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CASE REPORT

Nutritional management of a polytrauma patient in an intensive care unit

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A 32-year-old male was admitted to hospital with multiple injuries following a quadbike accident. Treatment of the patient included a left arm amputation, a right hemicolectomy and end ileostomy, and the orthopaedic management of a left femur fracture and degloving injury. The patient subsequently spent eight weeks in the intensive care unit, developing a series of complications including acute kidney injury, multiple electrolyte abnormalities, pneumonia and prolonged feed intolerance. Nutritional management required several restrictions and achieving goal nutrition was difficult. A suspected diagnosis of superior mesenteric artery syndrome was not confirmed but provided an interesting new aspect to intensive care nutrition at this facility.

Keywords: hemicolectomy, ileostomy, nutritional imbalance, superior mesenteric artery syndrome (SMAS)

Case study

A 32-year-old male with no known co-morbidities was admitted to hospital on April 24, 2021 with multiple injuries from a quadbike accident. He presented with a severe crush injury, an ischaemic left arm from the axilla down, a left compound femur fracture and a degloving injury to the lower left leg. A 'damage control' laparotomy on admission showed an ischaemic right colon and proximal third transverse colon secondary to a suspected internal injury of the right colic/ileocolic vessels.

By day 3 post-injury, the patient had had two surgical interventions resulting in a right hemicolectomy, end ileostomy with mucous fistula, a left arm amputation, and debridement and nailing of the left leg injuries. His abdomen was closed, and he was transferred to the intensive care unit (ICU), intubated and ventilated. A low-rate semi-elemental feed via nasogastric tube (NGT) was transiently started by the attending surgeons on day 4 post-injury but was stopped in the early hours of day 5 as the patient was due to be extubated later that day.

The initial dietetic assessment on day 5 post-injury determined the patient's pre-amputation body mass index (BMI) to have been 34 kg/m^2, classifying him as obese class 1, with notable abdominal adiposity. Using an approximate height of 1.64 m, his estimated weight was adjusted for both obesity and an arm amputation, providing a working weight of 79 kg[1] (Table 1).

Blood values reflected acute kidney injury, with elevated urea, creatinine and potassium; however, these were on a downward trend. Urine output was low at 135 ml in 24 hours (0.06 ml/kg/minute for 91 kg), and stoma output was expectedly low at 350 ml. The patient received haemodialysis later that day.

The American Society for Parenteral and Enteral Nutrition (ASPEN) guidelines were used to calculate a suitable dietary prescription, considering the need for progressive achievement of target nutrition in the acute phase of critical illness, as outlined by the European Society for Clinical Nutrition and Metabolism (ESPEN).[2,3] ASPEN recommends a hypocaloric, high-protein feeding plan for obese patients.[3] However, the lack of a relevant feed for this approach meant a normo-caloric prescription was calculated, using adjusted ideal bodyweight (IBW).[1] The aim was to restart the semi-elemental feed and achieve 26 kCal/kg and 1.2 grams per kilogram protein for adjusted IBW while progressing the patient to oral intake. Nasogastric feeds were ultimately only started on day 6 post-injury, by which stage the patient was on high-flow nasal oxygen, awake and alert. After a few hours of receiving enteral feeds, the patient complained of feeling bloated. However, the attending surgeons were satisfied that the feeds could continue. By day 7 post-admission, a Friday, the patient had vomited, and feeds were stopped. Parenteral nutrition (PN) was started according to the recommended guidelines[2,3] (Table 2).

From days 9 to 42 post-injury, the patient deteriorated. On day 9 the patient removed his NGT but oral intake was subsequently poor and he refused NGT reinsertion. PN therefore continued and remained the primary feeding route until day 41. The patient developed uremic encephalopathy on day 12 and was reintubated on day 14 because of hospital-acquired pneumonia. On day 20 an open tracheostomy was performed. Renal function worsened, requiring six further episodes of intermittent haemodialysis between days 12 and 28. Hyperkalaemia persisted between days 10 and 21. On day 27 post-injury, the patient had a seizure, which was attributed to uraemia. The patient's plasma sodium on this day was 150 mmol/l, marking the start of a prolonged period of hypernatraemia, which finally resolved on day 43. Electrolyte-free PN was used between days 12 and 41 in response to these electrolyte abnormalities. As renal function started to improve, from day 30, phosphate levels started to decline, and the patient experienced episodes of severe hypophosphataemia on days 34 and 41 post-injury.

