Why you should read this article:

- To assist you to provide appropriate nutritional support for patients who are critically ill
- To enhance your understanding of the pathophysiology of nutrition
- To enable you to undertake effective nutritional screening and assessment of patients who are critically ill
- To optimise the routes of administration and timing of nutritional interventions used in practice

Providing nutritional support for patients in critical care

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Abstract

The provision of nutritional support for patients who are critically ill is complex and multifaceted, in part because of the variety and complexity of potential clinical presentations. This article explores the importance of providing nutritional support for patients who are critically ill and explains the pathophysiology of nutrition in altered health states. It discusses nutritional screening and assessment, the various routes of nutrition administration and the nursing considerations involved in providing nutritional support in critical care.

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Keywords

artificial nutrition, critical care, diet, enteral nutrition, intensive care, malnutrition, nutrition, parenteral nutrition, undernutrition

Nutritional support is vital for patients who are critically ill, and is recognised as a therapy in its own right (Ramprasad and Kapoor 2012). Woodrow (2011) suggested that nutrition is a fundamental component of critical care, while Kreymann et al (2006) stated that it aids medical treatment and improves recovery. However, initiating and maintaining appropriate nutritional support for patients who are critically ill is challenging for several reasons, including the variety of potential clinical presentations.

Patients admitted to critical care may have one or more organ failures, and the underlying causes of these failures can vary – some may result from sepsis, while others may be caused by postoperative complications. Furthermore, there may be differences in the injuries, disease processes and severity of organ failure that these patients may experience (Casaer and van den Berghe 2014, Desai et al 2014). As a result, nutritional support for patients in critical care is complex and multifaceted, and the optimal routes of administration and timing of nutritional interventions are often debated in practice.

Pathophysiology of nutrition

Nutrition is essential for cellular function. The intake of micronutrients and macronutrients is vital for the metabolic processes that maintain homeostasis. In health, this is usually achieved by maintaining a balanced diet (World Health Organization 2015), consisting of adequate nutrients to fulfil the body's basal metabolic requirements (the calories required to maintain the body's function at rest) and daily activity. For adequate nutrition, the body is dependent on the availability of energy substrates, including carbohydrates, proteins and lipids, with glucose from carbohydrates being the preferred source of slow-release energy (Galgani and Ravussin 2008).

During illness, the metabolic requirements of the body change as a result of the stress response. The stress response is the body's reaction to a stimulus or stressor, and it aims to maintain homeostasis. Examples of stressors include raised temperature, infection or bleeding. The stress response is triggered after a chemical messenger sends a distress signal via the nervous system, which is received by the hypothalamus. The hypothalamus is a part of the brain responsible for many of the activities involved in homeostasis, including body temperature and hormonal regulation. The result of this distress signal can be divided into three phases: fight-or-flight response, resistance and exhaustion (Tortora and Derrickson 2011, Marieb 2014, Yancey 2016).

The fight-or-flight response is activated by the body to manage short-term stressors such as fear or injury (Marieb 2014). Adrenaline (epinephrine) and noradrenaline (norepinephrine) are released, which leads to an increase in glucose levels as the liver converts its stores of glycogen into glucose (glycogenolysis), all of which assist the body to manage the stressor. Oxygen delivery to the body's essential systems, such as the heart, brain and muscles, is also increased, which provides the energy to either manage or avoid a stressor (Tortora and Derrickson 2011, Marieb 2014).

In the resistance phase, the body continues to combat the stressor. To maintain energy levels and repair cellular function, the hypothalamus excretes hormones that prompt further endocrine responses from the anterior pituitary gland in the brain, which assists the body to deal with prolonged stressors. The hormones released from the anterior pituitary gland stimulate various hormone responses. These hormones regulate metabolism and glucose supply in the body, assisting with the generation of new sources of glucose, for example proteins and fats, via the process of gluconeogenesis. These new sources of glucose can be used for energy or cell repair (Tortora and Derrickson 2011).

If the body is unable to deal with the initial stressor in the resistance phase of the stress response, glucose reserves will soon become depleted, leading to exhaustion of the body's energy supply. As the body continues to attempt to manage the stressor, the high levels of hormone release during the resistance phase continues, which can lead to further breakdown of tissue, for example resulting in muscle wastage (Tortora and Derrickson 2011).

