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Nutritional Risk in Emergency-2017: A New Simplified Proposal for a Nutrition Screening Tool

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Abstract

Background: There are many nutrition screening tools currently being applied in hospitals to identify risk of malnutrition. However, multivariate statistical models are not usually employed to take into account the importance of each variable included in the instrument's development. *Objective:* To develop and evaluate the concurrent and predictive validities of a new screening tool of nutrition risk. *Methods:* A prospective cohort study was developed, in which 4 nutrition screening tools were applied to all patients. Length of stay in hospital and mortality were considered to test the predictive validity, and the concurrent validity was tested by comparing the Nuritional Risk in Emergency (NRE)-2017 to the other tools. *Results:* A total of 748 patients were included. The final NRE-2017 score was composed of 6 questions (advanced age, metabolic stress of the disease, decreased appetite, changing of food consistency, unintentional weight loss, and muscle mass loss) with answers yes or no. The prevalence of nutrition risk was 50.7% and 38.8% considering the cutoff points 1.0 and 1.5, respectively. The NRE-2017 showed a satisfactory power to indentify risk of malnutrition (area under the curve >0.790 for all analyses). According to the NRE-2017, patients at risk of malnutrition have twice as high relative risk of a very long hospital stay. The hazard ratio for mortality was 2.78 (1.03–7.49) when the cutoff adopted by the NRE-2017 was 1.5 points. *Conclusion:* NRE-2017 is a new, easy-to-apply nutrition screening tool which uses 6 bi-categoric features to detect the risk of malnutrition, and it presented a good concurrent and predictive validity. (*JPEN J Parenter Enteral Nutr.* 2018;42:1168–1176)

Keywords

emergency service; length of hospital stay; malnutrition; mortality; nutrition screening

Clinical Relevancy Statement

Nutritional Risk in Emergency (NRE)-2017 was constructed employing a multivariate statistical model from questions encompassed in different nutrition screening and assessment tools (advanced age, metabolic stress of the disease, decreased appetite) and categorized them into 2 categories to make it easier. This new tool showed promising levels of concurrent validity (compared with Nutrition Risk Screening 2002, Malnutrition Screening Tool, Malnutrition Universal Screening Tool, and Short Nutrition Assessment Questionnaire), even with different cutoff points to detect

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nutrition risk, and it showed significant association with prolonged length of hospital stay and mortality. NRE-2017 is a new, easy-to-apply, validated nutrition screening tool.

Introduction

Hospital malnutrition is highly associated with the risk of disease complications, longer hospital stays, worse prognosis, and mortality.[1] Consistently, the prevalence of malnutrition reported among patients admitted to different hospital units is elevated,[2] and may be up to 66% among patients admitted to specific units, such as emergency rooms.[3,4]

Nutrition screening according to a validated tool must be the first step applied to patients admitted to hospital units in order to identify patients who are malnourished or at risk of malnutrition and thus determine if a complete nutrition assessment should be performed and/or the need for nutrition support.[5,6] Screening and nutrition assessment are different processes that encompass variables related to identify nutrition problems. Nutrition screening is the act of identifying risk factors against the integrity of the nutrition status of a patient, and differs from nutrition assessment in the depth of the information obtained by the nutrition conditions of a patient, which allows the formulation of a diagnosis.[7]

However, despite being a mandatory component of the nutrition care process, there is no concordance regarding which components should be included in a practical and good nutrition screening tool. Weight loss, food or energy intake, body mass index (BMI), and the effect of the disease on nutrition status are parameters frequently asked and required by most nutrition screening tools used among inpatients.[8-12] However, other features may also be strongly related to the risk of malnutrition, such as advanced age,[13] gastrointestinal symptoms,[4] functional status, and free fat mass/subcutaneous fat loss detected by physical examination.[14]

