Nutrition in Clinical Practice
Volume XX Number X
Month 201X 1–7
© 2017 American Society
for Parenteral and Enteral Nutrition
DOI: 10.1177/0884533617692527
journals.sagepub.com/home/ncp

Nutritional Risk Screening 2002, Short Nutritional Assessment Questionnaire, Malnutrition Screening Tool, and Malnutrition Universal Screening Tool Are Good Predictors of Nutrition Risk in an Emergency Service

Estela Iraci Rabito, PhD[1]; Aline Marcadenti, PhD[2,3]; Jaqueline da Silva Fink, PhD[4]; Luciane Figueira, RD[4]; and Flávia Moraes Silva, PhD[5]

Abstract

Background: There is an international consensus that nutrition screening be performed at the hospital; however, there is no "best tool" for screening of malnutrition risk in hospitalized patients. *Objective:* To evaluate (1) the accuracy of the MUST (Malnutrition Universal Screening Tool), MST (Malnutrition Screening Tool), and SNAQ (Short Nutritional Assessment Questionnaire) in comparison with the NRS-2002 (Nutritional Risk Screening 2002) to identify patients at risk of malnutrition and (2) the ability of these nutrition screening tools to predict morbidity and mortality. *Methods:* A specific questionnaire was administered to complete the 4 screening tools. Outcomes measures included length of hospital stay, transfer to the intensive care unit, presence of infection, and incidence of death. *Results*: A total of 752 patients were included. The nutrition risk was 29.3%, 37.1%, 33.6%, and 31.3% according to the NRS-2002, MUST, MST, and SNAQ, respectively. All screening tools showed satisfactory performance to identify patients at nutrition risk (area under the receiver operating characteristic curve between 0.765–0.808). Patients at nutrition risk showed higher risk of very long length of hospital stay as compared with those not at nutrition risk, independent of the tool applied (relative risk, 1.35–1.78). Increased risk of mortality (2.34 times) was detected by the MUST. *Conclusion:* The MUST, MST, and SNAQ share similar accuracy to the NRS-2002 in identifying risk of malnutrition, and all instruments were positively associated with very long hospital stay. In clinical practice, the 4 tools could be applied, and the choice for one of them should be made per the particularities of the service. (*Nutr Clin Pract*. xxxx;xx:xxx-xxx)

Keywords

nutrition screening; mortality; hospital length of stay; malnutrition; nutrition assessment; emergency treatment; inpatients

Malnutrition has been reported to be as high as 20%–50% among hospitalized patients.[1-3] Many of them are malnourished when admitted to the hospital, but for the majority of these patients, malnutrition further develops while they are there.[1] Malnutrition has profound effects on disease course and recovery.[4] Several clinical studies have linked malnutrition to higher morbidity, mortality, and risk of infection, as well as longer length of stay in the hospital and higher costs.[2,3,5] This could be prevented if special attention were paid to patients' nutrition care. However, the absence of one best and widely accepted screening system to detect patients who might benefit clinically from nutrition support is commonly seen as a major limiting factor for improvement in this scenario.[6]

The purpose of nutrition screening is to estimate the probability of a better or a worse outcome due to nutrition-related factors and whether nutrition therapy may influence this. According to the European Society for Clinical Nutrition and Metabolism, screening tools should embody 4 main issues:

- *What is the condition now?* Body mass index (BMI) is frequently adopted for this purpose.
- *Is the condition stable?* Weight loss is the most used parameter to predict nutrition deterioration.
- *Will the condition get worse?* This can be answered by asking the patient whether food intake has decreased, how much, and for how long.
- *Will the disease process accelerate nutrition deterioration?* Metabolic stress associated with severity of disease is frequently evaluated for this purpose.[6]

From the [1]Department of Nutrition and Postgraduate Program on Food and Nutrition, Universidade Federal do Paraná, Curitiba, Brazil; [2]Department of Nutrition, Universidade Federal de Ciências da Saúde de Porto Alegre, Porto Alegre, Brazil; [3]Postgraduate Program in Health Sciences: Cardiology, Instituto de Cardiologia / Fundação Universitária de Cardiologia do Rio Grande do Sul, Porto Alegre, Brazil; [4]Hospital Nossa Senhora da Conceição–Grupo Hospitalar Conceição, Porto Alegre, Brazil; and the [5]Department of Nutrition, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil.

Financial disclosure: None declared.

Conflicts of interest: None declared.