Metabolic response to critical illness

During illness, the initial fight-or-flight response ensures that significant amounts of oxygen and glucose are quickly made available to areas of the body where they are required, but are restricted in non-essential systems such as the kidneys and the gastrointestinal tract, thereby preserving as much energy as possible. In critical illness, this is referred to as the 'ebb' phase of the metabolic response and can last for up to 24 hours (Rutledge and Nesbitt 2013).

The 'flow' phase of the metabolic response to critical illness is associated with increased levels of hormones during prolonged exposure to a stressor, as described in the stress response (Rutledge and Nesbitt 2013). To continue to combat the stressor, the body requires additional energy and increased levels of oxygen to meet the increased metabolic demand. This is commonly referred to as a hypermetabolic state. To meet this demand, the body uses up its stores of glucose developed from carbohydrate metabolism and must create a new energy source, which involves the breakdown of proteins and fats from muscle and adipose tissue. This is known as a catabolic state (Heyland et al 2003), and can lead to some of the complications associated with critical illness including rapid weight loss, delayed wound healing, a reduction in immunity and hyperglycaemia (Heyland et al 2003, Mehanna et al 2008).

Patients who are critically ill are often unable to feed themselves and frequently present in a fasting state, and it can be challenging to identify when they last received nutrition (Cove and Pinsky 2011). This, along with the patient's disease process, leaves them at risk of undernourishment and malnourishment, and often leads to the substrate breakdown involved in a catabolic state.

Macdonald et al (2013) summarised the potential effects of malnutrition in critical illness as:

- Impaired immune function.
- Increased length of hospital stay.
- Increased morbidity and mortality.
- Increased ventilator-dependent days.
- Muscle weakness.
- Prolonged recovery times.

These potential effects demonstrate the importance of optimal nutritional support for patients in critical care. Nutritional support targets the flow phase of critical illness, and, if initiated early and effectively, can reduce muscle wastage and length of hospital stay, improve recovery times and provide much-needed energy (Casaer and van den Berghe 2014, Desai et al 2014). To provide patients who are critically ill with appropriate levels of nutrition, accurate assessment must be undertaken.

Nutritional screening and assessment

Nutritional support aims to provide patients with the nutrients they need to fulfil their basal metabolic requirements. Assessment of the nutritional requirements of a patient who is critically ill should include multidisciplinary input from dieticians because of the potential variety of the patient's requirements, as well as the potential complexity of their presenting conditions (Frankenfield and Ashcraft 2011, Intensive Care Society (ICS) 2013, Preiser et al 2014).

To guide nutritional support for patients, the National Institute for Health and Care Excellence (NICE) (2017) guidelines recommend screening for malnutrition and risk of malnutrition in all hospital inpatients using a recognised tool, for example the Malnutrition Universal Screening Tool (British Association for Parenteral and Enteral Nutrition 2018), which uses the patient's body mass index, percentage of unplanned weight loss and acute disease effect to calculate their risk of malnutrition.

Patients considered high risk should be regarded as requiring nutritional intervention (NICE 2017). Because of their reduced dietary intake and the resulting catabolic effect of their illness, patients who are critically ill will be considered high risk of malnutrition according to the NICE (2017) guidelines, and should be screened for malnutrition on a weekly basis. Rahman et al (2016) suggested that assessing the risk of malnutrition in patients who are critically ill is more complex than in other patients and that a specialised approach to nutritional screening is required. However, no specialised risk assessment tools for this patient group have been developed and accepted in UK guidance.

One of the techniques used to measure a patient's energy requirements is indirect calorimetry, which uses a canopy, face mask, airtight bag or ventilation system to measure a patient's oxygen consumption and carbon dioxide levels so that their energy requirements can be determined (Frankenfield and Ashcraft 2011). However, indirect calorimetry can be inaccurate in patients who are critically ill because of metabolic disturbances, high oxygen concentrations resulting from oxygen therapy, and, in patients who require invasive ventilation, air that has leaked from ventilator circuits (Frankenfield and Ashcraft 2011).

Metabolic equations such as the Penn State equations (Frankenfield and Ashcraft 2011) are used instead to determine the energy requirements of patients who are critically ill, which are based on parameters such as: the patient's weight, gender, age and activity; whether they are breathing independently or using a ventilator; and the severity of their illness. Despite these equations being considered highly inaccurate in critical illness, they are the most commonly used in critical care because of the lack of alternative methods (Frankenfield and Ashcraft 2011, Berger and Pichard 2014, Rahman et al 2016).

