Case Study: Nutrition in the ICU and multi-organ failure

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The following case study was discussed at the recent SASPEN Congress held at Spier Estate, Stellenbosch, South Africa. The case study was adapted from the original and used with the kind permission of Fresenius Kabi, Germany. Herewith follows a summarised discussion of the case. It is a reflection of the general opinion of the audience.

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Learning objective:

- To discuss practical nutrition management of the ICU patient.
- To debate various treatment options and decide on the best approach.
- To incorporate evidence-based principles in the decision-making process.

Day 1

At 22:30 a 55-year old female is involved in a high-speed motor vehicle accident and admitted to intensive care from the emergency department for ventilator support. She has several high rib fractures with associated major lung contusion and a haemothorax that has been drained. She also has a fractured left humerus, left femur and collapsed pelvis. She has no cerebral injury. There are no abdominal signs and a computed tomography (CT) scan could not demonstrate any major intra-abdominal injury. She has type-2 diabetes mellitus, is known with coronary artery disease (on treatment for angina) and has a body mass index (BMI) of 29.

She is sedated with propofol and alfentanyl. She is orally intubated and has a large bore nasogastric tube (NGT) on free drainage. A triple-lumen central venous catheter is inserted. You are satisfied with her current haemodynamic status and, although she has to go to theatre to externally fix the pelvis and pin the femur, no set theatre time has been given.

Question 1: What are your decisions regarding her maintenance fluids and nutritional requirements?

Question 2: What would you suggest for the first 24 hours?

Comments: This polytrauma patient had no marked abdominal problems. Early enteral nutrition (EN) was recommended since the patient was haemodynamically stable. A polymeric feed was recommended as there was no indication for the use of a semi-elemental enteral feeding solution. A global fluid allowance of 30–35 ml/kg was suggested, divided between maintenance fluids and enteral feeds. Supply of enteral glutamine of 0.5 g/kg was recommended. A total energy target of 20–25 kcal/kg actual bodyweight with 1.2–1.5 g protein/kg ideal bodyweight was suggested.

Rationale: The provision of enteral nutrition to critically ill patients early upon admission to the intensive care unit (within 24–48 hours of resuscitation) exerts beneficial physiological effects such as down regulated systemic immune responses, reduced oxidative stress and improved patient outcomes[1] in terms of mortality[2] and infectious complications.[2,3] The use of a whole-protein feeding solution (polymeric) was recommended.[1,4] Currently no evidence demonstrates favourable clinically important treatment effects associated with the use of peptide-based formulas in the critically ill adult patient.[1] Immune-modulating enteral formulations (supplemented with agents such as arginine, glutamine, ω-3 fatty acids, and antioxidants) should be used in this case (critically ill trauma patient on mechanical ventilation),[4,5] since these diets appear to overcome the regulatory effect of myeloid suppressor cells. The ω-3 fatty acids eicosapentaenoic acid (EPA) and docosohexaenoic acid (DHA) displace ω-6 fatty acids from the cell membranes of immune cells, thus reducing systemic inflammation.[5] Glutamine, considered a conditionally essential amino acid, exerts various beneficial effects on antioxidant defences, immune function, production of heat shock proteins, and nitrogen retention.[6] The addition of enteral glutamine (0.3–0.5 g/kg/d) to an enteral nutrition regimen (not already containing supplemental glutamine) should be considered in thermally injured, trauma, and mixed ICU patients.[4,5,6] Addition of agents such as selenium, vitamin C and vitamin E provides further antioxidant protection.[5]

Day 3

Early in the morning increased ventilator and circulatory problems dictate more detailed cardiac output and lung water monitoring, deeper sedation and neuromuscular blockade to tolerate the necessary ventilator strategy. A restricted fluid regimen is introduced, but she also requires blood products because of coagulation disorders. She is requiring inotrope support and has marked peripheral oedema. Her albumin is 26 g/L and her blood glucose is

8.5 mmol/L. The nurse feels that she is tolerating her enteral feeding but during turning feed is regurgitated.

Question 3: A new nurse asks whether there is a problem with feed tolerance. What could be happening? What additional information do you need to make your judgement? What can you do?

Comments: A chest X-ray (CXR) is required to check and confirm the position of the NGT. An abdominal X-ray (AXR) should be taken to check whether the patient is developing ileus. Prokinetics could be considered and the administration rate of the feeding solution might be reduced to increase tolerance.

