REVIEW

Nutrition in the critically ill in resource-limited settings/low- and middle-income countries

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Purpose of review

To share current concepts and provide an overview of the contextual issues and nutrition practices in critically ill patients in resource-limited settings (RLSs)/low- and middle-income countries (LMICs). Most of the world's population reside in these settings which also carries the greatest burden of critical illness.

Recent findings

There is a paucity of evidence on nutrition practice in critically ill patients in RLSs and international guidelines are largely based on evidence derived from high-income countries (HICs). While some recommendations are adaptable to RLSs, many are not feasible or directly transferable. Despite the challenges that may prevail, pragmatic solutions can address many of the difficulties to enhance nutrition practice and improve patient outcomes.

Summary

This review provides a contemporary synopsis of nutrition practice in critically ill patients in RLSs covering the relevance of optimal nutrition, gives insights into relevant contextual issues and challenges in RLSs, evaluates recent scientific evidence and available literature pertinent to critically ill patients in RLSs, addresses nutrition guidelines, discusses some pragmatic options and solutions, deals with relevant and important complications that may arise, and offers suggestions and future considerations to enhance nutrition practice in critically ill patients in these settings.

Keywords

critical illness, guidelines, low- and middle-income countries, nutrition, refeeding syndrome, resource-limited settings

INTRODUCTION

Nutrition is an integral component of critical care patient management, and evidence relating to its efficacy, timing, composition, and route of administration has continued to evolve over the past two decades. Although nutrition is no longer considered a purely supportive element administered to critically ill patients to maintain lean body mass, malnutrition and under–nutrition remains a commonly encountered entity in patients worldwide. Malnutrition is often unrecognized and is an independent risk factor for increased morbidity, increased length of hospital stay and hospital costs, delayed recovery, readmission, impaired quality of life, and mortality [1–3]. This entity is of major relevance in resource-limited settings (RLSs). Studies from RLSs suggest that many patients are at risk of malnutrition on admission, and that their nutritional status frequently deteriorates during hospitalization with associated increased morbidity, mortality and hospital-related costs. [4,5,6▪,7]

Appropriately administered nutrition, which in RLSs pertains largely to oral or enteral nutrition (EN), is now believed to be associated with a reduction in complications, duration of stay in the intensive care unit (ICU), and improved patient outcomes [1,2,8]. Parenteral nutrition (PN) is generally not routinely available in many RLSs [9]. The provision of EN is thought to play a pivotal role in maintaining

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KEY POINTS

- Providing evidence-based nutrition in critically ill patients in resource-limited settings (RLSs) presents unique challenges due to limited resources, limited human resources and skills, and infrastructure.
- Globally, the burden of critical illness occurs in RLSs/ low- and middle-income countries (LMICs) where the bulk of the world's population resides.
- There is limited evidence and literature related to nutrition practice in critically ill patients in RLSs.
- International guidelines are based largely on evidence emanating from high-income countries (HICs) and recommendations may not necessarily be extrapolatable to RLSs.
- Many patients in RLSs are at risk of malnutrition on admission and their nutritional status frequently deteriorates during hospitalization.
- Nutrition screening tools that are noninvasive, require minimal support and that are easily implemented are useful in RLSs, and include body mass index (BMI), mid-upper arm circumference (MUAC), subjective global assessment (SGA) and the Nutrition Risk Screening 2002 (NRS-2002) score. They may substitute for advanced methods.
- Where commercial feeds may not be available or affordable, noncommercial feeds/hospital prepared foods/use of locally sourced ingredients serve as a useful way to provide enteral nutrition.
- Measures should be invoked to reduce the risk of aspiration and healthcare workers should have an awareness of the refeeding syndrome and its management
- There is a pressing and crucial need to evaluate and develop nutrition practice applicable to these settings.

gut integrity, thereby limiting the potential translocation of microorganisms into the bloodstream, and to favorably modulate stress and the systemic inflammatory response, with subsequent diminution of cellular injury, and attenuation of disease severity [1,2,8]. Additional benefits of EN include its role in stress ulcer prophylaxis [10] as well as facilitation of fluid and electrolyte replacement.

