has been validated in previous studies.[7] Measurements of skeletal or respiratory muscle function have also been used but are time consuming and often not practical in critically ill patients.

Biochemical markers

The plasma concentrations of proteins (albumin, pre-albumin, transferrin and retinol-binding protein) have been used to assess nutritional status but none are particularly sensitive or specific. A large study performed by Gibbs and colleagues suggested that preoperative hypoalbuminaemia is a good indicator of poor surgical outcome.[8] However studies suggest that albumin should not be used as a primary screening tool for nutritional status as sepsis and inflammatory processes may also lower albumin. Tests of lymphocyte function, total body nitrogen and bioelectrical impedance may be useful markers in a research environment but they are expensive and not practical in a ward setting.

No single variable is predictive of outcome although when they are combined they can be useful in determining malnutrition and its outcomes. Hill and colleagues suggested that although weight loss, loss of arm muscle bulk, anaemia, vitamin deficiencies and low albumin levels are not predictive of outcome when used alone, when combined they are of benefit in assessing malnutrition and identifying those patients who will have a poor outcome.[3] The subjective global assessment and nutrition risk index have been used in nutrition studies with >85% sensitivity.[7] The Nutrition Risk Index (NRI) is an equation using weight loss and serum albumin concentration. This equation is expressed as (1.519 x albumin g/L) + 0.417 x (present weight/ usual weight x 100). If the score is >100 the patient is well nourished, 97.5-100 demonstrated mild malnutrition, 83.5-97.5 moderate malnutrition and <83.5 correlates with severe malnutrition.[9]

Delivery of nutritional support

The NICE guidelines recommend that nutritional support should be given to patients who have eaten little or nothing for more than 5 days, have poor absorptive capacity, high nutrient losses or have increased requirements due to catabolic processes. After patients are identified as malnourished, the route and type of nutritional support must be decided. The usual approach to estimating a patient's nutritional requirement is to estimate the energy requirements using the basal metabolic rate (BMR) equation which takes into account an individual's age, sex and weight then adjust for stress and activity levels.[10] A similar equation is used for protein requirements which are based on weight with adjustments made for sepsis and stress. A suggested nutritional prescription would be 25-35kcal/kg/day energy, 0.8-1.5g protein/kg/day, 30-35ml fluid/kg and adequate electrolytes, minerals and trace elements. Allowances for extra losses from fistulas or extra intake from intravenous drugs must be tailored for individual patients.

Nutritional support can be administered in a variety of ways including dietary supplements, enteral tube feeding or parenteral feeding. Each mode of delivery has its own benefits and limitations and it is important that a dietician and nutritional support team are involved in aiding the clinician.

Oral nutritional supplements

Oral supplements should be given to patients who are unable to meet their daily nutritional requirements from hospital meals alone. They are liquid supplements containing protein, fat and carbohydrate and micronutrients. They are easy to administer, cheap, free from complications and more palatable for patients as they are available in a variety of flavours. Studies have shown that oral supplements increase weight gain in malnourished patients, reduce mortality and postoperative complications.[4,11,12] A meta-analysis of 18 randomised controlled trials in gastrointestinal surgical patients (undergoing gastrectomy, hemicolectomy, cholecystectomy, bowel resection and pancreatoduodenectomy) showed oral supplements significantly reduced postoperative complications such as wound and respiratory infections, ileus and wound dehiscence (OR 0.37 (95% CI 0.26-0.53).[4] There were concerns that oral supplements may suppress appetite in patients not keen to eat. However studies suggest that liquid supplements tend not to suppress appetite or food intake and are an effective treatment for patients with poor appetite.[13]

Enteral feeding

Enteral nutrition is used for patients who are unable to consume an adequate oral intake or in whom oral intake is contraindicated (unconscious, swallowing disorders or selected postoperative cases). During the 1990s there was a shift from parenteral nutrition to enteral nutrition particularly in surgical and ICU patients and the ongoing debate regarding whether enteral or parenteral nutrition is best continues. Enteral nutrition is considered cheaper, safer and more physiological as it is thought to preserve gut barrier function.