Nutrition Risk Screening 2002 (NRS-2002),[8] Mini Nutrition Assessment (MNA),[9] Malnutrition Universal Screening Tool (MUST),[10] Short Nutrition Assessment Questionnaire (SNAQ),[11] and Malnutrition Screening Tool (MST)[12] are some of the validated nutrition screening tools most commonly used among hospitalized patients. However, these tools may vary regarding reliability and validity in different populations. For example, it is suggested that NRS-2002[15,16] and MUST[15,17] may be used for nutrition screening among adult and elderly inpatients in general, but they could not be sufficiently sensitive to screen nutrition risk in individuals with kidney[18] and liver[19] disease. Furthermore, objective data such as amount or percentage of weight loss and BMI are necessary to point the final risk score in most nutrition screening tools, and frequently such information is difficult to obtain due to unavailability in medical records[20] or for being dependent on a patient´s memory. Subjective Global Assessment (SGA)[21] has also been used as a nutrition screening tool.[22,23] Despite being potentially superior for nutrition screening when compared with other methods[24] and taking into account functional capacity plus physical examination for malnutrition detection, SGA was originally designed as a nutrition assessment tool and its diagnosis also depends on anthropometric data; it may not be an easy and practical tool to apply, especially by untrained professionals.

As described above, there are many nutrition screening tools currently being applied in the hospital to identify risk of malnutrition, some more sophisticated and others simpler. In theory, the ideal instrument should be easy and quick to apply and have high sensitivity and specificity, with good performance to detecting nutrition risk. However, the attribution of a score to each question related as a risk determinant to malnutrition and the final addition of all theses often applied in the screening tools could represent a bias by prejudging the effect of a variable over the others. Multivariate statistical models should be employed to take into account the importance of each variable included in the instruments developed to identify risk of malnutrition.[7]

Emergency rooms are frequently the first units where patients are admitted in hospitals. Early identification of the nutrition risk at this location by any health professional could improve the nutrition care process because it accelerates both detailed nutrition assessment and therapy intervention. It should be noted that emergency rooms in developing countries such as Brazil are often crowded and have high patient turnover; thus, the selected nutrition screening tool should be easily applied and validated for the population in question. Considering this, the aim of this study was to develop and evaluate the concurrent and predictive validities of a new and simplified screening tool for the early identification of the nutrition risk in an adult and elderly heterogeneous population admitted to an emergency room of a tertiary public hospital.

Methods

A prospective cohort study was performed with patients admitted within 48 hours of hospitalization to the emergency service of a tertiary public hospital in Porto Alegre, Rio Grande do Sul, Brazil between September 2013 and February 2015.

The inclusion criteria were patients age ≥18 years who were able to move and communicate. The sample did not include pregnant women; individuals who had undergone limb amputation; patients who were unable to talk, were confused, or were bedridden; or those whose anthropometric measurements could not be obtained. The protocol was approved by the Ethical Committee of the hospital (protocol number 360.639), and all patients gave their written informed consent before data collection. This research

Table 1. Features of Nutrition Screening Tools and Nutrition Risk Criteria.

Feature	NRS-2002[7]	MUST[9]	MST[11]	SNAQ[10]
Body mass index	√	√		
Weight loss	√	√	√	√
Food/energy intake	√		√	√
Nutrition supplements				√
Severity of disease	√			
Acute effect of disease		√		
Age	√			
Nutrition Risk Criteria				
At risk	≥3 points	≥1 point	≥2 points	≥2 points

MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NRS-2002, Nutritional Risk Screening 2002; SNAQ, Short Nutrition Assessment Questionnaire.

was conducted according to the Brazilian ethical guidelines involving humans subjects and according to the Declaration of Helsinki.

Data were collected at the patients' bedside, with the application of a specific questionnaire. Sociodemographic characteristics, including sex, age, ethnicity (self-reported), marital status, level of education, procedence, lifestyle, and socioeconomic level were collected. Information regarding admission date, reason for admission, and previous and current medical history were obtained from electronic medical records. Vital status (death during hospital stay or not) was also obtained from medical records.