Corresponding Author:
Flávia Moraes Silva, PhD, Department of Nutrition, Universidade Federal de Minas Gerais, Av Alfredo Balena, 190, Santa Efigênia, Belo Horizonte, MG 30130-100, Brazil.
Email: flavia.moraes.silva@hotmail.com

There is an international consensus that nutrition screening be performed at hospital admission within the first 24–72 hours for all hospitalized patients. This is aimed to identify early patients at risk of malnutrition, to start an individualized nutrition support, and to minimize the development of malnutrition and its deleterious consequences.[6,7] It is important to reinforce the difference between nutrition screening and nutrition assessment. Nutrition screening is a process to identify an individual who is malnourished or who is at risk for malnutrition to determine if a detailed nutrition assessment is indicated.[8] According to the Academy of Nutrition and Dietetics, patients identified at risk for malnutrition must be submitted to an individualized nutrition assessment—that is the first step of the nutrition care process, and it comprises data regarding dietary history, detailed nutrient intake, anthropometric and biochemical measurements, physical and clinical conditions, physiologic and disease status, as well as functional and behavioral status. From the nutrition assessment, it is possible to determine the nutrition diagnosis (second step of nutrition care process) and set nutrition intervention (third step).[9] The Subjective Global Assessment (SGA) is a recognized method for nutrition assessment of hospitalized patients.[10] Parameters included in some screening tools are part of the SGA, so it allows for further investigation of screening test results.[8]

Several tools have been developed to screen hospitalized patients at nutrition risk, each one with advantages and disadvantages.[11-16] The Nutritional Risk Screening 2002 (NRS-2002), endorsed by the European Society for Clinical Nutrition and Metabolism, aims to screen patients at nutrition risk in the hospital setting.[6] A recent publication on the practical procedures for the detection and treatment of medical inpatients with or at risk for malnutrition based on validated guidelines supports the use of the NRS-2002 to identify patients at risk of malnutrition within 48 hours after hospital admission[17] and to determine those who would benefit from early nutrition therapy.[11,18] However, although it is rapidly administered, it requires trained healthcare workers, especially to evaluate food intake and metabolic requirements. The Malnutrition Universal Screening Tool (MUST) was developed by the British Association for Parenteral and Enteral Nutrition, and its purpose is to detect malnutrition based on nutrition status (body mass index [BMI] and weight loss) and disease-related dysfunction. It was primarily developed for use in community settings and then extended to other healthcare settings, including hospitals.[12] Other tools, such as the Malnutrition Screening Tool (MST) and the Short Nutritional Assessment Questionnaire (SNAQ), have been widely used in certain countries but less frequently worldwide. Developed by an Australian group, MST is a simple, quick, and valid tool consisting of 3 questions that can be completed by medical, nursing, dietetic, or administrative staff, as well as by family, friends, or the patients themselves on admission to the hospital.[13] The SNAQ was developed in the Netherlands, and it includes questions with regard to involuntary weight loss, loss of appetite, and recent use of supplemental drinks or tube feeding as the best indicators for malnutrition.[14] The Mini Nutritional Assessment (MNA) is composed of 2 groups of questions—1 to identify elderly patients at risk of malnutrition and 1 to determine the nutrition status of these patients.[15,16] Other studies have used the SGA as a screening tool for patients at risk of malnutrition[19-21]; however, the SGA is an accurate patient-centered tool that incorporates clinical history and physical examination, and it has been validated as a nutrition assessment tool.[22]

Despite several studies comparing different tools for nutrition screening,[19-21,23-26] there is no international consensus on a "best tool" for screening of malnutrition risk among hospitalized patients. Furthermore, few tools have been studied with respect to their ability to predict clinical outcomes such as morbidity, mortality, complications, or length of hospital stay (LOS).[21,25,26] As far as we know, only 1 Brazilian study with a large sample has evaluated 3 screening tools (MNA–Short Form, MUST, and NRS-2002). The authors considered the NRS-2002 the most effective tool to predict outcomes, with the largest area under the receiver operating characteristic curve as compared with the others.[23] Therefore, the aim of the current study was to evaluate (1) the accuracy of the MUST, MST, and SNAQ to identify patients at risk of malnutrition in comparison with the NRS-2002 and (2) the ability of these 4 screening nutrition tools in predicting morbidity and mortality.