Enteral feeding can provide nutritional support on a short term basis by means of a nasogastric or nasojejunal tube, or longer term via an endoscopic or radiologically inserted gastrostomy. The choice of enteral feed depends on the route of nutritional support, the requirements and period of support. Although enteral feeding is felt to be safer than parenteral feeding, complications are common and may even carry significant morbidity. They may be related to the procedure itself such as tube displacement or blockage, or related to the feed such as aspiration pneumonia, gastrointestinal upset or metabolic disturbances.[14]

There are numerous studies in the literature emphasising the benefits of early enteral feeding. Two large meta-analyses comparing the effect of "nil by mouth" versus early enteral feeding in critically ill and surgical patients report a reduction in infectious complications and length of hospital stay although there was no statistically significant change in mortality rates.[15,16]

Parenteral nutrition

Parenteral feeding was instituted in the 1960s when clinicians realised malnutrition was associated with increased morbidity and mortality in hospitalised patients. This resulted in the development of total parenteral nutrition (TPN) and the philosophy that if nutrition was good, more would be better. Many studies appeared in the literature emphasising the success of hyperalimentation but over time reality showed that not only did TPN not cure disease, but it was associated with certain complications. Over the last 20 years, the role of TPN has remained a hot topic of debate, and in some institutions is regarded with less enthusiasm than the more "physiological" enteral nutrition.

Parenteral nutrition should be used for patients who have a non-functioning gastrointestinal tract perhaps as a result of short bowel syndrome or high output intestinal fistulas in whom enteral nutrition is contraindicated. Parenteral nutrition may be given either through a peripheral cannula or a central venous line. The complications of both these routes are already well known and will not be discussed further in this review.

Is TPN effective at reducing mortality rates and complications, and is this most effective when given preoperatively or postoperatively? A recent meta-analysis of 2907 surgical patients (27 randomised controlled trials) compared the use of standard oral diet and intravenous glucose versus total parenteral nutrition. There was no effect on mortality in either group but there was a reduction in complication rates in those patients on TPN, although this was not statistically significant. However when the patients were subdivided into those who were malnourished compared with those who were normally nourished, there was a significant reduction in postoperative complications in the malnourished group (RR 0.52 (95% CI 0.30-.091) versus RR 0.95 (95% CI 0.75-1.2). The study also analysed the effect of preoperative versus postoperative TPN. Neither of these treatments had any effect on mortality rates but preoperative TPN showed a significant reduction in postoperative complications.[17] There are no studies in the recent literature comparing parenteral nutrition versus no nutrition as this raises ethical issues, especially in patients with enterocutaneous fistulae who would not survive without parenteral nutrition.

Preoperative versus postoperative TPN

A clinical trial looking at the effect of preoperative TPN on hepatectomy patients showed that preoperative TPN reduced the incidence of overall complications and sepsis.[18] These results are supported by a trial involving only malnourished surgical patients where TPN reduced both non infectious and infectious complications.[19] A large trial by the Veterans' Administration Group studied 395 malnourished patients undergoing abdominal or thoracic surgery, randomising them to preoperative TPN versus none. The overall 90 day mortality rates were similar in keeping with other studies. Perhaps surprisingly there was a higher rate of infectious complications in the group receiving TPN (14.1% versus 6.4%, $p=0.01$). Further subgroup analyses revealed no benefit from TPN for mildly malnourished patients but severely malnourished patients on TPN had fewer non septic complications than the control group (5% versus 43%, $p=0.03$).[20] Most studies suggest that preoperative TPN has greatest impact in reducing complications in malnourished patients, perhaps as these are patients in whom complications are likely to be more prevalent.

The evidence regarding postoperative TPN is not as encouraging and suggests postoperative parenteral support does not reduce complications in surgical patients.[17,21] Indeed a clinical trial involving patients after pancreatic resection for malignant disease showed a higher rate of septic complications in the TPN group than in controls (45% versus 23%) although further work is needed to determine the reasons behind this.[22] There are suggestions that increased rates of sepsis may be a result of hyperglycaemia from overfeeding. There are difficulties when appraising the literature from the 1970s as many patients who were given parenteral nutrition, for example preoperative hepatectomy patients, would now be given enteral feeding. This obviously confuses the conclusions which can be drawn and applied to today's patients.

