REVIEW ARTICLE

PARAMETERS FOR NUTRITIONAL STATUS MONITORING IN CRITICALLY ILL OLDER ADULTS: AN INTEGRATIVE REVIEW

Parâmetros de monitoramento do estado nutricional de idosos em estado crítico: uma revisão integrativa

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ABSTRACT

This integrative review was conducted to identify alternative tools for nutritional screening/evaluation of critically ill elderly patients that might overcome the limitations of traditional parameters. Four databases were searched. The criteria for inclusion were original articles, with full text available, published in Portuguese and English between 2013 and 2017. The search terms were: "*elderly AND critical ill AND nutritional assessment*" and "*elderly AND intensive care AND nutritional assessment*". Nine articles were selected and divided between those using conventional and those using alternative nutritional parameters. At the end of the article selection stage, we found that none of the included studies used bioelectrical impedance analysis (BIA). Thus, an additional search was conducted, using the keywords "*bioelectrical impedance analysis*", "*bioelectrical impedance vector analysis*", "*phase angle*", and "*intensive care*", and articles related to the topic of interest were included. Studies using the Nutrition Risk in Critical Ill (NUTRIC) score, which includes the Acute Physiology and Chronic Health Classification System II (APACHE II) and Sepsis-related Organ Failure Assessment (SOFA) scores, as well as those using either of these scores alone, presented good results. Although the final SOFA value remained the same in the studies included in this review, this instrument may be promising. We suggest that future research should explore the use of BIA (and its derived parameters, such as phase angle and bioelectrical impedance vector analysis – BIVA) and combinations of the NUTRIC score with phase angle and/or BIVA in critically ill elderly patients with decreased level of consciousness and/or edema.

KEYWORDS: aging; intensive care units; nutrition assessment.

RESUMO

Revisão integrativa realizada com a finalidade de identificar as ferramentas de triagem/avaliação nutricional do paciente idoso em estado crítico que constituem alternativas às limitações dos parâmetros tradicionais. Foram utilizadas quatro bases de dados e critérios de inclusão de artigos originais disponíveis na íntegra referentes à temática, em português e inglês, entre 2013 e 2017. As palavras-chave foram: "*elderly AND critical ill AND nutritional assessment*" e "*elderly AND intensive care AND nutritional assessment*". Nove artigos foram selecionados e divididos entre os que utilizaram parâmetros nutricionais convencionais e alternativos. Observou-se, no final do desenvolvimento, a ausência de estudos que utilizaram a análise da bioimpedância elétrica (BIA) e foram incluídos na discussão os artigos viáveis à temática do trabalho, segundo as palavras-chave "*bioelectrical impedance analysis*", "*bioelectrical impedance vectorial analysis*", "*phase angle*" e "*intensive care*". Os estudos que utilizaram o escore *Nutrition Risk in Critically ill (NUTRIC), que inclui os escores Acute Physiology and Chronic Health disease Classification System II* (APACHE II) e *Sepsis-related Organ Failure Assessment* (SOFA), e os que utilizaram esses escores isoladamente apresentaram bons resultados. Apesar do valor final do SOFA ter se mantido o mesmo nos estudos incluídos neste trabalho, nota-se que esse instrumento pode ser promissor. Sugere-se a exploração de estudos que avaliem a utilização da BIA, em pacientes idosos graves, da qual derivam o ângulo de fase, a análise vetorial da bioimpedância elétrica (BIVA) e outros que avaliem o NUTRIC associado ao ângulo de fase e/ou BIVA, nos pacientes críticos com baixo nível de consciência e/ou edema.

PALAVRAS-CHAVE: envelhecimento; unidades de terapia intensiva; avaliação nutricional.

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INTRODUCTION

Both population aging and the longevity of the world's population have grown rapidly. According to statistical projections by the United Nations in Brazil, the world's elderly population is expected to reach 2 billion by 2050.[1]

Physiological changes resulting from aging, compounded by multiple chronic diseases, polypharmacy, bone and degenerative diseases that affect mobility, as well as psychological issues and loss of appetite, mean that older adults are prone to various deficits, at a higher risk of being hospitalized, and vulnerable to nutritional problems. Reduced capacity for rehabilitation after an acute event is a characteristic of old age, which makes it more difficult to restore elderly patients to their premorbid condition.[2,3] Nevertheless, the significance of nutrition in the hospital setting, especially in intensive care units (ICUs), should not be underestimated.

