Marcela Fiuza Brito MSc, PgDip, RD
Cardiothoracic Dietitian, Royal Brompton Hospital

Ione de Brito-Ashurst MSc, PhD, RD
Nutrition Lead for the Trust, Royal Brompton Hospital

For full article references please email info@networkhealthgroup.co.uk

Marcela is a Specialist Dietitian with a strong interest in research. She is a member of ESPEN and a spokesperson for the BDA.

Ione is the Governance and Safety Lead for R&T, Nutrition Lead for the Trust, as well as Adult Dietetic Professional Lead.

PARENTERAL NUTRITION AND ITS ROLE IN THE SURGICAL CARDIOTHORACIC PATIENT

Nutritional management is increasingly recognised as an important component of perioperative care. Enhanced recovery programmes have become standard practice in major surgical centres and include components such as avoidance of preoperative fasting and re-establishment of oral feeding as early as possible after surgery. In this report we examine the use of PN in a critically ill patient who presented with GI complication following cardiothoracic surgery.

The majority of surgical patients will resume oral intake within one to three days of having surgery; therefore, only a minority of patients may benefit from artificial nutrition support, primarily those at high nutrition risk and those who develop complications.

Surgery is often associated with catabolism, thus, it is essential to provide nutritional support to those who cannot eat in order to prevent malnutrition. Malnutrition developing postoperatively has been shown to increase complications and mortality.[1]

Current international guidelines strongly recommend that enteral nutrition (EN) be used in preference to parenteral nutrition (PN) for nutritional support whenever the gastrointestinal tract is intact and functional.[2,3] The most important situations where EN is contraindicated and, therefore, PN should be considered, are certain gastrointestinal (GI) complications. The latter are relatively uncommon in cardiothoracic surgery (1%-4%); however, when they occur, mortality rates are between 13.9% and 63%.[4] The most common GI complications in thoracic surgery include GI haemorrhage, perforated ulcer and mesenteric ischemia.

CASE STUDY

A 68-year-old male was admitted to hospital for an elective coronary artery bypass graft (CABG). His past medical history included hypertension, hypercholesterolaemia and previous myocardial infarction.

Postoperatively, he suffered a cardiac arrest and required intra-aortic balloon pump (IABP). Once haemodynamic stability was achieved, nasogastric (NG) feeding was initiated. Two days later he presented with vomiting, abdominal distension and rising lactate.

Abdominal CT scan was suggestive of bowel ischemia. He underwent an urgent exploratory laparotomy and subsequent bowel resection with formation of a jejunostomy. Approximately one metre of small bowel remained.

He was initially managed with standard therapy and PN was initiated on day six post CABG while the patient was in intensive care.

Blood results on the day PN was initiated is presented in Table 1 overleaf.

Table 1: Biochemistry before TPN was initiated

	Case 1	Reference range
CRP (mg/L)	321	0 - 10
WCC (x 10^9/L)	4.9	4.4 - 10.1
Sodium (mmol/L)	138	133 - 146
Potassium (mmol/L)	4.2	3.5 - 5.3
Urea (mmol/L)	6.5	2.5 - 7.8
Creatinine (umol/L)	68	60 - 120
Bilirubin (umol/L)	40	0 - 20
ALP (U/L)	46	30 - 130
GGT (U/L)	35	11 - 51
ALT (U/L)	24	8 - 40
Albumin (g/L)	19	35 - 50
Corrected Calcium (mmol/L)	2.18	2.20 - 2.60
Phosphate (mmol/L)	0.77	0.80 - 1.50
Magnesium (mmol/L)	0.91	0.7 - 1.0

NUTRITION SUPPORT

The stress response to surgery is characterised by hypermetabolism and hypercatabolism; therefore, it is essential to provide nutritional support to those who cannot eat in order to prevent malnutrition. The influence of nutritional status on postoperative morbidity and mortality has been well documented.[6-9] Inadequate nutrient provision for more than 14 days postoperatively is associated with complications.[10] In a study of surgical patients, a negative energy balance of >10,000kcal was associated with increased mortality.[11]

Current international guidelines strongly recommend that, when nutrition support is indicated, EN be used when possible.[12,13] In patients in whom EN cannot be initiated, evidence-based recommendations[14] support PN, despite an association with increased infectious complications.[15] The optimal timing for initiating PN remains unclear and guidelines vary depending on the patient's clinical condition and nutritional status.

