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The role of energy and nutritional support in the intensive care unit

Mette M Berger* and René L Chioléro

MM Berger is a Staff Intensivist and RL Chioléro is Head of the Adult Intensive Care Unit, Department of Adult Intensive Care Medicine and Burns Centre, University Hospital (CHUV), Lausanne, Switzerland.

Correspondence
*Department of Adult Intensive Care Medicine and Burns Centre
University Hospital (CHUV)
BH-08.660
Rue du Bugnon 46
CH 1011 Lausanne
Switzerland
mette.berger@chuv.ch

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Critical illness is characterized by reproducible alterations in metabolism that can result in rapid loss of lean body mass and an increased risk of malnutrition. The vast majority of conditions requiring treatment in the intensive care unit (ICU) are associated with a systemic inflammatory response. As a consequence, affected individuals are generally hypermetabolic, insulin-resistant and catabolic. The magnitude of the metabolic response is proportional to the severity of both the systemic inflammatory response and the underlying illness, and is greatest in patients with major burns, trauma, and sepsis and lowest in conditions associated with muscle paresis or paralysis. Malnutrition develops in ~43% of all critically ill, hospitalized individuals and so represents a major problem for patient care.[1] The role of nutritional support in the ICU is, therefore, discussed in this Viewpoint.

The initial aim of nutritional support is to meet caloric and substrate demands in order to maintain lean body mass. Nutritional support also preserves vital organ and immune function, modulates metabolic and systemic inflammatory responses, and promotes metabolic control. As both overfeeding and underfeeding are clearly deleterious, many studies have focused on optimal levels of energy delivery. Indeed, determination of individual energy requirements is a prerequisite before nutritional support can be prescribed.

Energy requirements depend on the age, sex, body composition, nutritional status, clinical condition, and physical activity of the patient. Measurements of energy expenditure by the doubly-labeled water method (the gold standard) or by direct or indirect calorimetry are often unavailable in clinical settings. Prediction equations that state a range of requirements have been promoted by several international organizations, such as the American College of Chest Physicians, the American Society for Parenteral and Enteral Nutrition and the European Society of Clinical Nutrition and Metabolism. Nonetheless, these guidelines and equations that require the use of stress factors rely on clinical judgment and are, therefore, open to error. In addition, most of the predictive formulae are inaccurate when compared with measures obtained by indirect calorimetry.[1] Although resting energy expenditure can be measured under clinical conditions, precise determination of total energy expenditure (resting energy expenditure plus diet-induced thermogenesis plus physical activity) is difficult and requires continuous monitoring over a 24 h period. As a consequence, energy balance studies in the ICU are scarce.[2]

In terms of energy requirements, hypocaloric feeding is defined as the delivery of <80% of energy requirements, which corresponds to the measured energy expenditure plus 20–30%. By contrast, hypercaloric feeding corresponds to >150% of the measured energy expenditure. Whether delivery of the total energy expenditure is beneficial remains unclear. Identification and standardization of the optimal energy requirements is difficult as the ICU patient population is typically heterogeneous. For example, although 25 kcal/kg/day is an accepted target, patients with sepsis or injury could transiently require as much as 35–40 kcal/kg/day.[1,2]

It is important to distinguish between hypoenergetic feeding and underfeeding.[3] Some evidence suggests that hypoenergetic feeding (i.e. low energy but adequate protein delivery) could be associated with improved outcomes, especially in patients with obesity or those receiving parenteral nutrition, although this observation might not apply to lean patients.[4] By contrast, there is little evidence that meeting caloric goals is beneficial. Controversial data suggest that feeding below 25 kcal/kg/day is associated with improved outcomes, such as decreased hospital stay, ventilator dependence, and mortality.[5] Some clinicians have even suggested that hypoenergetic feeding could replace the paradigm of meeting measured energy requirements.[5] This strategy should be considered with great caution in ICU stays >7 days, however, as malnutrition will inevitably develop.[4,6] By contrast, underfeeding (i.e. low energy and protein delivery) quickly leads to a marked negative nitrogen balance and poor clinical outcomes. A study that examined nutritional support, either with or without intervention in accordance with evidence-based guidelines, showed that intervention delivered more daily energy per patient than did nonintervention (1,265 versus 998 kcal).[7] Increased energy provision was associated with shorter duration of hospital stay ($P=0.003$) and reduced mortality ($P=0.058$). Nonetheless, as both the intervention and nonintervention units were actually underfeeding, the relative value of each component of the intervention could not be determined.

In addition to energy requirements, the route of administration must also be considered. The enteral route is generally recommended (although it can result in insufficient energy delivery), whereas parenteral nutrition is reserved as a surrogate in cases where the gastrointestinal tract is nonfunctional. Although the importance of early initiation of enteral feeding to prevent energy deficits is well recognized, several issues remain unresolved, such as the site of administration (gastric versus postpyloric). The use of postpyloric feeding might be appropriate in cases of pyloric dysfunction. Nonetheless, although postpyloric feeding is extensively used in the pediatric ICU, current evidence does not support its systematic use in adults, despite more-efficient energy delivery by this route.[4] Combined enteral and parenteral nutritional support is often advocated in Europe to prevent energy deficits associated with enteral nutrition.[4,8] Optimal timing of feeding remains unclear, however, as trial data are lacking, but preventing the build-up of energy deficits requires initiation within 48 h.[6]

As with any therapy, nutritional support can result in complications. For example, a multicenter, prospective study showed that 23% of patients who received nutritional support developed liver dysfunction,[9] which occurred more frequently with parenteral nutrition (30%) than with enteral nutrition (18%). Determinants of liver dysfunction were organ failure on admission, sepsis, parenteral nutrition, and excessive calculated energy requirements (>25 kcal/kg/day). Glycemic control is also a major issue in the ICU. Reduced mortality has been reported in cardiac surgery patients rendered euglycemic with intensive insulin therapy. Nonetheless, the optimal glucose target is highly controversial as intensive insulin therapy carries the risk of hypoglycemia, which is associated with increased mortality.

Modulation of immune and inflammatory responses with nutritional support has proven both possible and beneficial. The effect of such interventions in critically ill patients remains controversial, however, as illustrated by the dual effect of immune-enhancing diets in patients with sepsis. The use of glutamine supplementation seems safe and effective in critical illness. Indeed, glutamine deficiency is associated with poor outcomes, whereas glutamine supplementation reduces mortality.[10] As glutamine is contained in normal food but not in the standard industrial preparations, its delivery in the ICU should be considered a substitution rather than supplementation. Some evidence suggests that ω-3 fatty acids alone or in combination with γ-linolenic acid and antioxidants exert beneficial effects on the outcome of patients with acute respiratory distress syndrome and sepsis. In addition, selenium supplementation seems warranted, particularly for patients from selenium-deficient areas (e.g. Australasia, Europe); however, the optimal substitution dose is still undetermined.

In conclusion, early initiation of enteral feeding is an evidence-based and beneficial approach to nutritional support for critically ill patients. Inclusion of specific nutrients should be considered. The energy target can be determined simply and an initial target of 25 kcal/kg/day seems safe. After a week, however, it is important to reassess the energy requirements, route of delivery, and patient response to nutritional support.

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Competing interests
The authors have declared an association with the following companies: B Braun Medical and Fresenius Kabi. See the article online for full details of the relationships.