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Review Article

Nutritional support in critical care patients: Challenges, strategies, and recent advances

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ABSTRACT

Nutritional support is a critical component of managing patients in intensive care units (ICUs). Critical illness triggers a hypermetabolic state, leading to significant nutritional demands and muscle wasting. Proper nutritional interventions can positively impact clinical outcomes, reduce the duration of mechanical ventilation, and improve overall recovery. However, delivering adequate nutrition to critically ill patients present several challenges, including the patient's unstable condition, varying metabolic needs, gastrointestinal dysfunction, and difficulties in achieving nutritional goals. Recent advances in understanding the nutritional requirements of ICU patients, the role of early enteral nutrition, and the development of specialized formulas have led to improved patient care. Strategies such as personalized nutrition, immunonutrition, and monitoring tools like indirect calorimetry have become essential components of ICU nutrition management. Additionally, managing critically ill patients with comorbidities, such as sepsis or multi-organ failure, requires tailored approaches to prevent malnutrition and overfeeding.

This review highlights the key challenges associated with nutritional support in critical care, current strategies employed to optimize nutrition, and the recent advances in the field. Evidence-based practices with individualized care, nutritional support can enhance patient recovery, reduce ICU stay, and lower morbidity and mortality rates.

1. Introduction

Nutritional support is vital in the care of critically ill patients, serving as an integral part of patient management within intensive care units (ICUs). Critical illness significantly alters metabolism, creating a hypermetabolic and catabolic state that leads to accelerated muscle wasting, immune dysfunction, and prolonged recovery times.[1,2] The primary goal of nutritional support in critically ill patients is to provide adequate macro- and micronutrients to meet the increased metabolic demands and to prevent or mitigate the effects of malnutrition.[3–7] Malnutrition in critically ill patients is associated with worse clinical outcomes, including increased susceptibility to infections, prolonged mechanical ventilation, extended ICU and hospital stays, and higher mortality rates. Therefore, early and appropriate nutritional intervention can play a pivotal role in improving these outcomes. The challenge lies in the complexity of delivering appropriate nutrition to patients who are often hemodynamically unstable, mechanically ventilated, or suffering from gastrointestinal dysfunction. Nutritional needs also vary significantly depending on the underlying illness, comorbidities, and the phase of critical illness (acute versus recovery).[8]

In recent years, advances in critical care nutrition have provided clinicians with better tools and strategies to address these challenges. Innovations such as early enteral

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nutrition, individualized caloric targets based on indirect calorimetry, and the introduction of immunomodulating nutrients have helped to improve nutritional care in the ICU setting. Additionally, guidelines from critical care organizations continue to evolve, offering updated recommendations on the timing, route, and composition of nutritional support.[9]

1.1. Poor nutrition and its effect on critically ill patient

In critically ill patients, poor nutrition significantly exacerbates the risk of adverse outcomes and impedes recovery. Critical illness triggers a hypermetabolic and catabolic response, characterized by increased energy demands and accelerated breakdown of muscle proteins. Without adequate nutritional support, patients experience rapid depletion of their body's energy stores and lean muscle mass, which has profound implications for their overall health and ability to recover.[10–13]

Malnutrition in critically ill patients contributes to a host of negative effects, the most prominent of which is muscle wasting. Muscle loss can impair respiratory function, making it more difficult for patients to wean off mechanical ventilation. The diaphragm and other respiratory muscles weaken as a result of prolonged catabolism, increasing the likelihood of respiratory complications and extended ventilator dependence. Prolonged mechanical ventilation, in turn, is associated with a higher risk of ventilator-associated pneumonia, further complicating the clinical course. Beyond its impact on muscle mass, poor nutrition weakens the immune system, making critically ill patients more susceptible to infections. Malnourished patients often suffer from impaired wound healing and a higher incidence of hospital-acquired infections, such as sepsis.[14] This immune dysfunction arises because vital nutrients are required to support immune cell function, and without them, the body struggles to mount an effective response to pathogens. Infections, in turn, prolong ICU stay and increase mortality risk.