The guidelines of the European Society of Parenteral and Enteral Nutrition (ESPEN) recommend that PN should be considered within two days after admission to ICU for patients who cannot be adequately enterally fed.[14] Conversely, in cases of postoperative complications impairing gastrointestinal function, they recommend that PN should be considered for patients who are unable to receive or absorb adequate oral/enteral feeding for at least seven days.[2] In line with the latter, the American and Canadian guidelines suggest that, where there is no evidence of protein-calorie malnutrition, PN should be initiated only after seven days of hospitalisation.[13,16,17] Providing PN to patients who do not meet criteria for malnutrition potentially accrues the added risk of infectious complications without the favourable outcome benefits of caloric replacement.[15]

Recently, the Impact of Early Parenteral Nutrition Completing Enteral Nutrition in Adult Critically Ill Patients (EPaNIC) study compared early versus late initiation of PN and concluded that late initiation of PN was associated with faster recovery and fewer complications in all patients groups, including a large cohort of patients who had undergone cardiac surgery.[18]

In the case study presented here, EN was contraindicated and PN was started on day six post-surgery while the patient was in intensive care.

NUTRITION REQUIREMENTS

The surgical critically ill patient is likely to be in a hypercatabolic state characterised by

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insulin resistance, increased oxidative stress and neuroendocrine alterations. This provokes muscle protein breakdown that exceeds synthesis and lipolysis in adipose tissue, which, coupled with insulin resistance, results in an abundance of circulating endogenous nutrients.[12-14] Catabolism in critical illness is not caused by lack of nutrition but by the catabolic hormonal environment. Provision of exogenous nutrients does not actually suppress gluconeogesis and will not completely avoid muscle wasting.[12-14]

Hyperalimentation, especially from carbohydrate sources, has been associated with hyperglycaemia, increased metabolic stress, hyperdynamic respiratory response and increased respiratory quotient.[21] A caloric intake of 36kcal/kg/day in critically ill patients compared to European recommendations of 20-25kcal/kg/day, was associated with increased rate of infections and ventilator requirements due to overfeeding.[22] Furthermore, hypocaloric feeding the non-obese critically ill surgical patient receiving PN has been shown to improve insulin sensitivity and avoid the adverse effects of overfeeding.[23]

Post hoc analysis of the EPaNIC study suggested a dose-response relationship between increased amount of PN and increased rate of infection.[19] The more recent Calorie Trial found no difference in 30-day mortality when early nutrition support was delivered via EN or PN in critically ill adults.[20] Their findings potentially support the hypothesis from the EPaNIC study that, among patients receiving parenteral nutrition, the dose is more associated with harm rather than the route of delivery.

Accurately measuring caloric and protein requirements is challenging. Resting energy expenditure can be measured with the use of indirect calorimetry, or more conveniently, with simplistic methods of kcal/kg as recommended by international associations.[14] Providing calories near target (80-90%) is recommended,[24] as negative energy balance indicates a poor prognosis and increased morbidity.[25] Once caloric requirements are determined, it is important to determine macronutrients requirements: proteins, carbohydrates and lipids.

It is well established that protein energy malnutrition (PEM) occurs in up to 50% of surgical patients.[1] PEM is associated with skeletal-muscle weakness, increased infection rate and prolonged ICU stay.[17] Multiple factors contribute to protein loss in the surgical critically ill patient: the metabolic insult itself, wounds, bed rest, and certain medications (paralytic drugs, sedatives, inotropic agents). These contributors result in mobilisation of labile protein from skeletal tissue, connective tissue and the non-stimulated gastrointestinal tract.[26] Therefore, sufficient protein needs to be provided post operatively, to maximize protein synthesis aiming to meet or match catabolism. To estimate protein requirements, a simplistic weight-based calculation can be used, where protein needs can be determined by 1.2-2.0g/kg/day.[14,17] There is no evidence that overfeeding nitrogen has deleterious effects as long as patients are not generally hyperalimented.[27]