CONTEXT OF RESOURCE-LIMITED SETTINGS

Critical care medicine plays a pivotal role in saving lives and improving outcomes for patients facing life-threatening conditions. Nutritional support is a key component of patient management in critical care medicine. Globally, the burden of critical illness as well as most deaths occur in resource-limited settings/low- and middle-income countries (LMICs) where the vast bulk of the worlds' population resides, and healthcare resources are limited the most [11]. Sadly, many of these deaths are potentially preventable. There is a crucial need for improved critical care delivery in RLSs to reduce the inequity that currently exists compared with high resourced settings.

Many issues and barriers impede the optimal care of critically ill patients in RLSs. These include limited human resources and skills, inadequately trained staff, limited training facilities and opportunities as compared to high-income countries (HICs), financial constraints, insufficient capacity and infrastructure, precarious electricity, water, and oxygen supplies and availability, lack of equipment (both adequate and functional), restricted technology and maintenance, limited availability of medications and support services (such as laboratory, radiology, surgical specialists, and allied health professionals, including dieticians and trained nutrition professionals), as well as staff burnout and disillusionment, among others. Many of these elements are further compounded by late and delayed presentations and a paucity of locally applicable guidelines and protocols. There is an approximately 20-fold difference in the annual spend per capita on healthcare in HICs versus LMICs – \$5226 versus \$266 [11]. This is significantly worse in Africa, where per capita health spending is around \$83, less than 2% of the average spending in HICs. When considering differences in critical care between RLSs and HICs, both setting specific factors, as alluded to, and disease specific factors require consideration. There are often different diseases and pathologies.

NUTRITION CHALLENGES IN RESOURCE-LIMITED SETTINGS

Providing evidence-based nutrition to critically ill patients in RLSs presents unique challenges due to many of the factors mentioned above, and commonly results in suboptimal nutrition practice. Challenges however also represent opportunities, and a variety of solutions can be invoked to overcome these difficulties. These include simplifying and adapting protocols to fit local scenarios while following core nutrition principles, using local food resources, training and task-shifting responsibilities to nonspecialist staff (including family members), educational initiatives, awareness projects, telemedicine and education exchange, context relevant research to better understand and implement measures, and guidelines that improve nutrition practice.

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ASSESSMENT OF NUTRITIONAL STATUS

Traditional tools to assess nutritional status in critically ill patients may not always be practical in RLSs due to equipment shortage, varying staff expertise, and limited access to specialized tests. Screening tools need to be uncomplicated, easy to follow, require limited resources, and be linked to training and support in practice. Simple bedside assessments such as body mass index (BMI), mid-upper arm circumference (MUAC), or subjective global assessment (SGA) may substitute for advanced methods. A very simple tool is the Nutrition Risk Screening 2002 (NRS-2002) score, which requires no measurement, and can be calculated in less than a minute based on visible characteristics. It is easily applicable in the ICU [12]. The NUTRIC (Nutrition Risk in the Critically Ill) score helps identify patients at high nutritional risk by combining clinical factors like disease severity (e.g., APACHE II score) with age and comorbidities and can help guide nutrition interventions. However, this tool requires some clinical and laboratory measurements (e.g., APACHE II score) that might neither be feasible nor available in RLSs [4]. Furthermore, it remains unclear whether patients with high modified NUTRIC (mNUTRIC) scores benefit from a different nutrition strategy as compared to low mNUTRIC score patients. Where available, ultrasonography offers a noninvasive way to track muscle mass and detect changes over time [4,13▪]