During anthropometric measurements, patients wore as little clothing as possible and no shoes. Height was measured with an anthropometer (Bodymeter 206, Seca®, São Paulo, Brazil) with a total capacity of 2 m and precision of 0.1 cm. Weight was obtained in kilograms and height in centimeters. BMI was calculated (weight/[height*height]) and expressed in kg/m^2. Information of usual body weight was obtained to evaluate the percent of weight loss ([usual body weight - actual body weight]*100/usual body weight), expressed in %.

Collected nutrition features included history of anorexia, nausea, vomiting, diarrhea, constipation, non-intentional reduction of food intake, changing of food consistency (using soft or liquid foods instead of whole foods), functional capacity (preserved or reduced) in the last 15 days, use of oral nutrition supplements in the last 30 days, and weight loss in the previous 6 months (self-reported or according to % of weight loss). The metabolic demand of the disease was considered for classifying its stress, as proposed by the SGA. A physical examination of body fat loss (orbital region [surrounding the eyes], upper arm region (triceps/ biceps), and thoracic and lumbar region (ribs, lower back, midaxillary line), muscle mass loss (temple region, clavicle and acromion bone, scapular bone region, and dorsal hand), and fluid accumulation (ankle edema and ascites) was performed and each aspect was classified as "no," "mild," "moderate," or "severe," as proposed by the SGA.[21] The variables related to physical examination were classified as bi-categoric (present or absent) for the analyses.

Nutrition screening was performed using the following 4 tools: NRS-2002,[8] MUST,[10] MST,[12] and SNAQ.[11] MUST[10] and SNAQ[11] screening tool scores were adapted for data analyses, as shown in Table 1.

All questions of the screening nutrition tools as well as all SGA composing items were used to elaborate a list of questions related to risk of malnutrition, which was used in the construction of the Nutritional Risk in Emergency (NRE)-2017 tool. The outcomes assessed to evaluate the predictive validity of NRE-2017 were length of stay in hospital (in days), which was obtained from medical records of each participant at the discharge from the hospital, and mortality during hospitalization. We considered very long hospital stay (VLHS) as a hospitalization ≥16 days, because in a multicentric Brazilian study it was associated with undernutrition.[25]

Statistical Analysis

Three phases were performed to investigate the questions that could be applied to early identification of patients at risk of malnutrition and develop the NRE-2017 tool, as conducted for the construction of the SNAQ tool.[11] In the first phase, the relative risk (RR) was calculated according to modified Poisson regression with robust variance for each question, considering presence or absence of risk of malnutrition according to NRS-2002 (reference method) as a dependent variable. Questions with significant RR ($P < .05$) remained in the second phase, in which another Poisson regression was performed considering the risk of malnutrition according to NRS-2002 as dependent variable.

Questions that remained significantly associated with the risk of malnutrition in the second phase (backward stepwise procedure) were included in the third and final phase, in which the Poisson regression coefficent was calculated to define the score of each question proposed by the NRE-2017 tool. This score was adjusted by multiplying constant 0.6, which was obtained by the ratio of the 6 questions selected in the second phase and by the 10 questions selected in the first phase (6/10) to weigh the points assigned to each question for the final score. The final NRE-2017 score ranges from 0 to 2.5 points. The cutoff point for the scores belonging to "at risk of malnutrition" was determined by the receiver operating characteristic (ROC) curve, using NRS-2002 as reference method.

The concurrent validity of NRE-2017 was determined by calculating the κ coefficient between NRE-2017 and NRS-2002, MUST, MST, and SNAQ. The value of κ varies from 0 to 1; a value of <0.2 indicates poor, 0.2–0.4 indicates fair, 0.4–0.6 moderate, 0.6–0.8 substantial, and >0.8 indicates almost perfect concordance. The discriminatory power of NRE-2017 to identify patients at risk of malnutrition was determined by the area under the ROC curve, considering as reference the NRS-2002, MUST, MST, and SNAQ tools. Sensitivity, specificity, positive and negative predictive values, and likehood ratio were also obtained.