It is important for nurses to undertake regular reviews of the energy levels of patients who are critically ill because their physiological requirements may change over time. To prevent the overfeeding of these patients when prescribing nutritional support, Berger and Pichard (2014) recommended that nurses should also consider any non-nutritional sources of energy, such as glucose and lipids contained in drugs such as propofol (a short-acting anaesthetic often used in mechanically ventilated patients). Similarly, the nutritional support of patients who are critically ill should be reviewed every 24 hours and revised by a dietician if necessary, depending on the patient's acuity, blood test results in terms of electrolyte balance, and whether the patient is absorbing the feed if they are receiving it enterally.

Rutledge and Nesbitt (2013) proposed that nutritional support should be a priority in the management of patients who are critically ill, and nurses should consider the most suitable route of administration as well as the short-term and long-term aims of the feeding regimen, for example to enable the patient to recover from their critical illness and rebuild their fat and protein stores. Box 1 outlines recommendations for the nutritional support of patients in critical care (American Society for Parenteral and Enteral Nutrition (ASPEN) 2016, Scottish Intensive Care Society 2016).

Routes of administration

Enteral nutrition

Enteral nutrition involves passing the feed directly into the patient's gastrointestinal tract via a feeding tube. Placement sites for feeding tubes include the stomach and the duodenum and jejunum (both segments of the small intestine). The feeding tube can be inserted nasally or orally, or via percutaneous endoscopic gastrostomy or jejunostomy tube (J-tube), depending on which is most suitable for the patient. For example, a nasogastric or orogastric tube might not be suitable for a patient with facial trauma because it may be challenging to insert; similarly, a patient who has experienced a neurological trauma might require an orogastric tube if a basal skull fracture is suspected, since there is a risk that a nasogastric tube would penetrate the skull. The most commonly used enteral feeding tube in practice is the nasogastric tube (Dougherty and Lister 2015).

Early enteral nutrition is the provision of enteral nutrition within the initial 24-48 hours of the patient's admission to critical care. Providing enteral nutrition early in a patient's admission has been found to reduce mortality in patients who are critically ill (ASPEN 2016), while early enteral nutrition can also preserve gut mucosal integrity, and reduce the risk of bacterial translocation (Schetz et al 2013, Casaer and van den Berghe 2014, Desai et al 2014). Early enteral nutrition is also considered to be beneficial in the early catabolic phase of critical illness (Schetz et al 2013, Casaer and van den Berghe 2014, Desai et al 2014). However, it should be noted that the benefits of early enteral nutrition are largely based on trials of suboptimal design, so the reliability of this evidence is questionable.

When receiving nutrition via the enteral route, some patients may

Key points

- **The intake of micronutrients and macronutrients is vital for the metabolic processes that maintain homeostasis. In health, this is usually achieved by maintaining a balanced diet (World Health Organization 2015), consisting of adequate nutrients to fulfil the body's basal metabolic requirements (the calories required to maintain the body's function at rest) and daily activity**
- **Because of their reduced dietary intake and the resulting catabolic effect of their illness, patients who are critically ill will be considered high risk of malnutrition according to the National Institute for Health and Care Excellence (2017) guidelines, and should be screened for malnutrition on a weekly basis**
- **Nutritional support should be a priority in the management of patients who are critically ill, and nurses should consider the most suitable route of administration as well as the short-term and long-term aims of the feeding regimen, for example to enable the patient to recover from their critical illness and rebuild their fat and protein stores**
- **Enteral nutrition is the first-choice nutritional intervention for patients who are critically ill; however, there are often challenges in administering the feed in a volume that is sufficient to meet their nutritional requirements. When enteral nutrition is inadequate or unsuitable for a patient who is critically ill, parenteral nutrition can be administered**

show signs of enteral nutrition intolerance, which occurs where the feed administered is not absorbed by the gastrointestinal tract. Common symptoms include vomiting, oesophageal regurgitation, abdominal distention and diarrhoea (Montejo et al 2010, Reignier et al 2013, Desai et al 2014, Ozen et al 2016).

One common method used to check whether the feed is being absorbed by the gastrointestinal tract is to aspirate contents from the gastrointestinal tract via the feeding tube to measure the gastric residual volume (GRV), which is the volume of fluid remaining in the stomach at a fixed point in time during feeding. Historically, a patient with a high GRV was considered at increased risk of aspiration pneumonia, although this has been contested and the ASPEN (2016) guidelines advise that GRV measurements are not required for patients in critical care, because the risk of aspiration pneumonia is unfounded (Montejo et al 2010, Reignier et al 2013, Ozen et al 2016). However, this recommendation is based on studies that involved patients on mechanical ventilation, which presumes they have a protected airway, and who were managed in an upright 30-degree angle, thus minimising the risk of aspiration pneumonia. Therefore, it may be prudent to continue to monitor GRV in patients in critical care who do not have a protected airway, and nurses should follow local policies in this respect.