GUIDELINES

Several guidelines, recommendation and opinion papers relating to nutrition and the provision of nutritional support to critically ill patients exist. There however, remains much controversy and debate in many areas and recommendations are not universally consistent. Of note, there has been sparse input from RLSs in major international guidelines and although recommendations and suggestions are adaptable in some instances, there is a paucity of content that specifically addresses critically ill patients being cared for in these settings. In response to recent evidence, international nutrition guidelines addressing critically ill patients have changed. European guidelines currently recommend a less aggressive approach in the acute phase of critical illness. While previous iterations (2006, 2009) of the guidelines advised starting enteral nutrition within 24 h of admission and reaching the energy target (25 kcal/kg/day) within 2–3 days, the 2019 and partially updated 2023 guidelines suggest initiating low-dose enteral nutrition within 48 h after ICU admission unless contraindicated, and advancing towards the energy target within 3–7 days [1]. If enteral nutrition is insufficient, parenteral nutrition is recommended to start between days 4 and 7. It is also suggested that protein doses of 1.3 g/kg/day can be delivered progressively [1]. The American guidelines for the provision of nutrition support therapy in adult critically ill patients have also changed over time. The 2009 American guidelines recommended early initiation of EN and no nutrition therapy if EN was not feasible, with the 2022 guidelines on nutrition support therapy in adult critically ill patients accepting EN or PN as primary feeding modalities in the first 7–10 days. A lower feeding target of 12–25 kcal/kg/day is also suggested in contrast to the 2009 target of 25–30 kcal/kg/day, although this range still includes the full target immediately after ICU admission. PN is not recommended before day 7 if EN is insufficient. A weak recommendation is provided for protein administration of 1.2–2 g protein/kg/day [2]. The differences between these major international guidelines highlight several uncertainties about optimal nutrition strategies for critically ill patients. Suggestions have been made for a pragmatic feeding strategy for ICU patients [3] but there has not been much consideration of critically ill patients in RLSs and the application and implications for these settings. There has also been limited RLS representation on major guideline panels. Recommendations with evidence generated largely in HICs may not necessarily be universally applicable, directly transferable, or feasible in all settings [14]. There is also the possibility that implementing inappropriate context standards may even be hazardous, as has been demonstrated in patients with sepsis and septic shock [15–17]. All these elements require further evaluation, thought and reflection.

A small number of guidelines and recommendation papers addressing nutrition in critically ill patients in RLSs have been published over the last decade. These include guidelines and recommendations from Ethiopia, India and Pakistan [18–20]. Evidence-based recommendations for nutritional support in patients with sepsis and septic shock in RLSs have also been published by the Global Intensive Care Group of the European Society of Intensive Care Medicine (ESICM) [9]. Intrinsic to these recommendations, consideration was given to availability, feasibility, affordability and safety for all suggested recommendations. These pragmatic recommendations suggested starting EN within 24–48 h in adequately resuscitated and hemodynamically stable patients. Additional suggestions were given on advancing EN over the first week according to patient tolerance to achieve target feed, a suggestion that feeding protocols be used to optimize delivery of EN, suggestions on how to establish energy and protein

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requirements (using weight-based equations), and with remarks on measures to reduce the risk of aspiration, as well as awareness of the refeeding syndrome [9]. The recommendations also convey that PN is not routinely available in many RLSs.

EVIDENCE ON NUTRITION PRACTICE ORIGINATING FROM RESOURCE-LIMITED SETTINGS

A review of the literature demonstrates limited scientific evidence and publications related to nutrition practice in critically ill patients in RLSs. Table 1 contains a summary of pertinent recent publications in the field. Common elements emanating from these publications address and include screening tools to identify patients at risk for malnutrition, use of feeds that are alternatives to commercial feeds, and the pressing and crucial need to evaluate and develop nutrition practice applicable to these settings.

ENERGY AND PROTEIN REQUIREMENTS/ TARGETS

Energy and protein requirements and methods to calculate them in critically ill patients have been the subject of much debate. Weight-based formulations have been suggested as a pragmatic and reasonable modality to establish energy and protein requirements in RLSs [9] given the lack of access to indirect calorimetry, and with the acknowledgement that predictive equations have been associated with inaccuracy, and that body weight may be difficult to accurately assess. International guidelines advocate the use of indirect calorimetry in mechanically ventilated patients to determine energy expenditure [1,24]. Potential reduction in 28-day mortality has previously been described for indirect calorimetry but the largest randomized controlled trial, TICACOS-International, comparing calculated versus measured energy targets, found no benefit from indirect calorimetry-based feeding. The trial which was performed in HICs was halted due to slow recruitment with several authorities questioning the feasibility of indirect calorimetry use [25].