The predictive validity was assessed by Poisson regression with robust variance, considering the length of hospital stay >16 days as dependent variable adjusted for sex, and Cox regression, considering death as dependent variable adjusted for sex, length of hospital stay, and infection. The Hosmer-Lemeshow test was performed to evaluate the quality of adjustment, and it was considered adequate if P value of χ^2 was non-significant ($>.05$).

Data were showed as mean and standard deviation or median and interquartile range (for parametric and non-parametric continuous variables, respectivelly) and as absolute numbers and percentages, for categoric variables. Prevalence, RR, and hazard ratio (HR) are presented with the 95% confidence intervals (95% CI). All analyses were performed with STATA software (13.0, STATA, Texas - USA). For each analysis, α-level $= 0.05$ was considered significant.

Results

Clinical and Nutritional characteristics of the 748 participants included in the study are shown in Table 2. The mean age of patients was 53.6 ± 15.5 years, and most of them were females (n = 415; 55.4%) and Caucasian (n = 645; 86.2%). Patients reported 8.0 (4.0–11.0) years of study, 23.1% were active smokers, and 5.5% reported frequent drinking of alcoholic beverages.

The 13 questions selected for the construction of NRE-2017 are shown on Table 3, and these questions were chosen from MUST, MST, SNAQ, NRS-2002, and SGA tools with the aim of having a screening nutrition tool without data on weight, height, BMI, or percent of weight loss. In order to turn this into a tool that can be more quickly and easily applied, questions with >2 possible answers were transformed into bi-categoric answers. In the first phase, 10 of the 14 questions showed significant results and were included in the second phase of selection; then 6 questions remained significant in this phase, and they were then used to compose the new nutrition screening tool. The RR and 95% CI for the questions that remained significant and composed the NRS-2017 are underlined in Table 3.

In the third phase, the regression coefficient was obtained to establish the numbers for NRE-2017 scores (Table 4). The final NRE-2017 score was composed of the following 6 questions with 2 possible answers: yes or no. Each positive answer received a specific score, as follows: 1. Is the patient's age above 65 years old? (0.25 points); 2. Does the patient have a high-stress disease? (0.25 points); 3. Has the patient reported decreased appetite in the last 2 weeks? (0.25 points); 4. Has the patient reported changing of food consistency in the last 2 weeks? (0.25 points); 5. Has the patient had non-intentional weight loss in the last 6 months? (0.5 points); 6. Does the patient have signs of muscle mass loss according to the physical exam (1.0 point)? The final score of NRE-2017 ranged from 0 to 2.5 points.

The cutoff point to identify patients at risk of malnutrition was established by comparison with NRS-2002 as a reference method for nutrition screening through the ROC curve, and the calculation of sensitivity and specificity was made. Considering the equilibrium between sensitivity (81.0%) and specificity (80.8%), an NRE-2017 score ≥ 1.5 was discriminatory to identify the risk of malnutrition. On the other hand, considering a highest sensitivity (91.7%) and an acceptable specificity (68.5%), an NRE-2017 score ≥ 1.0 was able to detect the risk of malnutrition (Figure 1).

The prevalence of nutrition risk was equal to 50.7% (95% CI, 47.0%–54.3%) and to 38.8% (95% CI, 35.4%–42.5%) considering the NRE-2017 cutoff points equal to 1.0 (most sensible) and 1.5 (equilibrium between sensitivity and especificity), respectively. According to NRS-2002, MUST, MST, and SNAQ, the prevalence of nutrition risk was 29.3% (95% CI, 26.0%–32.7%), 37.1% (95% CI, 33.9%–40.7%), 33.3% (95% CI, 29.9%–36.7%), and 31.6% (95% CI, 26.9%–33.7%), respectively.

The agreement between NRE-2017 (considering both cutoff points) and other nutrition screening tools was evaluated to analyze its concurrent validity (Table 5). A moderate agreement between NRE-2017 and all other screening nutrition tools was observed. The NRE-2017 showed a satisfactory discriminatory power to identify patients at risk of malnutrition, independent of the nutrition screening tool applied as reference method (area under the curve [AUC] >0.790 for all analyses). The new screening tool demonstrated high sensitivity and positive predictive value

Table 2. Clinical and Nutrition Characteristics of Sample (n = 748).

