Perioperative and postoperative nutrition

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Nutritional deficiency among hospitalized patients is common, and is often unrecognized and untreated. Perioperative starvation is detrimental to recovery. Nutritional support can reduce morbidity, mortality and length of hospital stay. This article reviews the evidence for parenteral, enteral and oral nutritional support in the perioperative and postoperative period.

It is frequently reported that up to 50% of surgical patients have biochemical or anthropometric evidence of malnutrition (Nightingale, 1997). Inadequate nutritional intake may cause muscle weakness, an impaired immune response, poor wound healing, increases in morbidity and mortality, and lengthier hospitalization (Nightingale, 1997). Surgical patients are particularly vulnerable to the development and consequences of malnutrition for a number of reasons. Certain operations may impose mechanical restrictions upon feeding during the postoperative period and malignancy is associated with a hypercatabolic state characterized by marked weight loss, anorexia, asthenia and anaemia.

Surgical stress is characterized by the release of the stress hormones (glucagon, cortisol and catecholamines) and inflammatory mediators (cytokines) (Nygren et al, 2001). These metabolic alterations are manifest as increased gluconeogenesis, depressed glycogenesis, glucose intolerance and insulin resistance (Nygren et al, 2001). Unchecked or exaggerated by sepsis these physiological processes are thought to underpin the detrimental aspects of the acute inflammatory response that may increase morbidity and mortality.

Despite an abundance of research into the benefits of perioperative nutrition uncertainties exist regarding which patients benefit most from nutritional support, which feeds should be used, by which route and when nutritional support should be started and finished.

THE NEED FOR NUTRITIONAL SUPPORT

Animal studies have demonstrated that fasting can negatively impact upon the ability of the host to cope with a given insult (Thorell et al, 1999). Starvation before haemorrhagic or endotoxic stress affects carbohydrate metabolism and increases susceptibility to stress (Nygren et al, 2001). A key feature of this catabolic response is the development of insulin resistance. Postoperative insulin resistance develops in a dose-dependent manner relating to the magnitude of the insult or surgery and is an independent factor determining length of hospitalization (Thorell et al, 1999).

Experimental animal data report increased bacterial translocation, increased muscle fatiguability, and more stressful endocrine and metabolic responses in fasted animals compared to fed animals for a given stressful event (Nygren et al, 2001).

PARENTERAL NUTRITION

Parenteral nutrition has the immediate advantage of ease of administration and early provision of optimal nitrogen and calorific requirements (*Table 1*). Central or peripheral venous catheterization can be quickly and safely accomplished by experienced individuals, and optimal nutritional quotients can be achieved immediately. In a stressed patient, increases in insulin resistance mean that even when calculated optimum nutritional intake is provided this can result in hyperglycaemia. Hyperglycaemia can induce hepatic dysfunction and impair host immune response, and such a mechanism may contribute to septic morbidity observed in some trials using parenteral nutrition (Torosian, 1999).

A three-armed study randomly allocated patients to receive standard enteral, parenteral or immune-enhanced enteral feed (Braga et al, 1996). Interestingly there were no significant differences between morbidity and mortality

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rates in the standard enteral and parenteral arms which were designed to be isocaloric and isonitrogenous during postoperative treatment.

Preoperative parenteral nutrition

Early randomized controlled trials (RCTs) reported significantly fewer complications in patients fed parenterally in the preoperative phase compared with conventionally managed controls (Torosian, 1999; Heyland et al, 2001a). These studies were relatively small and the control patients had surprisingly high rates of complications which undermined the credibility of data. The largest multicentre RCT was conducted by the Veterans Affairs group which examined the effect of perioperative parenteral nutrition in malnourished patients compared with controls; results indicated similar rates of major complications and mortality, but increased septic complications within the parenteral nutrition group (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991). Sepsis was not attributable to line infection but other common postoperative infections such as pneumonia and wound sepsis. However, subgroup analysis demonstrated that septic complications were reduced in patients categorized as severely malnourished who were given preoperative parenteral nutrition.

A reduction in postoperative complications by preoperative parenteral nutrition is also supported by the evaluations and recommendations of the National Institutes of Health (NIH) (Klein et al, 1997). A subsequent meta-analysis comprehensively and critically analysed 27 RCTs, and similarly reported a beneficial effect in preoperatively administered parenteral nutrition in a malnourished population, although lack of statistical heterogeneity in nutritional categorization weakened this conclusion (Heyland et al, 2001a).