Malnutrition also adversely affects the gastrointestinal (GI) system. The integrity of the gut mucosa is compromised when the patient does not receive sufficient nutrients, leading to an increased risk of bacterial translocation from the gut to the bloodstream, which can trigger systemic infections. Additionally, poor nutrition slows down the recovery of GI function, delaying the reintroduction of enteral feeding and perpetuating a cycle of underfeeding. Poor nutrition contributes to metabolic imbalances as well, including disturbances in glucose metabolism. Inadequate caloric intake may exacerbate hyperglycemia, a common condition in critically ill patients that is associated with worse outcomes.[15–17] This occurs because the body, deprived of sufficient nutrients, breaks down its own tissues for energy, leading to a release of glucose into the bloodstream. At the same time, poor nutritional intake can also lead to deficiencies in essential vitamins and minerals, further impairing organ function and recovery.

1.2. Challenges in nutritional support for critical care patients

Nutritional support in critically ill patients poses a unique set of challenges due to the complex nature of their conditions and the physiological alterations brought on by critical illness. One of the primary challenges is the significant metabolic changes that occur during illness or trauma. Critical illness induces a hypermetabolic state, where the body's energy demands are significantly increased. This is often coupled with a catabolic response that leads to muscle breakdown and the loss of lean body mass. The magnitude of this metabolic shift can vary depending on factors such as the underlying condition, severity of illness, and phase of critical care, making it difficult to establish precise caloric and protein needs for each patient. This hypermetabolic state complicates efforts to meet nutritional demands because it accelerates protein and energy depletion, often outpacing what can be provided via nutritional support.

Another challenge is gastrointestinal dysfunction, which is common in critical care patients. Conditions like gastroparesis, ileus, or malabsorption impair the digestive system's ability to absorb nutrients effectively. Enteral nutrition (EN) is often the preferred route for feeding critically ill patients as it helps preserve gut integrity, but its success is contingent upon the proper functioning of the gastrointestinal system. In patients with significant gastrointestinal dysfunction, enteral feeding may not be tolerated, and alternatives such as parenteral nutrition (PN) become necessary.[18,19] However, PN carries its own risks, such as infections related to intravenous access, liver dysfunction, and metabolic complications, particularly in patients with underlying comorbidities.

Hemodynamic instability, which is common in critically ill patients who are in shock or receiving vasoactive medications, further complicates nutritional support. Poor perfusion to the gastrointestinal tract may lead to decreased tolerance to enteral feeding. In such cases, initiating or continuing enteral feeding may not be feasible due to the risk of exacerbating gut ischemia. In these scenarios, clinicians must balance the need to provide nutritional support with the potential risks posed by the patient's unstable condition. Moreover, in cases where parenteral nutrition becomes necessary, there are risks associated with overfeeding or underfeeding. Accurately estimating energy requirements in critically ill patients is challenging, especially in the acute phase of illness, where both overfeeding and underfeeding can have detrimental effects. Overfeeding may result in hyperglycemia, liver dysfunction, or difficulty weaning from mechanical ventilation, while underfeeding can worsen malnutrition and prolong recovery.[20]

Additionally, many critically ill patients present with comorbidities such as sepsis, acute kidney injury, or respiratory failure, which further complicates nutritional management. These conditions alter nutrient metabolism and increase the risk of both over- and underfeeding. Sepsis, for example, triggers an intense inflammatory response that increases energy expenditure and protein catabolism, necessitating tailored nutritional interventions. Managing nutrition in patients with renal or liver dysfunction requires careful selection of macronutrient composition to avoid exacerbating organ failure, while simultaneously meeting metabolic demands.