Characteristics	Absolute Frequence or Tendency Measure	Relative Frequence or Variance Measure
Clinical features		
Causes of hospitalization (n = 748)		
Oncology	130	17.4%
Gastroenterology	150	20.0%
Neurology	59	7.9%
Pulmonology	51	6.8%
Nephrology	64	8.5%
Cardiology	85	11.3%
Surgery and vascular	75	10.0%
Infectious diseases	34	4.5%
Endocrinology	29	3.9%
Others	71	9.5%
Stress of the disease		
Mild	88	11.7%
Moderate	352	47.0%
High	305	40.7%
Length of hospital stay (days)	9.0	3.0–19.0
Incidence of death	28	3.7%
Nutrition characteristics		
Current weight (kg)	72.98	17.74
Usual weight (kg)	75.40	17.22
Current height (cm)	161.04	8.97
Body mass index (kg/m2)	28.13	6.39
Unintentional weight loss in previous 6 months	376	50.2%
Loss of muscle mass (n = 748)		
No	409	54.7%
Mild	178	23.8%
Moderate	132	17.6%
Severe	29	3.9%
Loss of subcutaneous fat (n = 748)		
No	419	56.0%
Mild	205	27.4%
Moderate	105	14.0%
Severe	19	2.5%
Presence of Ascites		
No	663	88.5%
Mild	46	6.1%
Moderate	24	3.2%
Severe	15	2.0%
Edema (n = 748)		
No	533	71.3%
Mild	114	15.2%
Moderate	78	10.4%
Severe	23	3.1%
Reduced functional capacity in last 15 days	326	43.5%
Use of oral nutrition supplement in last 30 days	20	2.7%
Reduced food intake in last 15 days	297	39.7%
Changing of food consistency in last 15 days	70	9.3%
Diarrhea in last 15 days	57	7.6%
Constipation in last 15 days	145	19.4%
Vomiting in last 15 days	158	21.1%
Nausea in last 15 days	231	30.8%

data are presented as absolute and relative frequencies.

when compared with the other tools as well as a positive likelihood ratio (LR).

The predictive value of NRE-2017 was tested considering both VLHS and death as outcomes. Patients at risk of malnutrition according to NRE-2017 have RR of VLHS twice as high as patients without risk of malnutrition (considering NRE-2017 ≥1.5 points; RR = 2.10 [CI, 95% 1.65–2.69] and NRE-2017 ≥1.0 points; RR = 2.08 [CI, 95% 1.66–2.60]), after adjusting for sex (P <0.001 for both analysis). Regarding death, the HR for mortality during hospitalization was equal to 3.33 (CI, 95% 0.99–11.21) in patients at risk of malnutrition (NRE-2017 ≥1.0 point) in comparison with patients without risk of malnutrition, considering sex, length of hospital stay, and infection as potential confounders (P = .053). However, the HR for mortality was equal to 2.78 (1.03–7.49) when the cutoff adopted to identify patients at risk of nutrition by NRE-2017 was 1.5 points (P = .044) after adjustment for confounding factors.

Discussion

In this study, a new easy-to-apply nutrition screening tool was developed and validated in a general population admitted to an emergency service. NRE-2017 showed promising levels of concurrent validity (compared with NRS-2002, MST, MUST, and SNAQ) even with different cutoff points to detect nutrition risk, and showed significant association with prolonged length of hospital stay and mortality. This new tool was constructed employing a multivariate statistical model that takes into account the relevance and the impact of each variable to the risk of malnutrition. This approach is not frequently adopted in the construction of nutrition screening tools, although it is more appropriate in validating the adequacy of an instrument.[7] Furthermore, the NRE-2017 was constructed from questions encompassed in different nutrition screening and assessment tools which were categorized into 2 categories for ease of use.

Table 3. Selection of NRE-2017 Questions.