TABLE 1.
Advantages and disadvantages of feeding regimens

	Advantages	Disadvantages
Parenteral	Easy to achieve nutritional goal	Requires venous access
	Well tolerated	Line-related complications
		Expensive
		Inpatient care
Enteral	Inexpensive	Difficult to achieve nutritional goal
	Relatively safe	Requires feeding tube
	Can be managed at home with minimal training	Tube dislodgement or blockage
		Limited tolerance
		Diarrhoea, bloating, nausea, vomiting
Oral	Safe	Palatability?
	Inexpensive	Effectiveness
	Practical	Small volumes postoperatively
	Given at home	
	Can be given conveniently pre- and postoperatively	

Postoperative parenteral nutrition

A meta-analysis of 27 RCTs involving 2907 patients by Heyland et al (2001a) found no significant positive or negative effects attributable to perioperative parenteral nutrition; however, the earlier reviews have reported a 10% increase in complication rates associated with the use of postoperative total parenteral nutrition (Klein et al, 1997; Torosian, 1999). Brennan et al (1994), studying malnourished patients undergoing surgery for pancreatic carcinoma, reported a two-fold increase in major complications and almost a four-fold increase in mortality.

ENTERAL NUTRITION

In animal models, beneficial effects of enteral feed include prevention of gastrointestinal mucosal atrophy, reduced incidence of bacterial translocation, attenuation of the injury-stress response and maintenance of immunocompetence (Takagi et al, 2000).

Preoperative enteral nutrition

The benefit of preoperative enteral nutritional support has not been established. Von Meyenfeldt et al (1992) reported no reduction in morbidity or mortality following resection of gastric or colorectal cancer in adequately nourished patients given enteral or parenteral nutrition for 10 days before surgery compared with controls. In contrast, Shukla et al (1984), studying patients with both malignant and benign gastrointestinal, breast or oropharyngeal disease, reported a 20% reduction in major complications with the administration of enteral nutrition.

Postoperative enteral nutrition

Lewis et al (2001) systematically reviewed and analysed 11 RCTs involving 837 patients comparing early enteral feeding *vs* 'nil by mouth' management after gastrointestinal surgery. There was no increase in morbidity or mortality and enteral feeding was associated with a reduced risk of septic complication and length of hospital stay. While evidence suggests that enteral feeding is safer and preferable to postoperative starvation, the relative benefit of enteral *vs* parenteral nutrition remains equivocal. Affordability and perceived safety favour enteral nutrition and laboratory data implies immunological advantage.

Hypothesized immunological benefits of enteral nutrition have led to the development of immunonutrition. Specific nutrients such as arginine, glutamine, nucleotides and omega-3 fatty acids alone or in combination have demonstrated modulatory effects on immunological and inflammatory parameters (Heyland et al, 2001b).

While controversial, several studies have reported benefit with immunonutrition in elective gastrointestinal surgery and trauma (McCowen and Bistrian, 2003). A meta-analysis of 22 trials including 2419 surgical and critically-ill immunonourished patients supports benefit, with arginine appearing particularly instrumental (Heyland et al, 2001b). Within elective surgical patients immune-enhanced feeds reduce infectious complications but have no effect upon mortality (Heyland et al, 2001b). This is not a universally applicable effect and immune-enhanced feeds may have a detrimental effect in critically ill patients (Heyland et al, 2001b; McCowen and Bistrian, 2003). Within critical care patients increased morbidity and mortality is particularly evident with feeds using supplements other than arginine (Heyland et al, 2001b).

ORAL NUTRITION

There remains considerable debate over the indications, efficacy and safety of enteral and parenteral feeding. Both rely on a physician-placed feeding set (either percutaneous or nasojejunal tube, or central or peripheral venous catheter) and nursing expertise in the management and administration of feeds to maintain asepsis and patency of lines. A simple but often overlooked nutritional intervention is oral nutritional supplementation (ONS). Inexpensive, safe and easy to distribute and administer, ONS is suitable for most patients and is increasingly palatable and well tolerated.

Preoperative oral nutrition

MacFie et al failed to demonstrate any benefit of ONS in the pre- and/or postoperative period following major gastrointestinal surgery (MacFie et al, 2000). ONS did significantly improve protein and caloric intake and was not associated with a reduction in voluntary food intake, but this did not translate to clinical benefit. This contrasts with a recent trial reporting reductions in weight loss and the incidence of minor complications in patients receiving perioperative ONS starting in the preoperative phase (Smedley et al, 2004).