Enteral versus parenteral nutrition

Current opinion suggests that enteral nutritional support is superior to parenteral nutrition for the following reasons – it is less expensive, is safer, is more "physiological", promotes gastrointestinal tract function and maintains muscosal barrier function, prevents bacterial translocation and improves outcome. Most authorities would continue to recommend that "if the gut works, use it" but over the last decade there have been many studies in the literature seeking to confirm or disprove the above reasons.

Enteral nutrition is cheaper than parenteral nutrition and a review by Lipman supports this although new economic analyses would be of value.[23] Enteral feeding can be provided safely and effectively but it can fail to achieve the necessary calories from side effects such as bloating, diarrhoea or high nasogastric aspirates. There are numerous potential complications from enteral tube feeding, especially with the increasing popularity of invasive methods of tube placements. There are case reports in the literature warning that although relatively safe, enteral feeding does carry significant morbidity.[14,24] The complications of parenteral nutrition, from mechanical difficulties with insertion of a central venous catheter, line sepsis to the metabolic complications of hyperglycaemia and electrolyte imbalances are well documented.[25] It is a common perception that TPN leads to mucosal atrophy leading to bacterial translocation. This is certainly the case in animal studies but the evidence is less clear when applied to humans.[26,27] MacFie and colleagues have shown that bacterial translocation does occur in surgical patients and is associated with increased rates of sepsis, although a study by Sedman suggested no increase in bacterial translocation with TPN.[28,29] There seems to be no evidence in the literature to date that parenteral nutrition promotes bacterial translocation or that enteral nutrition prevents it in humans.[30] Some authors suggest that the presumed higher rates of sepsis associated with parenteral nutrition may be due to the increased energy intake received, the associated hyperglycaemia or complications of the delivery system.[31]

Despite these views, the most important question is whether enteral or parenteral nutrition provides the best clinical outcome.

Enteral versus parenteral nutrition – specific outcome analysis

Mortality

Although malnutrition is associated with an increased risk of complications there are no studies which clearly show that artificial nutritional support reduces mortality when compared with standard care. However many trials intending to answer this question did not specifically look at malnourished patients but at a heterogeneous group.[23,32] It is perhaps surprising that

nutritional support does not reduce mortality but this suggests that correction of malnutrition alone is not enough and the disease process itself must be tackled to alter outcome.

Pancreatitis

Any patient with severe acute pancreatitis should be considered for nutritional support. It is interesting that recent British Society Gastroenterology guidelines regarding the management of acute pancreatitis do not mention nutritional support. A recent review of nutritional support in pancreatitis suggested that intrajejunal feeding is the route of choice for enteral support as there is less stimulation of pancreatic exocrine function than with oral or nasogastric feeding.[33] There has been one randomised controlled trial comparing TPN versus no support which suggested that TPN had no impact on mortality or overall outcome, although the TPN patients had a higher rate of catheter related infections.[34] There are three randomised trials comparing TPN and enteral nutrition. They observed no difference in length of hospital stay or overall mortality. Two studies showed no significant difference in the incidence of sepsis but the third study by Kalfarentzos showed higher rates of sepsis in patients receiving TPN. They concluded that enteral feeding should be used preferentially in patients with severe acute pancreatitis as it was well tolerated, associated with fewer complications (total $p<0.03$ and septic $p<0.01$) and was cheaper than TPN.[35,36,37]

Abdominal trauma

Studies comparing enteral and parenteral nutrition in patients after major abdominal trauma found a significantly higher rate of sepsis in those on TPN. These patients also received more energy and had higher injury severity scores. Despite higher infection rates, patients on TPN did not receive more antibiotics or have a longer hospital stay.[38,39]

Critical care

A meta-analysis by Heyland showed total parenteral nutrition does not influence the overall mortality rates of critically ill patients. However the data suggests a reduction in complication rates, especially in malnourished patients.[32] Cerra randomised 66 ITU patients who were septic and hypermetabolic to either enteral or parenteral nutritional support. There were no differences in the number of patients who developed multiorgan system failure, sepsis or died.[40]