Question	Phase 1 RR (95% CI)	Phase 2 RR (95% CI)
1. Is the patient's age above 65 years old?	1.90 (1.53–2.36)	1.39 (1.16–1.68)
2. Does the patient have a high-stress disease?	1.92 (1.53–2.41)	1.33 (1.10–1.61)
3. Has the patient had reduction of functional capacity in the last 2 weeks?	1.68 (1.34–2.11)	0.97 (0.80–1.18)
4. Has the patient had diarrhea in the last 2 weeks?	1.63 (1.20–2.23)	1.05 (0.80–1.38)
5. Has the patient had vomiting in the last 2 weeks?	0.86 (0.64–1.15)	–
6. Has the patient had nausea in the last 2 weeks?	0.97 (0.76–1.23)	–
7. Has the patient had constipation in the last 2 weeks?	0.80 (0.58–1.09)	–
8. Has the patient reported decreased appetite in the last 2 weeks?	2.43 (1.93–3.06)	1.42 (1.16–1.73)
9. Has the patient reported changing of food consistency in the last 2 weeks?	2.52 (2.03–3.13)	1.34 (1.12–1.59)
10. Has the patient reported the use of nutrition supplements in the last month?	2.31 (1.64–3.26)	1.09 (0.81–1.45)
11. Has the patient had unintentional weight loss in the last 6 months?	4.72 (3.43–6.50)	2.46 (1.78–3.39)
12. Does the patient have signs of muscle mass loss according to the physical exam?	7.65 (5.35–10.94)	4.47 (3.04–6.57)
13. Does the patient have signs of subcutaneous fat loss according to the physical exam?	6.49 (4.68–9.01)	1.13 (0.93–1.37)

NRE-2017, Nutritional Risk in Emergency-2017; RR, relative risk.
Poisson regression with robust variance.
Nutrition risk according to NRS-2002 as dependent variable.

Table 4. Score for Each Question of NRE-2017.

NRE-2017 Questions	ß	ß × (6/10)	Score[a]
Constant	3.33	–	–
1. Is the patient's age above 65 years old?	0.33	0.2	0.25
2. Does the patient have a high-stress disease?	0.28	0.2	0.25
3. Has the patient reported decreased appetite in the last 2 weeks?	0.35	0.2	0.25
4. Has the patient reported changing of food consistency in the last 2 weeks?	0.29	0.2	0.25
5. Has the patient had unintentional weight loss in the last 6 months?	0.90	0.5	0.5
6. Does the patient have signs of muscle mass loss according to the physical exam?	1.49	0.9	1.0

Poisson regression with robust variance.
Nutrition risk according to Nutritional Risk Screening 2002 as dependent variable.
[a]Score was obtained by multiplying the ß coefficient by a constant that was based on the ratio between the number of questions with significant relative risk (RR) in the first phase and the number of questions with significant RR in the second phase of NRE-2017 (Nutritional Risk in Emergency-2017) construction (6/10). The obtained value was rounded.

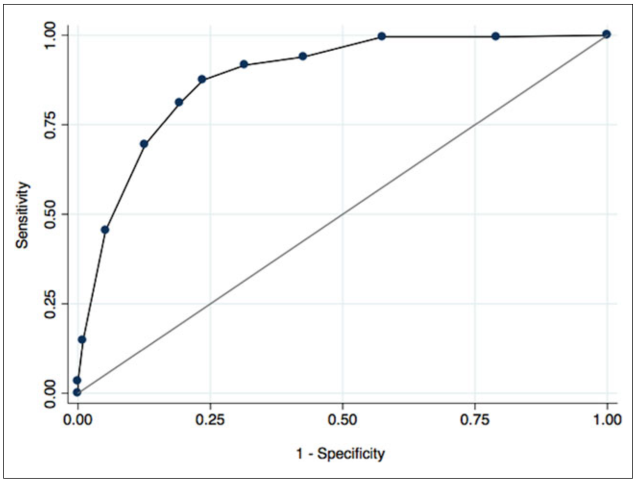

Figure 1. Receiver operating characteristic curve of nutrition risk according to Nutritional Risk in Emergency-2017 considering Nutritional Risk Screening 2002 as reference method.