Material and Methods

A prospective cohort study was carried out with patients admitted to the emergency service of a tertiary public hospital. The Ethics Committee of the hospital approved the protocol, and all patients gave their written informed consent. This research was conducted according to the guidelines established by the Declaration of Helsinki and the Brazilian resolution on ethical issues for studies involving human subjects.

The sample was randomly selected from all patients admitted to the emergency service between September 2013 and February 2015 within 48 hours of hospitalization. The inclusion criteria were as follows: patients aged ≥18 years who were conscious and able to move. The sample did not include pregnant women or those who had given birth less than a year before, those unable to talk or confused, and patients with lower limb amputation or bedridden status, because the anthropometric measurements could not be obtained.

Data were collected at the patients' bedsides by 3 trained researchers who administered a specific questionnaire and performed anthropometric measurements. Sociodemographic characteristics were collected, including sex, age, ethnicity, marital status, educational attainment, lifestyle, origin, and socioeconomic level. Hospital admission date, reason for admission, and medical history were obtained from electronic medical records.

Anthropometric measurements were obtained with patients wearing as little clothing as possible and no shoes. Height was measured in centimeters, with a 2-m stadiometer (Bodymeter

Table 1. Nutrition Screening Tools, Outcome Measures, and Nutrition Risk Criteria.

Features of Nutrition Risk	NRS-2002[8]	MUST[9]	MST[12]	SNAQ[13]
Body mass index	×	×		
Weight loss	×	×	×	×
Food/energy intake	×		×	×
Nutrition supplements				×
Severity of disease	×			
Acute disease effect		×		
Age	×			
Nutrition risk classification, points				
No risk	<3	0	<2	<2
At risk	≥3	≥1	≥2	≥2

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

206; Seca) at the nearest 0.1 cm. Patients stood barefoot, with the back straight, the arms hanging down, and the head straight, facing forward. BMI was calculated (weight / [height × height]) and expressed in kg/m^2. Usual body weight was obtained to calculate the percentage of weight loss ([usual body weight – current body weight] × 100/usual body weight). Nutrition parameters included history of anorexia, symptoms of nausea, vomiting, diarrhea, constipation, reduction of food intake, use of nutrition supplements, functional capacity, and weight loss in the prior 6 months. Metabolic demand and classification of disease stress, as proposed by the SGA, were also estimated.[22] Physical examination included loss of body fat, muscle mass deficit, and fluid accumulation (ankle edema and ascites), classified as *no*, *mild*, *moderate*, or *severe*.

Nutrition screening was performed with 4 tools: NRS-2002,[11] MUST,[12] MST,[13] and SNAQ,[14] which assessed the parameters described in Table 1. For patients at nutrition risk, we considered those classified as being at medium and high nutrition risk (≥2 points) according to the MUST[12] and those classified as moderately (≥2 points) and severely malnourished (>3 points) according to the SNAQ.[14] A questionnaire was developed to collect data on the redundant items across the 4 selected nutrition screening tools.

Other outcome measures included length of stay in emergency department (days), length of stay in the hospital (days), transfer to the intensive care unit, presence of infection during hospitalization (according to the medical records and complete blood count), and incidence of death. These outcomes were obtained from medical records of each participant. LOS was categorized as *intermediate* based on a median of 9 days or *very long* based on 16 days as the cutoff point.[23]

Statistical Analysis

The sample size was calculated with a computer program on the basis of a type I error of 5%, a type II error of 80%, and an incidence of death of 9.1% among patients classified as being at nutrition risk according to the NRS-2002 in a previous study conducted in Brazil.[23] The sample size was inflated by 20% to account for the potential loss of follow-up. Based on these assumptions, a sample size of 746 patients was required (http://www.openepi.com/Menu/OE_Menu.htm).

Agreement among nutrition screening tools was calculated by the kappa coefficient. Kappa varies from 0–1: a value <0.2 indicates poor agreement; 0.2–0.4, fair; 0.4–0.6, moderate; 0.6–0.8, substantial; and >0.8, almost perfect.[27] The accuracy of the MUST, MST, and SNAQ to predict nutrition risk, with the NRS-2002 as the reference method, was analyzed by sensitivity, specificity, and area under the receiver operating characteristic curve.

The association between nutrition risk assessed by the 4 screening tools and outcomes were evaluated by the chi-square test. LOS was categorized according to the cutoff point established in the literature as a very long LOS (≥16 days). Poisson regression with robust variance was performed to assess the relative risk of very long LOS among patients at risk of nutrition, adjusted for age and disease stress. Cox regression was conducted to assess the performance of different screening nutrition tools to predict mortality in hospitalized patients, with age, sex, and disease stress as confounders in the adjusted model.