Rationale: In critically ill patients who experience feed intolerance (high gastric residuals, emesis), the use of agents to promote motility such as prokinetic drugs (metoclopromide and erythromycin) or narcotic antagonists (naloxone and alvimopan) should be initiated where clinically feasible.[1,4,5,7]

Question 4: Do you need to do anything about the low albumin, oedema or her blood glucose? Why are they abnormal and is there anything that you can do?

Comments: There is no indication for the administration of IV albumin to relieve the peripheral oedema. The blood glucose is high, but is managed without insulin at this stage. One could consider mixed nutrition in terms of supplemental parenteral nutrition (PN) to help aim for target energy goals at Day 3. One could consider a semi-elemental feeding solution in the presumed presence of gut oedema (assuming that peripheral oedema is a reflection of the presence of gut oedema). There is no evidence that the patient is not absorbing feeds; however, the patient might have problems with motility.

Rationale: Critical illness is associated with catabolic hormonal and cytokine responses which lead to increased glycogenolysis and gluconeogenesis, causing a net breakdown of skeletal muscle and enhanced lipolysis.[8] Although plasma substrate levels may be increased, their availability for use by the peripheral tissues may be blunted (because of factors such as insulin resistance). The role of hyperglycaemia in morbidity and mortality in ICU patients is complex, but most investigators agree that a blood glucose value exceeding 180 mg/dL (10 mmol/L) may be associated with increased rates of death and complications.[1,5,9,10]

PN represents an alternative and often an additional approach when other feeding routes are not succeeding or when it is not possible or unsafe. The main goal of PN is to deliver a nutrient mixture closely related to nutritional requirements safely and to avoid complications. This nutritional approach has been subject to debate over the past decades. The recommendation in terms of the time frame at which supplementary PN should be started is controversial. Some advocate that all patients receiving less than their target enteral feeding after two days should be considered for supplementary PN. It is further stated that all patients who are not expected to be on normal nutrition within three days should receive PN within 24–48 hours if EN is contraindicated or if they cannot tolerate EN.[4,9] Others recommend that if early EN is not feasible or available the first seven days following admission to the ICU, no nutrition support therapy should be provided. In the patient who was previously healthy prior to critical illness, use of PN should be reserved and initiated only after the first 7–10 days of hospitalisation.[4]

The implementation of nutritional support within three days of ICU admission is recommended.[11] One multicentre study performed in 1209 ICU patients has shown that achieving the energy target in the first three days of ICU stay, whatever the route of feeding (enteral or parenteral feeding), was associated with a decrease in morbidity and mortality.[12] A meta-analysis of 465 publications showed that early PN could decrease ICU mortality in comparison with delayed enteral nutrition (> 24 hours). However, this positive effect of PN on survival was no longer evident when comparing PN with patients who received EN within 24 hours of ICU admission.[13] The administration of early PN has also been associated with increased complications that could be related to overfeeding rather than to PN itself. Therefore, individualising patient needs is extremely important.

Day 6

She undergoes a percutaneous tracheotomy as prolonged ventilator support is expected. During the night a rise in her temperature and rising white cell count suggests a new infection and antibiotics were started. All her vascular lines were changed. She has passed a loose stool. Liver and renal function is moderately impaired.

Contrary to what you might have decided she has remained only on NG feeding and despite the best of intentions, the review of her energy intake since admission shows less than 50% of target achievement.

Question 5: Why less than 50% energy target achieved? What are the common reasons and are they avoidable? Do you have systems in place to monitor and prevent this?

Question 6: Is this amount of feed sufficient? What is the evidence for and against this? Can you catch up for the missing feed by giving more?

Question 7: Will her nutritional requirements have altered since admission in composition and/or amount? What should you do now?

Comments: Several factors potentially limit enteral intake in critically ill patients, including lack of feeding protocols, gastrointestinal intolerance of enteral tube feedings, displacement or obstruction of the feeding tube, and interruption of tube feedings for tests and procedures. Gastrointestinal intolerance of tube feedings (e.g. large gastric residual volumes, nausea and vomiting, ileus, abdominal distension, and diarrhoea) is a major factor limiting adequate enteral intake in patients. In order to reduce the risk of aspiration of enteral formula, feeding is routinely withheld in patients with unstable haemodynamic parameters and in preparation for surgical or diagnostic procedures, weaning, and various nursing care activities.[14] Supplementary PN should be considered since EN is not meeting energy requirements. The addition of immunonutrients such as glutamine and ω-3 fatty acids should be considered.