Postoperative oral nutrition

Until recently the routine use of nasogastric decompression postoperatively until the resolution of ileus had prevented early oral feeding. It is now known that the routine placement of nasogastric tubes is not required and may be detrimental (Cunningham et al, 1992). Several studies have demonstrated that early oral feeding in the postoperative period is safe, feasible and cost-effective (Lewis et al, 2001).

Stewart et al (1998) randomized patients to receive early feeding following elective colorectal resections. Feed was well tolerated although co-dependent on early mobilization, and accelerated the resolution of ileus and hospital discharge. These results were in keeping with similar earlier RCTs examining early feeding (Reissman et al, 1995; Oritz et al, 1996). In orthopaedic patients treated for femoral neck fractures, oral protein-rich postoperative supplementation increased energy intake, reduced length of hospital stay and complications, and improved survival over a 6-month period of follow-up (Delmi et al, 1990).

Beattie et al (2000) studied 101 malnourished surgical patients and randomized patients to receive ONS as required in the postoperative period. They reported reduced weight loss in the treatment group, although all patients showed decline in their nutritional status. Muscle strength and quality of life scores were also higher in the fed group although there was no significant difference in infection rates or length of stay between the two groups (Beattie et al, 2000).

Keele and colleagues, in a two-phase trial, randomized patients to receive ONS in the postoperative inpatient period (phase 1) and then again following discharge (phase 2) (Keele et al, 1997). Significant benefits in the inpatient phase were recorded for the fed group with improved muscle strength, reduced infective complications and improved subjective measures of fatigue. Post-discharge ONS enhanced protein and caloric intakes in the treatment group initially but no clinical benefits were observed. By the second month there were no significant differences in nutritional intakes between the control and treatment groups. This corroborates an earlier study in which patients were randomized to receive protein-rich supplements for 4 months following discharge to home after elective colorectal surgery (Jensen and Hessov, 1997). Nutritional intake was improved in the intervention group and gains in weight and lean body mass were also higher although no observable differences in function or quality of life were evident (Jensen and Hessov, 1997).

CONCLUSIONS

Nutritional supplementation is only one component of perioperative surgical care, with other factors such as mobilization, type of surgery, anaesthesia and analgesia being confounding variables. Attempts to control such factors limit study sample sizes and impact upon statistical power. Evidence to date suggests that 'malnourished patients' benefit most from preoperative nutritional support. Parenteral nutrition is indicated for malnourished patients if started early (7–10 days before surgery) and can reduce morbidity and mortality. Parenteral nutrition may also be of benefit in those where enteral feeding is contraindicated or not tolerated. Postoperative enteral nutrition is generally preferable to parenteral nutrition which may be associated with increased septic complications. Immunonutrition requires further evaluation before widespread application and regimens should be founded upon an evidence base.

It would seem surprising that small studies of early oral nutrition would demonstrate clinical advantage when the effects of enteral or parenteral nutrition are less obvious. This may be a reflection of the necessarily better health of patients able to tolerate ONS but such trials should be interpreted with caution as no such study hitherto is adequately powered or of such methodological quality that firm conclusions can be drawn. HM

Conflict of interest: none.

KEY POINTS

- Perioperative starvation is unnecessary and may potentiate a detrimental metabolic effect.
- The postoperative phase is characterized by catabolism and insulin resistance.
- Insulin resistance may be attenuated by preoperative feeding and aggressive insulin therapy can reduce morbidity and mortality.
- Parenteral nutrition may benefit the most malnourished patients if commenced well before surgery, but if used inappropriately may lead to increased infections.
- Enteral nutrition has demonstrable cellular and immunological advantage in animal experiments but human clinical benefit is variable, although this remains the preferred route of hyperalimentation in the postoperative period.
- Oral nutritional supplements are an economical and easily implementable form of nutritional support in the early postoperative period, and may improve outcome.