Enteral nutrition is aimed at either full calorific feeding or trophic (low-dose) feeding (Desai et al 2014). Full calorific feeding in patients who are critically ill has been linked to signs of absorption intolerance, which can lead to inadequate levels of enteral feed and subsequently failure to meet calorific and protein targets for feeding. Trophic feeding aims to maintain gut integrity while minimising the risk of perceived feeding intolerance and, while the practice of underfeeding a patient could be questioned, it can contribute to meeting the patient's full calorific requirements if combined with parenteral nutrition.

NICE (2017) guidelines recommend cautiously introducing the feed to critically ill patients, starting at no more than 50% of the target requirement and increasing this over a 24-48-hour period. However, in the authors' experience, this is not a common approach in practice, and the risks for each patient should be individually assessed by the multidisciplinary team.

Parenteral nutrition

Parenteral nutrition is the provision of nutrients directly into the patient's vein. It requires venous access and is commonly administered into a central vein to avoid the solution irritating the veins, although some solutions can be administered via a peripheral cannula for short-term use.

Parenteral nutrition can be used as the sole source of nutritional intake; however, there is no evidence that it improves mortality rates compared with enteral nutrition (Desai et al 2014). Casaer and van den Berghe (2014) stated that parenteral nutrition can be used to meet calorific targets when enteral nutrition fails, although evidence is inconclusive regarding the risks and benefits to patients and the optimum time at which parenteral nutrition should be introduced.

Harvey et al (2016) suggested that parenteral nutrition is more likely to accurately deliver targeted nutrition than enteral nutrition, and that the risk of infection such as catheter-related bloodstream infection is outdated because of improved infection control measures (Loveday et al 2014). ASPEN (2016) guidelines recommend the use of parenteral nutrition as a supplement to enteral nutrition after 7-10 days if a patient is unable to meet more than 60% of their energy target. ASPEN (2016) guidelines also recommend administering parenteral nutrition as soon as possible after admission to critical care in patients where enteral nutrition is not feasible.

Parenteral nutrition can be withdrawn once adequate oral or enteral nutrition is tolerated and the patient's nutritional status is stable. Withdrawal should be planned in stages with a daily review of the patient's progress. However, Preiser et al (2014) highlighted that enteral feed targets are frequently missed in patients who are critically ill, who might be underfed or overfed as a consequence. It has been demonstrated that having a clear protocol to follow when establishing feeding can reduce this risk (NICE 2017).

Nursing considerations

Care and management of feeding tubes

When providing nutritional support, nurses must ensure they undertake appropriate care and management

BOX 1. Recommendations for the nutritional support of patients in critical care

- Nurses should assess patients for nutrition risk on admission to critical care, and calculate their energy and protein requirements to determine the aims of nutritional support
- Scottish Intensive Care Society (2016) guidelines state that patients who are critically ill should be fed, preferably enterally, within 24 hours of admission to critical care, while the American Society for Parenteral and Enteral Nutrition (ASPEN) (2016) guidelines state that enteral nutrition should be initiated within 24-48 hours, and that the target nutrition levels should be increased over the first week of their stay
- Measures to improve the delivery of enteral feed should be employed as soon as possible if nasogastric feeding proves inadequate, for example by using a prokinetic drug (a drug that improves gastric motility) or postpyloric feeding (enteral feeding but with the tube reaching the small bowel)
- Steps should be taken as required to reduce the risk of aspiration or improve the patient's tolerance to gastric feeding, for example by using a prokinetic drug, continuous infusion or chlorhexidine mouthwash. Patients should be nursed at a 30-45-degree angle with their head elevated, to reduce the risk of aspiration
- If enteral feeding is not successful or is contraindicated, parenteral nutrition should be considered in patients who are high risk or malnourished
- Every effort should be made to avoid breaks in the delivery of nutritional support, since achieving calorific targets is challenging even in stable patients in critical care
- The placement of a patient's nasogastric tube should be checked regularly. Scottish Intensive Care Society (2016) guidelines state that gastric residual volumes (GRVs) of 250mL should be tolerated as part of a feeding protocol, while the ASPEN (2016) guidelines state that GRV should not be used as part of routine care to monitor patients in critical care who are receiving enteral nutrition