1.3. Strategies for optimal nutritional support

In response to the challenges presented by critical illness, several strategies have been developed to optimize nutritional support and improve patient outcomes. One key strategy is the early initiation of enteral nutrition (EN), which has been shown to confer significant benefits when started within the first 24 to 48 hours after ICU admission. Early EN has been associated with reduced infection rates, shorter durations of mechanical ventilation, and decreased ICU length of stay. This is because enteral feeding helps maintain gut integrity, reduces bacterial translocation, and modulates the immune response in a favorable manner. Even in patients with gastrointestinal dysfunction, early enteral feeding can often be facilitated by using small bowel feeding or prokinetic agents that enhance gastric motility.[21] Such measures ensure that a large proportion of critically ill patients receive at least some of their nutritional requirements enterally, which is beneficial for overall recovery.

For patients who are unable to tolerate enteral feeding due to gastrointestinal complications or severe illness, parenteral nutrition (PN) becomes an important alternative. Current guidelines emphasize that PN should not be started early in ICU admission unless absolutely necessary, particularly in patients at low nutritional risk, due to the associated risks of overfeeding and infection. However, for patients with high nutritional risk or prolonged gastrointestinal intolerance, initiating PN earlier can prevent the deleterious effects of prolonged malnutrition. Advances in PN formulations have made this mode of nutrition safer and more effective.[22] For example, new lipid emulsions enriched with omega-3 fatty acids have shown promise in reducing the inflammatory response and improving clinical outcomes by modulating immune function and enhancing tolerance to parenteral nutrition.

Tailoring nutritional interventions to meet the specific needs of each patient is a key component of effective ICU care. Indirect calorimetry has emerged as the gold standard for determining energy expenditure in critically ill patients, providing an accurate assessment of their caloric requirements.[23] By measuring oxygen consumption and carbon dioxide production, indirect calorimetry allows clinicians to individualize nutritional targets and avoid the complications associated with over- or underfeeding. This technology is particularly useful for patients with unpredictable metabolic responses, such as those with sepsis or multi-organ failure, where traditional predictive equations may not adequately capture the patient's true energy needs. Although indirect calorimetry is not yet universally available in all ICUs, its growing use represents a significant advancement in critical care nutrition.[24]

Immunonutrition is another strategy gaining traction in critical care settings. This approach involves the use of specific nutrients that have been shown to modulate the immune response, reduce inflammation, and improve clinical outcomes in certain patient populations. Nutrients such as omega-3 fatty acids, glutamine, arginine, and antioxidants have demonstrated benefits in trauma, surgical, and septic patients by enhancing immune function and reducing infection rates. Immunonutrition formulations are increasingly being incorporated into both enteral and parenteral nutrition regimens, offering a promising adjunct to conventional nutritional support.

Protein supplementation is crucial in the care of critically ill patients due to the rapid muscle breakdown and catabolism that occurs during illness. Adequate protein intake is necessary to preserve lean body mass, support wound healing, and maintain immune function. Guidelines recommend higher protein intake (1.2–2.0 g/kg/day) compared to non-critically ill patients, and studies suggest that meeting these targets can improve outcomes, particularly in patients with prolonged ICU stays. Supplementing protein either through enteral or parenteral routes has been shown to be beneficial, particularly when traditional caloric goals are difficult to achieve due to gastrointestinal intolerance or hemodynamic instability.

1.4. Recent advances in nutritional support

The field of critical care nutrition has seen significant advances in recent years, many of which have helped to address the challenges of providing adequate nutritional support to critically ill patients. One of the most important advances is the development of tailored nutrition protocols that take into account the individual needs and conditions of patients. For example, patients with sepsis or trauma have different metabolic requirements compared to those with chronic conditions like chronic obstructive pulmonary disease (COPD) or heart failure. Tailoring nutrition to meet these specific needs has been shown to improve clinical outcomes by reducing complications associated with under- or overfeeding and addressing the unique metabolic demands of each patient population.[25]

The increased use of indirect calorimetry has also revolutionized the way clinicians approach nutritional support in the ICU. Indirect calorimetry offers real-time, accurate measurements of a patient's energy expenditure, allowing for the precise calculation of caloric needs. This has reduced the reliance on predictive equations, which are often inaccurate in critically ill patients.[26] As a result, clinicians can now more accurately adjust nutritional support based on actual energy expenditure rather than estimates, which has been shown to reduce the risk of overfeeding and underfeeding, both of which can complicate recovery.