Table 5. Concurrent Validity of NRE-2017.

	NRS-2002	MUST	MST	SNAQ
κ coefficient				
NRE-2017 ≥1.0 point	0.488	0.496	0.525	0.503
NRE-2017 ≥1.5 points	0.555	0.545	0.609	0.609
Sensitivity				
NRE-2017 ≥1.0 point	91.7%	83.7%	89.6%	91.6%
NRE-2017 ≥1.5 points	81.2%	79.2%	80.7%	84.1%
Specificity				
NRE-2017 ≥1.0 point	63.3%	69.6%	69.6%	68.0%
NRE-2017 ≥1.5 points	79.4%	81.8%	82.6%	81.4%
AUC ROC curve				
NRE-2017 ≥1.0 point	0.790 (0.760–0.822)	0.766 (0.736–0.796)	0.800 (0.768–0.823)	0.798 (0.771–0.825)
NRE-2017 ≥1.5 points	0.802 (0.771–0.834)	0.775 (0.743–0.806)	0.816 (0.786–0.846)	0.827 (0.798– 0.856)
Predictive positive value				
NRE-2017 ≥1.0 point	91.7%	83.7%	89.6%	91.6%
NRE-2017 ≥1.5 points	81.2%	73.2%	80.7%	84.1%
Predictive negative value				
NRE-2017 ≥1.0 point	67.3%	69.6%	69.6%	68.0%
NRE-2017 ≥1.5 points	79.4%	81.8%	82.6%	81.4%
Likelihood ratio				
NRE-2017 ≥1.0 point	11.1%	5.1%	8.6%	10.9%
NRE-2017 ≥1.5 points	6.9%	4.4%	6.7%	8.5%

AUC, area under the curve; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NRE-2017, Nutritional Risk in Emergency-2017; NRS-2002, Nutritional Risk Screening 2002; ROC, receiver operating characteristics; SNAQ, Short Nutrition Assessment Questionnaire.

Prevalence of nutrition risk detected by NRE-2017 ranged from 38% to 50% according to different cutoff points proposed (1.5 and 1.0, respectively), which was higher than the prevalence detected by other validated tools for nutrition screening (29.3%–37.1%). When it comes to choosing a screening tool, many issues must be taken into account, including the purpose of the tool (i.e., to identify the nutrition status and/or the need for a detailed nutrition assessment/intervention to predict clinical outcomes) and practical questions related to its implementation.[26] NRE-2017 was constructed and validated to be used in emergency rooms, where the early identification of risk of malnutrition and/or the need of specific nutrition interventions in a large number of individuals should be accomplished in a simplified and quick way. The highest cutoff (1.5 points) suggested for NRE-2017 identified a prevalence of nutrition risk similar to MUST, a screening tool originally designed both to establish nutrition risk and to detect the need for nutrition support.[10] On the other hand, the lowest cutoff (1.0 point) suggested for NRE-2017 showed a higher sensitivity, identifying a large number of individuals at risk of malnutrition, which was expected, but maybe not all of them require specific nutrition intervention. Thus, despite the need for further studies, the cutoff point for using the NRE-2017 in clinical practice may be chosen according to the population evaluated and the purpose of using the tool.

Many nutrition screening tools have been developed and validated in different settings.[4,27-34] Regarding emergency rooms, it has been suggested that a simplified instrument composed of 4 items (unintentional weight loss, dietary acceptance, clinical diagnosis, and gastrointestinal symptoms) may adequately identify individuals at risk of malnutrition and this proposed instrument showed an excellent agreement with SGA. (κ 0.80),[4] the reference method chosen for these analyses. However, SGA is not a widely accepted tool for nutrition screening,[24] and it was originally designed for diagnostic purposes.[21] Furthermore, in this study dietary acceptance was defined according to percentages (objective data), which adds a greater chance of errors in data collection.