TYPE OF FEED: COMMERCIAL VERSUS NON-COMMERCIAL FEEDS

The type of enteral feed and the selection of an appropriate enteral formulation have been the subject of many investigations. In RLSs where commercial feeds may not be available or affordable, noncommercial feeds/hospital prepared foods/use of locally sourced ingredients may be administered to critically ill patients as a practical solution and useful alternative. Recipes may vary according to countries, regions, and available ingredients. Suggestions include the administration of milk supplemented by cooking oil, salt, sugar, soya and a multivitamin tablet via a nasogastric tube in mechanically ventilated, hemodynamically stable patients [9,26], to mixtures involving eggs, milk powder, soya, maize oil, rice, squash, flour, sugar and fruit. Mixing these foodstuffs in a blender with subsequent administration serves as a useful way to provide EN. Although noncommercial feeds provide a practical solution, they require careful planning and assessment to ensure that they meet the nutritional requirements of critically ill patients, including appropriate provision of both macronutrients (protein, lipid, carbohydrate) and micronutrients (vitamins, minerals and trace elements). Where commercial feeds are available, a standard polymeric formula is recommended [8,9]. These preparations contain intact proteins, fats and carbohydrates (which require digestion prior to absorption), in addition to electrolytes, trace elements, vitamins and fibers, and tend to be lactose–free. Commonly used ingredients in these products include casein (protein from milk), soy protein, maize and soya oils, as well as the carbohydrate maltodextrin. In general, a ready to use standard feed will contain 1 kcal and 0.04 g protein per ml and is usually well tolerated [8,9].

The utilization and employment of feeding protocols is advocated in several guidelines, commentaries, and recommendations. They are associated with an increase in the overall percentage of nutrition provided and may also positively impact outcome [8,9].

COMPLICATIONS OF NUTRITIONAL SUPPORT IN RESOURCE-LIMITED SETTINGS AND STRATEGIES TO MINIMIZE THEM

Complications of nutritional support include aspiration, the refeeding syndrome and overfeeding. Critically ill patients receiving EN should be assessed for the risk of aspiration and steps to reduce this risk should be employed. A randomized trial on early nasogastric EN in nonintubated patients with malaria and depressed level of consciousness in Bangladesh, was terminated prematurely because of an increased aspiration risk in the early feeding group [27]. The risk of aspiration may be increased in enterally fed nonintubated comatose patients with inadequate nursing supervision. This point is highlighted in the RLSs recommendations addressing nutrition in patients with sepsis and septic shock [9]. Risk factors for aspiration are described in Table 2 [9,28,29].

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Table 1. Recent scientific evidence addressing nutrition in RLSs in critically ill patients