Another exciting area of research is the role of the gut microbiome in critical illness and recovery. The gut microbiota plays a crucial role in maintaining immune function, metabolism, and the integrity of the gastrointestinal barrier. However, critical illness often disrupts the gut microbiome, leading to dysbiosis, which is associated with increased susceptibility to infections and poor outcomes. Probiotics are being investigated as a potential therapeutic tool to restore gut microbiota balance in critically ill patients.[3,5] Early studies suggest that probiotics may help reduce infection rates and improve clinical outcomes, although more research is needed to fully understand their role in critical care nutrition.

Enhanced Recovery After Surgery (ERAS) protocols, initially developed for surgical patients, are increasingly being applied to critically ill patients undergoing major surgery or trauma care. These protocols emphasize the importance of early nutrition, along with other perioperative strategies, to reduce postoperative complications and hospital length of stay.[6] ERAS protocols have demonstrated significant improvements in patient recovery, and their principles are being adapted to improve outcomes in critically ill patients who require surgical interventions.

Lastly, advancements in lipid emulsions, particularly those enriched with omega-3 fatty acids, have shown promise in reducing inflammation and improving outcomes in critically ill patients. Omega-3 fatty acids have been shown to have immunomodulatory effects, reducing the production of pro-inflammatory cytokines and improving immune function.[8] These lipid formulations are now being incorporated into both enteral and parenteral nutrition strategies, offering a more tailored approach to managing the inflammatory response in critically ill patients.

2. Conclusion

The management of nutritional support in critically ill patients is a challenging yet essential component of critical care. The complexity of metabolic demands, gastrointestinal dysfunction, and comorbidities requires a nuanced approach to ensure adequate nutritional delivery. Early enteral nutrition, individualized caloric goals, the use of immunonutrition, and advances in parenteral nutrition have all contributed to improving outcomes in this patient population. Recent innovations, such as the use of indirect calorimetry and tailored nutrition protocols, are helping to further refine nutritional support, ensuring that it meets the specific needs of each patient. Ongoing research into the role of the gut microbiome and the benefits of probiotics, along with advances in lipid formulations, represents the next frontier in critical care nutrition.

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4. Conflict of Interest

None.

References

1. Hill A, Elke G, Weimann A. Nutrition in the Intensive Care Unit-A Narrative Review. *Nutrients*. 2021;13(8):2851.
2. Al-Dorzi HM, Arabi YM. Nutrition support for critically ill patients. *JPEN J Parenter Enteral Nutr*. 2021;45(S2):47–59.
3. Singer P, Blaser AR, Berger MM, Calder PC, Casaer M, Hiesmayr M, et al. ESPEN practical and partially revised guideline: Clinical nutrition in the intensive care unit. *Clin Nutr*. 2023;42(9):1671–89.
4. Sharma K, Mogensen KM, Robinson MK. Pathophysiology of Critical Illness and Role of Nutrition. *Nutr Clin Pract*. 2019;34(1):12–22.
5. Rougier L, Preiser JC, Fadeur M, Verbrugge AM, Paquot N, Ledoux D. Nutrition During Critical Care: An Audit on Actual Energy and Protein Intakes. *JPEN J Parenter Enteral Nutr*. 2021;45(5):951–60.
6. Lambell KJ, Tatucu-Babet OA, Chapple LA, Gantner D, Ridley EJ. Nutrition therapy in critical illness: a review of the literature for clinicians. *Crit Care*. 2020;24(35):1–11.
7. JP-Saw, Merriweather JL, Wandrag L. Mal)nutrition in critical illness and beyond: a narrative review. *Anaesthesia*. 2023;78(6):770–8.
8. Frankenfield DC, Coleman A, Alam S, Cooney RN. Analysis of estimation methods for resting metabolic rate in critically ill adults. *JPEN J Parenter Enteral Nutr*. 2009;33(1):27–36.
9. Kagan I, Zusman O, Bendavid I, Theilla M, Cohen J, Singer P. Validation of carbon dioxide production (VCO2) as a tool to calculate resting energy expenditure (REE) in mechanically ventilated critically ill patients: a retrospective observational study. *Crit Care*. 2018;22(1):186.
10. Flancbaum L, Choban PS, Sambucco S, Verducci J, Burge JC. Comparison of indirect calorimetry, the Fick method, and prediction equations in estimating the energy requirements of critically ill patients. *Am J Clin Nutr*. 1999;69(3):461–6.
11. Oshima T, Berger MM, De Waele E, Guttormsen AB, Heidegger CP, Hiesmayr M. Indirect calorimetry in nutritional therapy. A position paper by the ICALIC study group. *Clin Nutr*. 2017;36(3):651–62.
12. Bendavid I, Zusman O, Kagan I, Theilla M, Cohen J, Singer P. Early administration of protein in critically ill patients: a retrospective cohort study. *Nutrients*. 2019;11(1):106.
13. Casaer MP, Berghe GD. Comment on "protein requirements in the critically ill: a randomized controlled trial using parenteral nutrition". *JPEN J Parenter Enteral Nutr*. 2016;40(6):763.
14. Passier RH, Davies AR, Ridley E, Mcclure J, Murphy D, Scheinkestel CD. Periprocedural cessation of nutrition in the intensive care unit: opportunities for improvement. *Intensive Care Med*. 2013;39(7):1221–6.
15. Doig GS, Simpson F, Finfer S, Delaney A, Davies AR, Mitchell I, et al. Effect of evidence-based feeding guidelines on mortality of critically ill adults: a cluster randomized controlled trial. *JAMA*. 2008;300(23):2731–41.