Triglycerides measured on days 11, 20, 24 and 32 post-injury were 4.56, 6.34, 4.02 and 5.22 mmol/l, respectively. Attempts to limit IV lipids to the lower end of the range of 0.7–1.5 g/kg were complicated by the simultaneous administration of ketofol which, on day 20, was running at 14 ml/hour and providing two-thirds of the restricted lipid requirements.[4] Given these multiple constraints to feeding, provision of protein and energy varied from 1.3 to 1.9 g/ kg and 22 to 34 kCal/ kg respectively for

Table 1: Anthropometry

Weight	Pre-amputation	Post-amputation (−5%)[1]
Estimated actual bodyweight (ABW)	96 kg	91 kg
Ideal bodyweight (IBW) (BMI 24.9 kg/m^2)	70 kg	67 kg
Adjusted IBW [0.5 × (ABW–IBW)] + IBW[1]	83 kg	**79 kg**

adjusted IBW, between days 10 and 43. During this same period the patient was hyperglycaemic and on an insulin infusion, but carbohydrate provision never exceeded 3 mg/kg/minute. Table 3 summarises the lowest to highest ranges of key blood values between days 16 and 43 post-injury.

An ongoing, unexplained and inconsistent pattern of vomiting provided another major challenge, developing on day 17 and persisting until day 38 post-injury. There was no evidence of abdominal sepsis and the surgeons saw no need for further surgery. When investigations such as a gastroscopy and a gastrograffin challenge yielded normal results, and prokinetics did not provide consistent relief, the surgeons considered superior mesenteric artery syndrome (SMAS) as the possible cause of the clinical picture. Computed tomography (CT) angiography was unremarkable. Feeding varied from exclusive PN, to PN and trophic nasogastric feeds, to PN and oral nutritional supplements (ONS) over the course of four weeks. Chewing gum was given to stimulate peristalsis. While recommendations for the management of SMA syndrome and enteral intolerance include post-pyloric feeding as well as PN, the facility experienced a temporary shortage of naso-jejunal tubes and PN remained the primary feeding route.[2,5] To alleviate the patient's notable muscle wasting, he was given testosterone injections of 200 mg on days 25, 32 and 40.

By day 39 post-injury, the vomiting stopped spontaneously, and the patient was cautiously moved onto full enteral feeds and weaned off PN by day 42. Decannulation took place on day 41. Oral intake steadily improved between days 45 and 51, during which time nasogastric feeds were reduced from 24-hour continuous feeds to 12-hour continuous feeds at progressively lower rates. By the time of discharge from ICU to the surgical ward on day 52, the patient was achieving 41 kCal/ kg and 1.9 g/kg protein intake with the ward diet and ONS, and the nasogastric tube was removed (Table 4). Until ICU discharge, the ileostomy output remained under 1 l per day. The patient was finally discharged home on July 7, 2021 (day 75 post-injury), clinically well, feeding himself, and with his wounds grafted and closed.

Table 2: PN feeding recommendations in critical illness

Recommendation	Energy	Protein	Lipid	Timing of PN
ASPEN:[3] critically ill	Obese: 11–14 kCal/ kg ABW 25–30 kCal/ kg PN hypocaloric with adequate protein or 80% requirements to start	2g/kg IBW BMI 30–40 kg/m^2 1.2–2 g/kg	–	For supplemental PN: 7–10 days or earlier if severe malnutrition
ESPEN[2]	70% EE days 1 and 2 80–100% EE day 3	1.3 g/kg over time	Max 1.5 g/kg	Supplemental PN: case by case. Apply all efforts to achieve EN tolerance before starting PN
Dept of Health:[4] PN ICU	Acute: 20–25 kCal/ kg TE Recovery 25–30 kCal/ kg TE Or obesity as per ASPEN[4]	1.3–1.5 g/kg (IHD) 1.5–2g/kg	0.7–1.5 g/kg	As per ASPEN/SCCM: severe catabolism with or without malnutrition where EN not possible 5–7 days[3]
Dept of Health:[4] PN surgery	25–30 kCal/ kg IBW	1.5 g/kg	30–50% TE with fish oil	

kCal: kilocalories; EN: enteral nutrition; EE: energy expenditure, TE: total energy, IHD: intermittent haemodialysis, dept: department.