TPN is a lifesaving form of nutritional support for patients with intestinal failure. It also has a role to play in malnourished patients although in some cases there may be higher rates of sepsis. There is insufficient evidence in the literature to suggest that enteral feeding has any advantage over TPN in preserving gut barrier function or reducing bacterial translocation. Enteral nutrition is less likely to deliver the targeted nutritional intake and is associated with significant procedure related complications. However most studies would suggest that enteral feeding should still be used in patients with a functioning gastrointestinal tract and TPN reserved for those without a functioning GI tract.

Immunonutrition

There are over 200 feeds currently available for use but there has been a recent interest in the additional benefits with immune modulating feeds, known as immunonutrition. During immunonutrition nutrients are given in supranormal amounts to achieve a pharmacological effect in response to surgery, infection and trauma. Many nutrients are potentially immunonutrients but the most renowned are glutamine, arginine and omega-3 fatty acids. These nutrients are added to commercially available feeds and are administered either enterally or parenterally. Glutamine is a conditionally essential amino acid which acts as an energy source for lymphocytes and small bowel mucosa. Low plasma levels are associated with poor outcomes and when added to traditional feeding regimens a recent meta-analysis demonstrated a reduction in the number of infectious complications but had no effect on mortality.[41,42] There continues to be a debate revolving around whether arginine is potentially harmful or beneficial.[43] There is currently no clear clinical data proving that arginine is toxic whereas there are many trials suggesting its advantages. In general immunonutrition can decrease infectious complications but trials have failed to show any decline in mortality rates.[44] Recent reviews and meta-analyses suggest that immunonutrition is more effective when delivered enterally than parenterally, although most studies in the literature assessing the benefits of glutamine only look at intravenous administration. Immunonutrition is more beneficial in malnourished patients but some nutrients, in particular arginine and intravenous lipids may have both beneficial and detrimental effects.[45]

Conclusion

Malnutrition is a common problem in surgical patients and is associated with poor outcomes. Although albumin remains a useful preoperative indicator of significant morbidity, there is no one nutritional marker which can define malnutrition and suggest which patients would benefit from a period of nutritional support. While further research takes place in this area, a variety of markers in the form of nutritional assessment tools must be used. If oral intake is inadequate, nutritional support in the form of oral nutritional supplements or artificial enteral and parenteral feeding is important for recovery after surgical insult. The mode of nutrient delivery should be decided by intestinal tolerance. Perhaps for most patients, enteral nutrition would be appropriate with parenteral support reserved for those with inadequate gastrointestinal function. This article focuses specifically on undernutrition in the context of malnutrition. However in current times perhaps the issues surrounding overnutrition will provide new challenges in our clinical practice and for our nutrition support teams.

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Multiple choice questions on Surgical Nutrition

Which of the following statements are true?

1) Malnutrition

- Affects 10% of surgical patients
- Is associated with impaired cardiac muscle function
- Always causes a low serum albumin
- Increases the risk of pressure sores and septic complications
- A BMI of <15 is associated with significant morbidity

2) Nutritional requirements

- A healthy adult requires 20-25kcal/kg body weight/day
- Protein requirements are calculated using the basal metabolic rate
- Basal metabolic rate is not affected by activity levels or sepsis
- Vitamin E is an antioxidant
- Vitamins and trace elements are not routinely needed as part of nutritional support

3) Enteral feeding

- A percutaneous endoscopic gastrostomy tends to be used for short term nutritional support
- Should be used in patients with a functioning gastrointestinal tract
- Nasojejunal feeding can be used in patients with gastroparesis
- Reduces infectious complications in critically ill patients
- Reduces mortality in surgical patients

4) Parenteral feeding

- Indications include short gut syndrome and high output intestinal fistulas
- Does not reduce mortality in surgical patients
- Post operative TPN is more effective in malnourished patients than pre operative TPN
- TPN is more expensive than enteral nutrition
- Refeeding syndrome is more frequent in severely malnourished patients

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