Critical illness is usually associated with a state of catabolic stress, systemic inflammatory response, increased rate of infectious morbidity, multiple organ dysfunction, and prolonged hospitalization. Currently, nutritional interventions for critical patients are geared to attenuating the metabolic response to stress, preventing oxidative cell injury and modulating the immune response favorably.[4]

An accurate nutritional diagnosis can guide nutritional management for maximal adequacy. There are a number of validated nutritional screening tools that aim to detect the presence or risk of malnutrition. Anthropometric parameters, biochemistry tests, clinical and physical examination, and dietary assessment help in the diagnosis and monitoring of nutritional status.[5] However, in the intensive care setting, these traditional markers are not always applicable.

Anthropometry is unreliable, as simple parameters such as weight and height cannot always be measured directly in bedbound patients; although predictive formulas are available, patient positioning, dressings, IV lines and edema all limit access to the body segments which must be measured (e.g., knee height, arm and calf circumference), interfering with estimation. Serum protein levels reflect the acute phase response, and do not accurately represent nutritional status.[4]

Another aspect to be considered in obtaining a precise nutritional diagnosis is the evaluator's experience in clinical detection of significant nutritional changes. In addition, critically ill patients often have a decreased level of consciousness or are not chaperoned by anyone who can provide information on the patient's status before admission.[4,6]

Within this context, this integrative review was conducted to identify alternative tools for nutritional screening/evaluation of critically ill elderly patients that might overcome the limitations of traditional parameters.

METHODS

This study followed the integrative review model proposed by Whittemore and Knafl.[7] The guiding question was: "Which alternative tools for nutritional screening/evaluation of critically ill elderly patients might overcome the limitations of traditional parameters?".

The LILACS, SciELO, and MEDLINE (PubMed) electronic databases were searched for relevant articles. The following inclusion criteria were adopted: original articles, available for full-text download, published in Portuguese and English in the last five years (2013 to 2017). Duplicate records and those not published in journals (books, monographs, dissertations, theses, and abstracts) were excluded.

The search terms were: "*elderly AND critical ill AND nutritional assessment*" and "*elderly AND intensive care AND nutritional assessment*". Fifty-eight articles were retrieved. Of these, 11 were excluded as duplicates or because they were unrelated to the topic of interest. The titles and abstracts of the remaining studies were reviewed for consistency with the guiding question established for the investigation. Twenty-seven articles were excluded at this stage. After full-text reading of the remaining articles, a further 18 were excluded for the same reason. Therefore, nine articles were ultimately selected for analysis and discussion.

Identifiers, methodology, results, and main conclusions were extracted from each of the included articles. Data were presented and discussed descriptively.

Due to the scarcity of topical articles which included only older adults, two articles that had non-elderly patients in their samples were also considered for analysis.

At the end of the article selection stage, we observed a complete absence of studies that used bioelectrical impedance analysis (BIA). Thus, the same databases previously used were searched again with the terms "*bioelectrical impedance analysis*", "*bioelectrical impedance vector analysis*", "*phase angle*" and "*Intensive care*", using the same inclusion and exclusion criteria. This search yielded 19 articles, only three of which were directly related to the topic of interest; these were included in the discussion.

RESULTS

The eligible articles were divided into two groups for analysis. Chart 1 lists those which evaluated nutritional screening/assessment tools which are already well established in clinical practice for their associations with patients' clinical outcomes; these tools were not compared to other traditional nutritional monitoring parameters.

Chart 1 Summary of studies that employed conventional nutritional parameters.