Glucose is a convenient and readily available energy source; yet, excess intake has been associated with potential deleterious effects. For example, hyperglycaemia in PN-fed patients is associated with increased risk of pneumonia (OR 3.1; 95% CI 1.4-7.1) and acute renal failure (OR 2.3; 95% CI 1.1-5.0).[28] Conversely, tight glycaemic control has been shown to reduce morbidity and mortality in critically ill patients.[29] Therefore, recommendations are for glucose to provide 70-85% of non-protein calories in PN, with a minimal of 2.0g/kg/day[14] without exceeding 7.0g/kg/day.[30]

The inclusion of lipids in PN regimens may avoid the negative effects of hyperglycaemia on clinical outcomes. For example, a prospective open-labelled trial of 33 multiple trauma patients examined the effects of PN lipid-based nutrition compared to a standard glucose-based nutrition. The lipid group had significantly lower energy intake (17.9 vs 22.3kcal/kg), blood glucose (7.4 vs 8.7mmol/l), carbon dioxide production, minute volume and shorter duration of mechanical ventilation (13.0 vs 20.4 days) and stay in the ICU (17.9 vs 25.1 days).[31] In a PN regimen, recommendations are for lipids to provide 15-30% of non-protein calories[30] with a minimum of 0.7g/kg/day to a maximum of 1.5g/kg/day.[14]

THE FEEDING PROCESS

Nutritional assessment has three key indicators:[32]

- actual body mass index (BMI)
- recent weight loss (three to six months)
- recent decrease in nutrient intake

Nutritional assessment in this case study showed a weight of 73kg, BMI=29kg/m^2 and no history of weight loss or reduced intake prior to surgery. Enteral feed was started on day one post CABG, with a polymeric iso-osmolar formula as per local protocol. Following bowel resection on day three, the patient was placed NBM; PN was commenced on day six post CABG at half rate and progressed to meet 80% of calculated requirement in two days. Phosphate was replaced prior to commencing PN and blood levels closely monitored. Other refeeding bloods (K, Mg, Ca) were also monitored daily. PN regimen (Nutriflex Lipid Special® (C) - B. Braun) incorporated on average 270g carbohydrates, 1.0g/kg lipids and 1.3g/kg of protein.

Clinical guidelines agree that in the early phase post massive enterectomy, PN is needed in order to maintain nutrient and fluid balance, but not necessarily in isolation.[33-35] Patients with a short bowel should receive 25-33kcal/kg depending upon stoma output.[35] ESPEN recommends that enteral/oral nutrition should be introduced and progressively increased depending on gut tolerance. In this case, enteral nutrition was restarted on day seven at a trophic rate. We were unable to increase feeding rate further due to high stoma output (>3L/day) despite optimal dose of a proton pump inhibitor and Loperamide.

For patients with a jejunostomy and total small intestinal remnant less than 100cm, which was the case here, PN is essential for survival.[33-35] In such circumstances, it is unrealistic to assume that intestinal adaptation will happen to an extent that will allow the patient to rely on enteral nutrition. The patient in this case was transferred to a gastro unit on day 22 to be established on home PN. On transfer, the patient's weight was 68.4kg; there was a weight loss of 6% which is relatively small for critical illness. Despite the physiological complications of muscle weakness, at transfer, the patient was independent with all personal care.

CONCLUSION

Most elective surgery patients do not need nutrition support. Those who do require it are usually the patients who develop complications. Surgery provokes a series of reactions such as release of inflammatory mediators and stress hormones placing the body in a catabolic state. Provision of nutrients is crucial to support healing and rehabilitation.

EN when feasible is the first choice of therapy. Several factors have been identified as barriers for early initiation of EN post cardiothoracic surgery, often inappropriately, including fear of aspiration, haemodynamic instability and possible need for preoperative intervention. When EN is a real contraindication, international guidelines agree that PN should be considered.

There is debate regarding the optimal timing for the initiation of PN and macronutrient composition of the PN bag, particularly in patients who are critically ill. In the patient example reported here, PN was started late (day six) and nutrients were provided to match the patient's requirements at the end of the first week in order to minimise endogenous amino acid unitisation, reduce weight loss and promote recovery. This case illustrates the potential benefits of PN in the management of complex cardiothoracic surgical patients.