Author, year	Location/focus	Design and aim	Main results/findings	Comments
Zaw *et al.*, 2017 [21]	Myanmar	Cross-sectional descriptive pilot study using a semi-structured questionnaire related to feeding practice. The objective was to describe and provide an overview of EN practices in patients with neurological problems in Myanmar	56.7% of patients had normal BMI, 10% were underweight, 30% overweight, 3.3% obese Total energy and protein intakes of all participants were found to be inadequate	Suggestion made for use of evidence-based nutritional guidelines, assessments
Mer *et al.*, 2017 [9]	Global RLSs focus	Evidence-based practice recommendations for RLSs Aim to improve, optimize practice in RLSs	Evidence-based and pragmatic recommendations for core elements of general supportive care, including nutrition in critically ill patients in RLSs	Address timing, how feeds should be advanced, determination of energy and protein requirements, feeding protocols, reducing risk of aspiration and awareness of refeeding syndrome. Alternatives to commercial feeds and indicate that PN is not routinely available
Mehta *et al.*, 2018 [19]	India	Evidence-based guideline following literature review. Aim to provide guidelines relevant to Indian settings	Nutrition practice recommendations covering a wide spectrum of topics	Aspects covered include nutrition screening and assessment, EN, PN, micronutrients and immune-nutrients, nutrition in hepatic, renal & respiratory diseases, documentation of nutrition practices. Summary of optimum nutrition practices for critically ill patients and providing solutions to overcome challenges in the field
Yilkal *et al.*, 2019 [18]	Ethiopia	Systematic review with the aim of developing clinical practice guidelines for nutrition support in critically ill patients admitted to the ICU	Strong preference for EN over PN Standard polymeric enteral formula recommended, initiated 24–48 h following admission to ICU Patient positioning: semi-recumbent advocated	Noncommercial feeds addressed (use of local sourced ingredients to create EN), nursing considerations when feeding
Narayan *et al.*, 2020 [4]	India	Review: Nutritional status in the critically ill	Pathophysiology of malnutrition, nutritional risk screening and assessment, practical implications of bedside nutritional assessment covered	Authors suggest further research warranted
Dixit *et al.*, 2021 [22]	India, global RLS relevance	Review. Aim to address and see whether evidence generated in developed countries, can inform critical care nutrition in all countries	Nutritional assessment, macronutrient availability, EN, PN, micronutrient nutrition, extrapolation of evidence to developing countries addressed	A "one size fits all" approach may not be universally applicable. Evidence generated in the developed world may not be fully appropriate and executable in the developing world

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Table 1 (*Continued*)

Author, year	Location/focus	Design and aim	Main results/findings	Comments
Barcus *et al.*, 2021 [5]	Malawi	Audit of critical care patients in two public tertiary referral hospitals. Study investigated whether reported dietary intake and disease state of adults in critical care units was related to malnutrition determined by MUAC	The prevalence of moderate and severe malnutrition was 62%. 57.6% of patients reported reduced dietary intake, with 81.1% reporting borderline or decreasing intake and 18.9% reporting being unable to eat. In those unable to eat, the rate of severe malnutrition was 50%. Patients with organ-related diseases and infectious diseases had the highest rates of reduced reported dietary intake. Review of hospital nutrition identified a daily gap in calories and protein	Findings support the need for increasing dietetic/nutrition services and simple screening tools to prevent and treat malnutrition in critically ill patients. Relevance of EN in patients with reduced oral intake or nil per mouth
Dixit *et al.*, 2021 [14]	India	Scoping review. Evaluation of nutrition practice changes over decade 2011–2020	Nutritional assessment and requirements. Choosing and initiating EN and PN at the right time. Relevance of macro and micronutrients	Potential use of telemedicine to share practice between HICs and RLS critical care units. Developing strategies for patients to include nutrition needs post discharge. Further data required
Carter C, *et al.*, 2022 [7]	Global RLS applicability, particularly Sub-Saharan Africa	Review addressing EN practices in RLSs	Discussion of approaches to implement EN in resource-limited environments	Further evidence to develop sustainable EN strategies for critically ill patients urgently required. Paper commissioned as part of the Humanitarian and Disaster Relief Operations special issue of *BMJ Military Health*
Chimera-Khombe *et al.*, 2022 [6■]	Malawi	Cross-sectional study involving patients from two public tertiary hospitals. Aim to estimate rates of malnutrition in critical care units and to determine the extent to which malnutrition diagnoses are documented in medical records by physicians	Nutrition status measured by SGA and MUAC. In adults >50% were malnourished, with a higher proportion moderately to severely malnourished using SGA compared to MUAC. Patients with cancer had the highest rates of malnutrition. Only 9.6% of adults had documentation of malnutrition in the medical records	Authors call for comprehensive screening practices and methods, improved documentation of malnutrition and the improved use of nutrition interventions
Anku *et al.*, 2024 [23■]	Ghana	Cross-sectional survey assessing nutrition support practices in the ICU of a tertiary hospital. The objective was to explore current nutrition support practices among healthcare professionals (doctors and nurses)	Almost half of the respondents were unaware of or were not familiar with an in-house nutrition support protocol. General lack of standardization of execution of most nutrition support practices	In view of the varying nutrition support practices and competencies demonstrated, the authors suggest that there is a need for standardized and practical feeding protocols in accessible formats, ongoing education, and training in nutrition support to improve nutrition support practices and competencies of healthcare professionals providing support in the ICU setting