(Adapted from American Society for Parenteral and Enteral Nutrition 2016, Scottish Intensive Care Society 2016) of any feeding tubes used. Because of the increased risk of infection associated with central venous access and parenteral nutrition, nurses must ensure that they adhere to infection prevention and control guidelines, particularly in the use of a dedicated lumen for parenteral nutrition. Similarly, any catheter manipulation, for example changing the feed at 24 hours, should be considered a sterile procedure using an aseptic non-touch technique (Loveday et al 2014).

Glycaemic control

The body regulates blood glucose levels using the hormones glucagon and insulin, which assist in the increase or reduction of blood glucose levels respectively. Hyperglycaemia is common in critical illness, resulting from both the initial fight-or-flight stress response, and the formation of 'new' glucose from the action of cortisol on protein and fat. Insulin is resistant to this new glucose and therefore secretion is inhibited, leading to a rise in blood glucose levels. Glycaemic control in patients who are critically ill is complex because blood glucose levels are not only raised through the stress response, but also as a direct result of the nutritional support they receive and some of the pharmacological therapies that may be provided, since some medicines are mixed with or contain glucose.

ASPEN (2016) guidelines recommend a target blood glucose range of 140-180mg/dL for patients who are critically ill. In clinical practice, insulin therapy is usually initiated as a continuous infusion if a patient's blood glucose level exceeds 180mg/dL. Once insulin therapy has been commenced, regular blood glucose monitoring should take place as per local policy, with additional monitoring following any changes to the insulin infusion rate, during changes in nutritional support (increase, decrease or temporary discontinuation), or at mealtimes in patients taking an oral diet, to enable safe titration.

Refeeding syndrome

Patients who are severely malnourished are at risk of refeeding syndrome when nutrition is re-introduced. Refeeding syndrome is a potentially life-threatening condition where the electrolyte balance of the body's cells is altered following the introduction of enteral or parenteral nutrition. As nutrition is reintroduced, the body's demand for electrolytes and micronutrients increases, meaning that patients may require potassium, phosphate and magnesium supplements (Martyn 2010). NICE (2017) guidelines recommend starting any feed at no more than 50% strength for the first two days to reduce the risk of refeeding syndrome.

Discontinuing feed

When discontinuing enteral or parenteral nutrition, the patient's ability to continue to consume enough nutrients must be considered. A multidisciplinary team approach with input from a dietician, and incorporating the views of the patient, should be used. Where there is concern about a patient's ability to swallow – for example, in patients with endotracheal or tracheostomy tubes in place, neurological deficits or muscular dystrophies – referral to the local speech and language therapy service should be considered. Persenius et al (2009) reported that patients can begin to feel increasingly empowered when feeding tubes are removed.

In the authors' experience, when a patient initially restarts an oral diet and fluids, it may be useful for the nurse to leave any feeding tubes in place until they are confident that the patient has achieved a sufficient calorie and protein intake. If the patient's nutritional intake remains inadequate, overnight nutritional support, typically in the form of enteral feeding, can be provided to ensure nutritional targets are met. When discontinuing a feed, caution must be exercised and consideration given to any glycaemic control measures in place, since continuing insulin therapy could result in hypoglycaemia.

Conclusion

Providing nutritional support for patients who are critically ill can be complex, because of the variety of potential clinical presentations. Therefore, it is important that screening and assessment of the nutritional status of these patients is undertaken on their admission to critical care, then on a weekly basis and/or if there are significant changes to their clinical condition. Early assessment of the patient's nutritional status enables appropriate nutritional interventions to be undertaken that provide energy for cell repair, as well as preventing muscle wastage and premature fat breakdown.

Enteral nutrition is the first-choice nutritional intervention for patients who are critically ill; however, there are often challenges in administering the feed in a volume that is sufficient to meet their nutritional requirements. When enteral nutrition is inadequate or unsuitable for a patient who is critically ill, parenteral nutrition can be administered. Nurses should also consider the care and management of the feeding tubes, glycaemic control, the risk of refeeding syndrome, and when to discontinue the feed. It is important that they work with other members of the multidisciplinary team, such as dieticians, to provide appropriate nutritional support for patients who are critically ill, following local policies and practising within their own scope of practice.

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