Author	Parameter	Method	Result
Santos et al., 2017[10]	SGNA	Retrospective cross-sectional review of data from hospitalized adults and older adults who received enteral and/or parenteral nutrition, designed to analyze the demographic, clinical, and nutritional profile (diagnosed by SGNA), as well as parameters associated with a higher frequency of malnutrition and death.	688 patients, mean age 69 years. Of those assessed, 55.5% had some degree of malnutrition and 22.5% were seriously malnourished. The majority (81.5%) reached their nutritional goal; 56.6% died. Age ≥ 60 years, ICU admission, and treatment within the public Unified Health System were associated with higher rates of malnutrition and death.
Sheean et al., 2014[11]	SGNA, MNA, and NRS-2002	Prospective cohort of older adults admitted to ICUs and classified according to MNA, SGA, NRS-2002, and MNA-short form (MNA-SF). Eligible sample: English speakers aged ≥ 65 years with an ICU length of stay > 24 hours.	260 patients, mean age 74.2 years. Malnutrition was prevalent in 23 to 34% of patients. Compared with the MNA, the NRS-2002 had greater sensitivity, while the SGA and MNA-SF had higher specificity. Malnutrition at ICU admission was associated with longer hospital stay, lower likelihood of discharge, and death.
Lee et al., 2013[12]	CGA, which includes MNA	Nationwide multicenter cohort study conducted at 5 post-acute care units. CGA within 72 hours of admission. Non-inclusion criteria: admitted for elective procedures; acute conditions related to terminal illness; malignancy; and patients considered to lack potential for functional recovery.	918 patients, mean age 82.5 years. The readmission group had a lower BMI, worse functional status, poorer cognitive function, worse ambulation, and worse nutritional status by MNA score, but did not differ with regard to depression. On multivariate logistic regression, lower MMSE was the only independent predictor of clinical instability.
Doig et al., 2013[15]	BMI, MUAC, score of 1 to 4 for muscle wasting and fat loss according to SGNA	Multicenter, randomized clinical trial in ICUs at 31 hospitals. Included critically ill adults with initial contraindications to EN who were expected to remain in the ICU for > 2 days, designed to determine whether early TPN changed outcomes at 60 days.	1,372 (686 to standard care, mean age 68.6 years; 686 to early TPN, mean age 68.4 years). Day-60 mortality and infection rate did not differ significantly. Patients in the early TPN group had less muscle wasting, statistically higher quality of life at day 60, and fewer days of invasive ventilation, but this did not result in shorter length of hospital stay.
Rahman et al., 2016[16]	Modified NUTRIC: all NUTRIC score variables with the exception of IL-6 levels	Randomized case-control study of ICU patients with multiorgan failure. A logistic model including the NUTRIC score, nutritional adequacy, and their interaction was constructed to evaluate whether NUTRIC modified the association between nutritional adequacy and mortality at 28 days.	1,199 patients. Mortality was significantly modified by the NUTRIC score. There was a strong positive association between nutritional adequacy and 28-day survival in patients with a high NUTRIC score, and this association declined with decreasing scores. Higher scores were also significantly associated with higher 6-month mortality; the positive association between nutritional adequacy and 6-month survival was significantly stronger with higher scores.

BMI: body mass index; CGA: Comprehensive Geriatric Assessment; EN: enteral nutrition; ICU: intensive care unit; IL-6: interleukin-6; MNA: Mini Nutritional Assessment; MNA-SF: Mini Nutritional Assessment - Short Form; MUAC: mid-upper arm circumference; NRS: Nutritional Risk Screening; NUTRIC: Nutrition Risk in Critically ill; SGA: Subjective Global Assessment; SGNA: Subjective Global Nutritional Assessment; TPN: total parenteral nutrition.

Of the five included articles, four used the Subjective Global Nutrition Assessment (SGNA) and two used the Mini Nutritional Assessment (MNA); in one, the MNA was part of the Comprehensive Geriatric Assessment (CGA). Other parameters used were the Nutritional Risk Screening 2002 (NRS-2002), the modified Nutrition Risk in Critically ill (NUTRIC) score, and the anthropometric parameters of body mass index (BMI) and mid-upper arm circumference (MUAC).

Chart 2 lists those articles that used unconventional parameters, but to test for their association with clinical outcomes in the sample, not used as tools for nutritional assessment. These studies used atypical laboratory tests or morbidity and mortality assessment tools validated for clinical use in the intensive-care setting. Of the four included articles, three used the Sequential Organ Failure Assessment (SOFA) and one used specific laboratory tests not commonly employed in clinical practice.