BMI, body mass index; EN, enteral nutrition; HICs, high-income countries; ICU, intensive care unit; MUAC, Mid-Upper Arm Circumference; PN, parenteral nutrition; RLSs, resource-limited settings; SGA, Subjective Global Assessment.

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Table 2. Risk factors for aspiration [9,28,29]

• Inability to protect the airway	• Neurologic deficits
• Reduced /diminished level of consciousness	• Elderly patients
• Supine position	• Inadequate nurse/patient ratio
• Presence of nasoenteric enteral access device (e.g., nasogastric tube)	• Gastroesophageal reflux
• Mechanical ventilation	• Transportation out of ICU
• Poor oral care	• Use of bolus intermittent EN
• Dysphagia	• Abdominal pathologies (e.g., bowel obstruction, paralytic ileus, gastroparesis)
• Repeated vomiting	• Impaired cough function

EN, enteral nutrition; ICU, intensive care unit.

The refeeding syndrome occurs in patients who are severely malnourished or who have undergone a significant period of starvation [30], a situation frequently encountered in RLSs. The pathophysiological mechanism relates to a loss of intracellular electrolytes in starvation or undernutrition, followed by an insulin-mediated influx of electrolytes and thiamine into the cells when carbohydrate is provided, which can result in rapid and marked reductions in serum levels of phosphate, magnesium, potassium and calcium. Patients may also develop lactic acidosis. Clinical features include edema, diarrhea, neuromuscular abnormalities, seizures, coma, cardiac arrhythmias, and respiratory failure. Risk factors for the refeeding syndrome include a BMI of $<18.5\,kg/m^2$, weight loss of $\geq$10–15% in the prior 3–6 months, little or no nutritional intake for $\geq$ 5 days, history of alcohol abuse or drugs including insulin, chemotherapy, antacids or diuretics, and very low levels of phosphate, potassium and magnesium. At-risk patients should be identified, and feeding must be commenced slowly. It has been suggested that feeding commences at 5–10 kcal/kg/day with a gradual escalation over 4–7 days. Electrolytes must be closely monitored and replaced. Thiamine and other B vitamins should be administered intravenously prior to commencing feeding, and then daily for at least 3 days [31,1,9].

Overfeeding must be avoided as it may be associated with fluid overload, worsening renal function, hyperglycemia, hyperlipidemia, fatty liver, and hypercapnia (particularly with excess carbohydrate administration) and may prolong weaning from mechanical ventilation. It has also been associated with a less favorable outcome. [1,2,9]. Moreover, based on one randomized controlled trial and one observational study, nutrient restriction in patients developing early hypophosphatemia may improve survival, although these patients were not identified by the above risk factors for the refeeding syndrome [32,33]. Consequently, it might be safe to build up nutrition slowly in all patients if daily phosphate measurements are not available.

CONCLUSION

Nutrition is a key component of critical care medicine in all settings around the globe. There is however a striking paucity of nutrition guidelines and research applicable to RLSs. Major guidelines with evidence emanating largely from HICs may not necessarily be transferable to RLSs. There is a pressing need for context-specific research to address this void. RLS representation and input into future guideline panels will be a valuable addition. Despite the various challenges faced in RLSs, pragmatic solutions to overcome many of these barriers can be invoked to enhance both nutrition practice and patient outcomes. Being poor and being in a resource-poor environment does not necessarily mean poor care. Sound practice with excellent quality care is both feasible and possible. Committed collaborative cohesive efforts will go a long way to ensure that this is the case in respect of nutrition practice in critically ill patients in RLSs.

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Conflicts of interest

There are no conflicts of interest.

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