16. Nguyen NQ, Chapman MJ, Fraser RJ, Bryant LK, Holloway RH. Erythromycin is more effective than metoclopramide in the treatment of feed intolerance in critical illness. *Crit Care Med*. 2007;35(2):483–9.
17. Wischmeyer PE, Bear DE, Berger MM, De Waele E, Gunst J, Mcclave SA, et al. Personalized nutrition therapy in critical care: 10 expert recommendations. *Crit Care*. 2023;27(1):261.
18. Hermans AJH, Laarhuis BI, Kouw IWK, Van Zanten A. Current insights in ICU nutrition: tailored nutrition. *Curr Opin Crit Care*. 2023;29(2):101–7.
19. Van Zanten A, Waele D, Wischmeyer E. Nutrition therapy and critical illness: practical guidance for the ICU, post-ICU, and long-term convalescence phases. *Crit Care*. 2019;23(1):368.
20. Ridley EJ, Lambell K. Nutrition before, during and after critical illness. *Curr Opin Crit Care*. 2022;28(4):395–400.
21. Mehta Y, Sunavala JD, Zirpe K, NTyagi, Garg S, Sinha S. Practice Guidelines for Nutrition in Critically Ill Patients: A Relook for Indian Scenario. *Indian J Crit Care Med*. 2018;22(4):263–73.
22. Patel JJ, Hurt RT, Mcclave SA, Martindale RG. Critical Care Nutrition: Where's the Evidence? *Crit Care Clin*. 2017;33(2):397–412.
23. Nienow MK, Susterich CE, Peterson SJ. Prioritizing nutrition during recovery from critical illness. *Curr Opin Clin Nutr Metab Care*. 2021;24(2):199–205.
24. Wischmeyer PE, Bear DE, Berger MM, De Waele E, Gunst J, Mcclave SA, et al. Personalized nutrition therapy in critical care: 10 expert recommendations. *Crit Care*. 2023;27(1):261.
25. Kagan I, Hellerman-Itzhaki M, Bendavid I, Statlender L, Fishman G, Wischmeyer PE, et al. Controlled enteral nutrition in critical care patients - A randomized clinical trial of a novel management system. *Clin Nutr*. 2023;42(9):1602–9.
26. Stoppe C, Wendt S, Mehta NM, Compher C, Preiser JC, Heyland DK, et al. Biomarkers in critical care nutrition. *Crit Care*. 2020;24(1):499.

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