Chart 2 Summary of studies that employed unconventional parameters for nutritional assessment.

Author	Parameter	Method	Results
Rugeles et al., 2016[21]	SOFA	Controlled, prospective, randomized trial. ICU patients receiving EN for more than 96 hours. The intervention group received a hypocaloric diet (15 kcal/kg/day) and the control group, a normocaloric diet (25 kcal/kg/day); both received a hyperproteic diet (1.7 g/kg/day). SOFA (evaluated in the first 48 to 96 hours), insulin requirements, hyper/hypoglycemia, length of ICU stay, days on mechanical ventilation, and 28-day mortality.	120 patients (60 in each group), mean age 53.8 years in the hypocaloric group and 21.8 years in the normocaloric group. There were no between-group differences in SOFA score at baseline or at 48 hours. The hypocaloric group had lower daily requirements of insulin, and a lower percentage of patients in this group needed insulin.
Hall et al., 2014[22]	SOFA	Randomized controlled trial. Patients with sepsis were randomized to receive either parenteral ω-3 or standard care only (control group). SOFA score (assessed for 2 weeks or until discharge), 28-day mortality, overall mortality, length of stay, mean CRP, and days free of organ dysfunction/failure.	60 patients, mean age 64.5 years in the control group and 63.8 years in the intervention group. Treatment with parenteral ω-3 was associated with a significant reduction in CRP and new organic dysfunction, i.e., SOFA scores did not increase. There was no significant reduction in length of stay in either group. Patients treated with ω-3 in the strata of less severe sepsis had a significant reduction in mortality.
Elke et al., 2013[23]	SOFA	Prospective, controlled, multicenter trial. Only patients with severe sepsis or septic shock with length of ICU stay > 7 days were included. Data on nutritional therapy were collected daily for up to 21 days. Morbidity (as measured by SOFA score), incidence of secondary infections, renal replacement therapy, ventilator-free days, severe hypoglycemia, length of ICU stay, and 90-day mortality were compared among three nutritional strategies: EN *vs.* TPN *vs.* EN + TPN.	537 patients, mean age 66 years. The 90-day mortality rate was lower with EN than with EN + TPN, as were the rate of secondary infections, need for renal replacement therapy, and duration of mechanical ventilation. SOFA scores did not differ significantly across the nutritional strategies. EN + TPN was associated with a higher risk of mortality and higher risk of secondary infections compared to EN alone.
Su et al., 2015[24]	Serum levels of 42 AAs	Dynamic concentration profiles of 42 AAs in patients with SIRS, sepsis, and healthy subjects were assessed by high-throughput mass spectrometry. Serum samples were collected on days 1, 3, 5, 7, 10, and 14 following ICU admission.	14 patients with SIRS (mean age 57 years), 35 with sepsis (mean age 47 years), and 18 healthy controls. The metabolic spectrum of AAs changed clearly in patients with sepsis. Taurine concentrations decreased as the severity of sepsis increased, and concentrations were significantly lower in the non-survivor group compared to the survivor group.

AA: amino acids; CRP: C-reactive protein; EN: enteral nutrition; ICU: intensive care unit; SIRS: systemic inflammatory response syndrome; SOFA: Sequential Organ Failure Assessment; TPN: total parenteral nutrition.

DISCUSSION

The SGNA has been widely used in clinical practice because it is easy to apply at bedside and can be administered by any member of a multidisciplinary team after proper training. According to Detsky et al.,[8] the purpose of this assessment is to establish not only prognosis, but also a nutritional diagnosis. Despite its advantages and potentials, one of the disadvantages of this instrument is that it depends on the clinical judgment and experience of the administering practitioner and on the good cognitive status of the patient or presence of a family member and/or chaperone, who must be able to answer questions related to the patient's history, such as recent weight changes, changes in dietary intake, and current gastrointestinal symptoms.[9]

As shown in Chart 1, Santos et al.[10] did not report in detail how the SGNA was administered to their sample of patients in intensive care; it is thus impossible to identify how data on nutritional history were collected. In the study by Sheean et al.,[11] one of the limitations of the SGNA was precisely the patients' inability to communicate, due to several factors related to critical illness; thus, a family member and/or other appropriate proxy was approached and consulted for three attempts. Patients who had no proxy present that could respond appropriately to the assessment questions were excluded from the sample.