Table 3: Monitored blood electrolytes, renal function and nutritional parameters days 16 to 43 (from lowest to highest results)

Parameter:	Normal range	Range Days 16–22	Days 23–29	Days 30–36	Days 37–43
Potassium (mmol/l)	3.5–5.1	4.8–6.4	3.2–4.5	3.8–4.6	4.2–5.5
Sodium (mmol/l)	136–145	127–138	135–150	151–161	143–155
Phosphate (mmol/l)	0.8–1.4	1.99–5.73	1.15–2.83	0.33–1.11	0.28–1.7
Urea (mmol/l)	1.7–8.3	24.6–91.3	32.8–63.5	23.2–33.7	10.0–17.7
Creatinine (μmol/l)	64–104	286–643	126–594	78–139	64–86
Glucose (mmol/l)	<10 in ICU	11.4–17	11.5–12.3	5.7–15.1	6.8–17.1
Triglycerides (mmol/l)	<1.7	6.34	4.02	5.22	–
Albumin (g/l)	32–52	13–21	21–23	21–22	22–25

Table 4: Progression of oral intake in final full week of ICU stay (days 45–49)

Factor	Monday	Tuesday	Wednesday	Thursday	Friday
Revised weight	Estimated pre-amputation BMI 28 kg/m^2	Weight (post-amputation) 75 kg			
Biochem	U & E normal; glucose normal; Mg and PO4 low—replaced; albumin 26				
Clinical	Some confusion	Confusion resolved; mobilised to chair; appetite improved			
Prescribed diet	24 h EN SWD 2 × 125 ml ONS	12 h EN SWD 2 × 125 ml ONS	12 h EN FWD 3 × 125 ml ONS	12 h EN FWD 3 × 125 ml ONS	12 h EN half rate FWD 3 × 125 ml ONS 1 × 200 ml ONS
Actual intake	24 h EN No food 1 × 125 ml ONS	12 h EN SWD 2 × 125 ml ONS	12 h EN SWD × 2 meals 3 × 125 ml ONS	EN not given FWD × 2 meals 3 × 125 ml ONS	12 h EN half rate FWD × 2 meals 3 × 125 ml ONS 1 × 200 ml ONS
Energy	36 kCal/kg	28 kCal/ kg	32 kCal/ kg	26 kCal/kg with FWD	41 kCal/ kg with FWD
Protein	1.8 g/kg	1.8 g/kg	2 g/kg	1.2 g/kg with FWD	2.1 g/ kg with FWD

Biochem: biochemistry; U & E: urea and electrolytes; Mg: magnesium; PO4: phosphate; EN: enteral nutrition; SWD: soft ward diet; FWD: full ward diet.

Discussion

The metabolic impact of critical illness and trauma results in a high rate of muscle catabolism, which can have a deleterious effect on recovery, quality of life and survival.[2,6] Up to one kilogram of muscle mass may be lost during the first 10 days of hospitalisation in critically ill patients, which is exacerbated by a lack of mobility and inability to meet nutritional requirements.[2,7] Obese patients are often erroneously overlooked in terms of their nutritional risk, and usually experience severe muscle wasting during critical illness. This is aggravated by impaired lipid metabolism and insulin resistance.[3] It is well known that early enteral nutrition (EN) in critically ill patients is recommended where feasible, although goals should be achieved gradually over the first week in the ICU.[2,3] The timing of supplementary PN is controversial. If all attempts to achieve enteral tolerance have failed, PN should be started, but not usually before 5–7 days in surgical patients.[2,3] Nutritional requirements post-ICU remain high to re-establish functional recovery and quality of life.[7]