Rationale: Despite insufficient data from randomised trials to recommend the use of a feeding protocol in critically ill patients, it is advised to consider the use of a feeding protocol as a strategy to optimise nutritional intake.[1,2,5, 7,11] However, negative energy balances are very frequent during severe critical illness despite nutrition protocols. Underfeeding is correlated with increased prevalence of complications and infections.[8] Delaying the initiation of nutritional support exposes the patient to energy deficits that

cannot be compensated for during the remaining ICU stay.[11,15] A prospective, non-randomised study by Genton[16] showed that calorie and protein deliveries increased within five days of EN initiation. No precise amount of energy can be recommended as EN therapy should be adjusted according to gut tolerance and disease progression. Equations give only an approximate valuation and indirect calorimetry is not available or used in many units. Moreover, evidence-based studies to demonstrate the usefulness of measuring energy expenditure in the critically ill are lacking.[9,15] During the acute and initial phase of critical illness an exogenous energy supply in excess of 20–25 kcal/kg/day may be associated with a less favourable outcome. During recovery (anabolic flow phase), the aim should be to provide the patient with 25–30 kcal/kg/day.[2,9,11]

Day 10

She is now more awake and self-triggering the ventilator on pressure support ventilation. Her chest drains are out. She is complaining of upper abdominal discomfort, nausea and vomiting. You attempt to assess the extent of her catabolism.

Later that day she suffers a circulatory collapse and undergoes urgent laparotomy. A retro-peritoneal duodenal rupture is diagnosed and treated. The surgeon asks if you want a feeding route via the jejunum.

Question 8: What type of approach would you suggest – naso-jejunal or jejunostomy tube? On return from theatre you are asked for advice on her nutrition.

Comments: The patient might benefit from a double-lumen jejunostomy tube (ideally placed during the laparatomy procedure). It is believed that the patient will be able to tolerate a polymeric feed. A semi-elemental feeding solution is only prescribed if there is documented evidence of malabsorption of the polymeric feed.

Rationale: Despite multiple studies' evaluation of gastric vs jejunal feeding in various medical and surgical ICU settings, it is advocated that either gastric or small bowel feeding is acceptable in the ICU setting. Critically ill patients should be fed via an enteral access tube placed in the small bowel if at high risk for aspiration or after showing intolerance to gastric feeding (high gastric residual volumes).[4,5,7] The Canadian Clinical Practice Guidelines recommend the routine use of small bowel feedings in units where obtaining small bowel access is feasible.[1]

Day 13

She has deteriorated gas exchange with fever and purulent excretions. Her renal function is deteriorating and she has a septic dynamic circulation. Despite fluids and inotropes, renal support is required and continuous veno-veno haemofiltration is commenced. She regurgitates a large volume of bile stained fluid. There are no abdominal signs.

Question 9: It is Friday and the pharmacy request nutrition orders for the weekend. Do you need to make any specific requests or restrictions? How much will you feed?

Comments: Energy intake should be increased to 30–40 kcal/kg/day (Stage 5 level of kidney failure patient receiving haemodialysis requires 35 kcal/kg/d <6 0 years of age[17]) and enough total parenteral nutrition (TPN) should be ordered to meet the patient's nutritional needs over the weekend. An attempt should also be made to advance to EN.

Rationale: Acute renal failure seldom exists as an isolated organ failure in critically ill patients. The underlying disease process, pre-existing comorbidities, and current complications should be taken into account when prescribing EN. If significant electrolyte abnormalities exist or develop, a specialty formulation designed for renal failure (with appropriate electrolyte profile e.g. reduced phosphate and potassium) may be considered for the ICU patient with acute renal failure.[5] Patients receiving haemodialysis should receive formulations with 1.5–2.0 g/kg/d of protein, up to a maximum of 2.5 g/kg/d to achieve positive nitrogen balance in this population.[5]

Day 18

She is now improving and breathing spontaneously through her tracheostomy on continuous positive airway pressure (CPAP). She has been sitting out of bed, propped in a chair. She still requires intermittent haemodialysis that she has late in the afternoon and is off all inotropic support and antibiotics.

She is being prepared to move from the ICU to high care. She is having large loose bowel movements and also mentions to you that she wants something to eat.

Question 10: What do you suggest? What are the risk-benefits? Do you have any concerns? What might compromise her eating?

Comments: The patient is likely to be exhausted with muscle weakness and may be suffering from ICU neuropathy. Patient needs support in terms of physiotherapy, rehabilitation and psychotherapy. Patient's jejunostomy should ideally remain intact to enable nursing staff to administer overnight feeds for an additional 2–3 days. This should meet some nutritional needs in case the patient has dysphagia due to muscle weakness.

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