Lee et al.[12] used the MNA instrument for evaluation. This is currently considered the best method for nutritional screening and assessment in the elderly, as it provides for the particular characteristics of this population. The instrument includes anthropometry, dietary assessment, a global clinical evaluation, and a self-assessment (self-perception of health and nutritional status), and can be used for both nutritional screening and nutritional evaluation. However, like the other instruments mentioned above, it is fundamentally reliant on the patient's preserved cognitive capacity or the presence of a family member and/or proxy.[13]

Critically ill patients often have their ability to communicate temporarily or permanently disrupted because of their decreased level of consciousness, due to sedation, mechanical ventilation, mental confusion, delirium, and other issues that prevent communication with care providers. Just as with the ASG, for the care team to obtain more information about the patient's history, including diet/feeding, there must be a family member and/or proxy to serve as interlocutor. Although older adults constitute a protected age group under Brazilian legislation and have the legal right to a chaperone in the hospital environment, this is not always enforced or respected, making it difficult to obtain data on patients' nutritional history.[11,14]

Faced with this reality, Doig et al.[15] chose to administer only the physical examination component of the SGNA, which subjectively evaluates for presence or absence of loss of muscle mass and subcutaneous fat (scored on a scale of 0 for no loss to 4 for severe loss). Although the study does not justify the exclusion of the objective part of the instrument (clinical history and nutritional history), it corroborates the challenges of applying this SGNA component. These authors also used anthropometric parameters, such as BMI and MUAC.

Anthropometry is simple, easy, convenient, noninvasive, inexpensive, and widely used as an adjunctive method to assess nutritional status. However, in patients who are bedridden, wheelchair-bound, or have significant contraction of the upper body (such as those with severe spinal curvature), indirect measurements of other body segments (such as knee height, calf circumference, and arm circumference) can be obtained and mathematical formulas applied to estimate these parameters.[5] Even though these measurements are considered more readily obtainable in critically ill patients, positioning in bed, dressings, IV lines, and, especially, the presence of edema (due to underlying disease or to fluid resuscitation with large volumes needed to maintain hemodynamic stability) limit access to the body segments required for measurement.[6]

Rahman et al.[16] used the modified NUTRIC scale for assessment. The NUTRIC scale is considered the first validated nutritional risk assessment tool for ICU patients. It includes variables that are easily obtained in the critical care environment, such as the Acute Physiology and Chronic Health Classification System II (APACHE II) and SOFA. Additional variables include body temperature, mean arterial pressure, heart and respiratory rate, arterial blood pH, laboratory tests (sodium, potassium, creatinine, hematocrit, white blood cell count, platelet count, bilirubin, interleukin [IL]-6), Glasgow Coma Score, number of comorbidities, and length of ICU stay in days; the modified NUTRIC excludes IL-6 from the tool because it is not routinely measured, thus enhancing its utility in clinical practice.[17,18]

One advantage of NUTRIC is its applicability in situations in which patients are unable to communicate, such as those receiving mechanical ventilation, as the instrument variables are obtained from data routinely available in medical records; this was done by design, seeking to overcome the limitation of verbal communication in critically ill patients.[19] Thus, NUTRIC seems to be an adequate tool for assessing the nutritional risk of ICU patients, since those with greater respiratory, cardiac, and renal dysfunction, electrolyte imbalances, and reduced level of consciousness appear to be more prone to nutritional risk and, therefore, more likely to benefit from early nutritional therapy. Despite these advantages, the scale has yet to be validated for monitoring of nutritional status.[20]

Due to the challenges that preclude conventional nutritional assessment within the intensive-care setting, alternative methods have been proposed (Chart 2). Rugeles et al.,[21] Hall et al.,[22] and Elke et al.[23] used the SOFA to evaluate impact and survival in critically ill patients receiving nutritional therapy (NT). These authors evaluated the mortality of the sample after a defined period of time, and tested for its association with the different NTs administered. There was no specific parameter for monitoring nutritional status, only a report of the results evaluated after the intervention, which corroborates the difficulty of evaluating and monitoring the effectiveness of NT during the period of critical illness.