Energy recommendations vary from 11 to 14 kCal/kg actual bodyweight (ABW) in critically ill obese patients with a BMI from 30–50 kg/m^2, to 20 to 35 kCal/ kg in trauma patients, depending on the stage of illness.[3] Protein guidelines range from 1.2 to 2 g/ kg in ICU and trauma, to 2.5 g/ kg (EN) in patients who are dialysed repeatedly.[2,3] Obese and critically ill patients should be fed to IBW, unless otherwise specified.[3] However, where ABW exceeds IBW by more than 30%, half of the difference between the two may be used (adjusted IBW).[1] Patients experiencing acute kidney injury (AKI) can receive the recommended prescription for critical illness, but specialised feeds may be necessary in the event of electrolyte derangements.[3] Critical illness may alter fat metabolism. Lipids in PN should be kept to a maximum of 1.5 g/kg, with regular monitoring of liver function and triglycerides for potential restrictions.[2] Once patients are tolerating 60% of their estimated requirements via EN, PN can be stopped.[2] High-energy and protein provision remains essential after ICU to recover lost muscle and regain muscle function.[7]

Postoperative ileus (POI) is the impaired peristalsis of the gastrointestinal tract, usually of the small bowel, after surgery.[8,9] Although definitions of it vary, symptoms typically include nausea, vomiting, enteral feeding intolerance, abdominal distension and delayed time to flatus and stool.[9] Prolonged ileus can have a notable impact on recovery and length of hospital stay.[10] To manage POI, ESPEN recommends intravenous erythromycin or metoclopramide, or a combination of both.[2] Gastrograffin is a radiological contrast substance used to analyse the GIT during CT studies.[8] As well as detecting obstructions, its hyperosmotic nature may make it useful for treating relevant symptoms, although this use is limited and does not reduce the need for surgery.[8] Another novel idea of treating POI is the use of chewing gum as a means of stimulating peristalsis.[8,9,10] Studies have shown that chewing gum post-surgery may reduce time to first flatus, bowel sounds, bowel movement and length of hospital stay, but these have historically been small studies, limited to colorectal surgery and Caesarean sections.[10]

SMAS, also called Wilkie's syndrome, is a rare form of intestinal obstruction that occurs when severe weight loss, and thus the loss of mesenteric fat, reduces the angle between the superior mesenteric artery and the abdominal aorta, constricting the third part of the duodenum.[11] Vague symptoms such as early satiety, bloating, sporadic vomiting, abdominal cramps and weight loss can lead to delayed diagnosis. Zaraket and Deeb reported the case of a 17-year-old girl who experienced symptoms for two years before SMAS was diagnosed.[11] Treatment is usually conservative, involving PN and post-pyloric feeding for weight gain.[11] According to ASPEN, small bowel feeding depends on hospital practices and the 'ease and feasibility' of tube placement.[3]

Recovery from an ICU stay may extend for months after discharge as catabolism prevails.[7] Although the causes of ICU-associated weakness are multifactorial, the use of anabolic medications, along with suitable nutritional support and exercise, may facilitate functional improvements and better quality of life.[7,12] ICU patients have been found to be testosterone depleted by day 7.[7] Research on the beneficial effects of these drugs has, until recently, largely pertained to burns injuries. However, the GAINS trial in Australia, a placebo-controlled, randomised trial, investigated the effect of nandrolone, an anabolic steroid, on various markers of strength, including grip strength, in weak adult ICU patients.[12] The nandrolone group had better grip strength and functional activity scores than the placebo group, although the results were not significant. No harmful effects of nandrolone were reported, and further research is warranted.[12]

Conclusion

Critically ill trauma patients experience a variety of complications during their hospital stay. Achieving goal nutrition is difficult and requires daily compromise. Multidisciplinary collaboration and retaining a clear vision of the goals ahead are essential in achieving successful intake, and ultimately reducing the long-term effects of critical illness.

Consent

The patient discussed in this case study has provided written consent for his information to be used in a case study write up and was made fully aware that he would remain anonymous.

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