Beattie AH, Prach AT, Baxter J, Pennington CR (2000) A randomised controlled trial evaluating the use of enteral nutritional supplements postoperatively in malnourished surgical patients. *Gut* **46:** 813–18

Braga M, Vignali A, Gianotti L et al (1996) Immune and nutritional effects of early enteral nutrition after major abdominal operations. *Eur J Surg* **162:** 105–12

Brennan M, Pisters PW, Posner M et al (1994) A prospective randomised trial of total parenteral nutrition after major pancreatic resection for malignancy. *Ann Surg* **220:** 436–41

Cunningham J, Temple WJ, Langevin JM, Kortbeek J (1992) A prospective randomized trial of routine postoperative nasogastric decompression in patients with bowel anastomosis. *Can J Surg* **35**(6): 629–32

Delmi M, Rapin CH, Benmgoa JM et al (1990) Dietary supplementation in elderly patients with fractured neck of the femur. *Lancet* **335:** 1013–16

Heyland DK, Montalvo M, Macdonald S et al (2001a) Total parenteral nutrition in the surgical patient: a meta-analysis. *Can J Surg* **44**(2): 102–11

Heyland DK, Novak F, Drover JW et al (2001b) Should immunonutrition become routine in critically ill patients? A systematic review of the evidence. *JAMA* **286**(8): 944–53

Jensen MB, Hessov I (1997) Randomisation to nutritional intervention at home did not improve postoperative function, fatigue or well-being. *Br J Surg* **84:** 113–18

Keele AM, Bray MJ, Emery PW, Duncan HD, Silk DBA (1997) Two phase randomised controlled trial of postoperative oral dietary supplements in surgical patients. *Gut* **40:** 393–9

Klein S, Kinney J, Jeejeebhoy K et al (1997) Nutrition support in clinical practice: review of published data and recommendations for future research directions; National Institute of Health, American Society for Parenteral and Enteral Nutrition, and American Society for Clinical Nutrition. *J Parenter Enteral Nutr* **21**(3): 133–56

Lewis SJ, Egger M, Sylvester PA, Thomas S (2001) Early enteral feeding versus "nil by mouth" after gastrointestinal surgery: systematic review and meta-analysis of controlled trials. *BMJ* **323:** 1–5

MacFie J, Woodcock NP, Palmer MD et al (2000) Oral dietary supplements in pre- and postoperative surgical patients: a prospective and randomised control trial. *Nutrition* **16:** 723–8

McCowen KC, Bistrian BR (2003) Immunonutrition: problematic or problem solving? *Am J Clin Nutr* **77:** 764–70

Nightingale JMD (1997) Undernutrition – underdetected & undertreated. *CME Journal Gastroenterology, Hepatology & Nutrition* **1**(1): 9–13

Nygren J, Thorell A, Ljungqvist O (2001) Preoperative oral carbohydrate: An update. *Curr Opin Clin Nutr Metabolic Care* **4:** 255–9

Oritz H, Armendariz P, Yarnoz C (1996) Is early feeding feasible in elective colon and rectal surgery? *Int J Colorect Dis* **11:** 119–21

Reissman P, Teoh TA, Cohen SM et al (1995) Early oral feeding after elective colorectal surgery: is it safe. *Ann Surg* **222:** 73–7

Shukla HS, Rao RR, Banu N (1984) Enteral hyperalimentation in malnourished surgical patients. *Indian J Med Res* **80:** 339–46

Smedley F, Bowling T, James M et al (2004) Randomized clinical trial of the effects of preoperative and postoperative oral nutritional supplements on clinical course and cost of care. *Br J Surg* **91:** 983–90

Stewart BT, Woods RJ, Collopy BT et al (1998) Early feeding after elective open colorectal resections: A prospective randomized trial. *Aust N Z J Surg* **68:** 125–8

Takagi K, Yamamori H, Toyoda Y et al (2000) Modulating effects of the feeding route on stress response and endotoxin translocation in severely stressed patients receiving thoracic esophagectomy. *Nutrition* **16:** 355–60

Veterans Affairs Total Parenteral Nutrition Cooperative Study Group (1991) Perioperative total parenteral nutrition in surgical patients. *N Engl J Med* **325**(8): 525–32

Thorell A, Nygren J, Ljungqvist O (1999) Insulin resistance: a marker of surgical stress. *Curr Opin Clin Nutr Metabolic Care* **2:** 69–78

Torosian MH (1999) Perioperative nutrition support for patients undergoing gastrointestinal surgery: critical analysis and recommendations. *World J Surg* **23:** 565–9

Von Meyenfeldt MF, Meijerink WJ, Rouflart MM et al (1992) Perioperative nutritional support: a randomised clinical trial. *Clin Nutr* **11:** 180–6