The critically ill patient exhibits metabolic hyperactivity, a marked catabolic state, increased energy expenditure and protein catabolism at rest, a negative nitrogen balance, insulin resistance, hyperglycemia, and increased hepatic glycogen production. All these factors affect the reliability of traditional serum protein markers, such as albumin, prealbumin, transferrin, and retinol-binding protein.[4,23] In this context, other markers could be investigated to monitor the response to NT. This would allow practitioners to provide the optimal NT for each patient based on consistent biomarkers.

Su et al.[24] measured changes in serum levels of 42 amino acids in patients with the systemic inflammatory response syndrome (SIRS) and sepsis and in healthy subjects to investigate their concentration profiles by high-throughput mass spectrometry. The authors found that these parameters can provide a theoretical basis for nutritional support in the treatment of sepsis, and raised the hypothesis that taurine might be a marker of severity.

Regarding BIA, it is a simple, fast, noninvasive technique that can be performed at the bedside and its designed to measure the patient's total body composition through the basic parameters resistance (R) and reactance (Xc). The relationship between these two parameters represents the phase angle, which is a potential indicator of interest in critically ill patients because it can be used even in situations in which BIA is invalid, such as patients with massive obesity and disorders of fluid balance.[25]

The direct relationship between phase angle and nutritional status is still a point of controversy in the literature, as there is still no consensus as to whether low values alone can be interpreted as malnutrition. Studies have suggested that phase angle may be a sensitive tool for assessing prognosis in several clinical scenarios, such as the nutritional status and even the effectiveness of NT, because it represents the mass of the body's cells and worse nutritional status is known to correlate with depletion of body cell mass.[25-28]

Among the three studies included in this review which used BIA in critically ill patients, Díaz-De Los Santos et al.[29] showed that the phase angle determined by BIA is a good predictor of mortality in critically ill and septic patients, superior to the APACHE II score, while Vermeulen et al.[30] stated that it can be used to establish nutritional prognosis. However, Berbigier et al.[28] found no correlation of phase angle with mortality, APACHE II, SOFA, length of ICU stay, C-reactive protein, or albumin. None of the studies made any claims as to the utility of phase angle for monitoring nutritional status.

There are no known restrictions to or adverse effects of the BIA technique, but it must be taken into account that it can affect the electrical activity of pacemakers and defibrillators, and should be avoided when these are present.[31,32]

Bioelectrical impedance vector analysis (BIVA) is an approach that allows reliable assessment of patients in whom calculation of body composition by conventional BIA is difficult due to changes in fluid balance. This method obviates the need for predictive equations that can cause significant error; as it is not based on estimation of any body compartment, it is not dependent on operator training or expertise.[33,34]

BIVA can be particularly useful in the nutritional assessment of older adults (due to the changes that occur with aging) and in critically ill patients (a population in which other nutritional assessment methods are hindered by frequent changes in fluid balance).[34,35]

CONCLUSION

In critically ill older adults who are alert and have no significant edema, the use of conventional anthropometric, clinical, biochemical, and dietary methods for nutritional assessment is feasible, alongside history and physical examination and nutritional screening. However, in those with edema or altered level of consciousness, both of which are common findings in the intensive care setting, it is difficult to assess and monitor nutritional status and evaluate the efficacy of NT. In this scenario, all currently available techniques have limitations.

Studies that used the NUTRIC score, which incorporates the APACHE II and SOFA scores, and those that used either of these scores alone reported good outcomes for identification of nutritional risk and indication of early nutritional support. Although the final SOFA value remained the same in the studies included in this review, this instrument may still be promising due to its feasibility and ease of administration in the ICU setting. We suggest that future research should further explore the use of BIA (and its derived parameters phase angle and BIVA) in critically ill older adults and test combinations of the NUTRIC score with phase angle and/or BIVA, especially in critically ill patients with decreased level of consciousness and/or edema.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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