To guide nutrition screening tool selection, both concurrent validity (the extent to which screening tools agree with each other) and predictive validity (the extent to which screening tools predict certain outcomes, such as length of hospital stay and mortality) must be considered.[26] NRE-2017 showed moderate to substantial concordance with commonly used nutrition screening tools (κ 0.488–0.609), similar to other nutrition tools previously validated in specific settings in which MUST was used as the gold standard.[27,28,32,34] Also, our new tool was able to detect the risk for VLHS and mortality linked to nutrition risk, thus showing good concurrent and predictive validities.

The lack of association with mortality in the lowest cutoff (NRE-2017 $\geq$1.0 point) may be due to the small number of individuals who died during hospitalization.

Anthropometric data, mainly actual weight and amount of kilograms lost, are necessary to perform many nutrition screening tools.[8,10,28,30,32-34] NRE-2017 was constructed and validated with the use of dichotomous variables ("yes" or "no") to be quickly used in settings were anthropometric data are not available or are difficult to obtain. Despite issues like the lack of practical and clinical experience[30] for performing physical examination and identifying the disease's metabolic stress, other nutrition screening tools validated and applied by non-dietitian nutritionists also included these features in their final scores,[33,34] such as NRE-2017. In the second phase of the construction of our new screening tool, the loss of muscle mass was the feature that was most strongly related to the risk of malnutrition according to NRS-2002, which does not include this issue among its items, showing independent association without collinearity regarding this variable. The logistic regression model has been used to select indicators for the development of nutrition screening tools.[30] However, we chose the Poisson regression model because our outcome (risk of malnutrition) showed prevalence higher than 10%, independent of the tool evaluated, and when the prevalence of the outcome is elevated or if the magnitude of the effect is also high, the odds ratio overestimates the risk, thus distorting the magnitude of the effect to be estimated.[35,36]

This study has some limitations. First, regarding derivation procedures and validation from existing methods, it was expected that NRE-2017 would show higher sensitivity and specificity because of the parameter adopted as reference standard (NRS-2002) and also because those used in the concurrent validation may have presented high collinearity with most of the final variables included in the mathematic model.[37] It should be noted that NRE-2017 was derived from features included in NRS-2002, MUST, MST, SNAQ, and SGA. However, all new tools are usually derived from at least some features included in the "classical" nutrition screening tools previously cited and used as gold standard, so the limitation of collinearity may be detected in general regarding the validation of new instruments. Second, only patients able to communicate and those whose information regarding weight and height were available were evaluated, and this does not represent the reality in many emergency rooms. Finally, NRE-2017 was constructed, developed, and validated in a generally lower socioeconomic status Brazilian population admitted to an emergency room of a tertiary public hospital; therefore, our results should be interpreted with caution regarding different populations. However, it is noteworthy that a large-sized sample was evaluated in our study, and we were able to design a simple nutrition screening tool composed of few dichotomic features and which can be quickly applied. Further studies are necessary to show whether professional non-dietitian nutritionists may also apply the NRE-2017 to confirm its reproducibility and to evaluate the time spent with this application to confirm that it is an easy-to-apply tool. In the absence of a universally accepted "gold standard" tool to detect the risk of malnutrition, hindering the validation of any new nutrition screening tool,[26,32] NRE-2017 was compared with NRS-2002 because NRS-2002 strongly predicted unfavorable clinical outcomes in a Brazilian hospitalized population when compared with other tools.[16]

Conclusions

NRE-2017 is a new, easy-to-apply nutrition screening tool that uses 6 features to detect the risk of malnutrition (advanced age, metabolic stress of the disease, decreased appetite, changing of food consistency, unintentional weight loss, and muscle mass loss) validated in an emergency room. It has a good concurrent validity compared with other currently available screening tools, and it showed a positive association with length of hospital stay and mortality. The use of NRE-2017 in other populations must be evaluated regarding its reliability and acceptance.

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Statement of Authorship

A. Marcadenti and F.M. Silva wrote the manuscript. F.M. Silva designed the study and analyzed the data. L.L. Mendes analyzed the data. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

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