Data are shown as mean ± SD (parametric variables) or median and interquartile range (nonparametric variables). Qualitative data are described as absolute and relative frequencies. Relative risk and hazard ratio are presented with 95% CIs. Data analyses were performed with SPSS 20.0, and *P* values <.05 were considered statistically significant.

Results

A total of 752 patients were included, with a mean age of 53.6 ± 15.5 years. Most of them were women (n = 410, 54.5%) and of white ethnicity. The median years of school completed was 8.0 (4.0–11.0); 23.1% were active smokers; and 5.6% reported frequently drinking alcoholic beverages. Most patients were married (n = 438, 58.2%) and came from the city of Porto Alegre (n = 373, 49.6%).

Their clinical and nutrition features are described in Table 2. The majority of patients were admitted to the hospital for gastrointestinal disorders (21.3%) or cancer (19.7%). Median unintentional weight loss in the 6 months prior to the hospital admission was 6.4% of usual weight, reported by half the participants; most of these patients also reported reduced food intake. Loss of muscle mass and subcutaneous fat was identified in 45.6% and 44.3% of patients, respectively, and ascites and ankle edema in 11.4% and 29.1%, respectively. Anorexia was reported by 39.6% (n = 298) of patients; diarrhea, 7.6% (n = 57); vomiting, 21.1% (n = 159); and nausea, 30.9% (n = 232).

The relative frequency of patients at nutrition risk was different among the screening tools: 29.3% of patients were at nutrition risk (n = 220) by the NRS-2002, 37.1% by the MUST,

Table 2. Clinical and Nutrition Characteristics of Participants (N = 752).

Characteristics	Descriptive Statistics[a]
Clinical characteristics	
Ward of admission	
Oncology	148 (19.7)
Gastroenterology	160 (21.3)
Neurology	59 (7.8)
Pulmonology	51 (6.8)
Nephrology	64 (8.5)
Cardiology	85 (11.3)
Surgery	41 (5.5)
Infectious diseases	34 (4.5)
Endocrinology	29 (3.9)
Others	81 (10.8)
Metabolic demand (stress)	
Mild	88 (11.7)
Moderate	352 (46.8)
High	306 (40.7)
Previous hospitalization (in the past 6 mo)	238 (31.7)
Length of hospital stay, d	9.0 (3.0–19.0)
Length of emergency stay, d	3.0 (2.0–5.0)
Transfer to intensive care unit	30 (4)
Infection	230 (30.6)
Death	28 (3.7)
Nutrition characteristics	
Current weight, kg	73.04 ± 17.75
Usual weight, kg	75.49 ± 17.28
Current height, cm	160.90 ± 10.47
Body mass index, kg/m^2	28.13 ± 6.39
Weight loss in the previous 6 mo, yes	379 (50.4)
kg	5.0 (2.0–9.0)
%	6.41 (3.02–11.89)

[a]Data are presented as No. (%), mean ± SD, or median (interquartile range).

33.6% (n = 253) by the MST, and 31.3% (n = 235) by the SNAQ. Based on the NRS-2002 as the reference method for nutrition screening, its agreement with the other tools to identify patients at nutrition risk was assessed. According to kappa coefficient and values of sensitivity, specificity, and accuracy, all instruments showed a moderate agreement with the NRS-2002 (kappa coefficient between 0.581–0.599) and a satisfactory performance to identify patients at nutrition risk (Table 3).

A summary of the association between the presence of nutrition risk according to nutrition risk screening tools and outcome measures is presented in Table 4. Relative frequency of infection during hospitalization did not differ between patients at nutrition risk and those who were not, regardless of the nutrition screening tool. However, the proportion of patients at nutrition risk with very long LOS (≥16 days) and the rate of mortality were higher as compared with patients who were not at nutrition risk. Difference in the proportion of patients transferred to the intensive care unit during hospitalization was detected between the MUST and MST.

Patients at risk of malnutrition had a higher risk of very long LOS than patients without nutrition risk, independent of the screening nutrition tool applied. Cox regression was conducted to analyze the performance of different screening nutrition tools to predict mortality in hospitalized patients. In the univariate analysis, the NRS-2002, MUST, and MST were able to demonstrate a significant association between nutrition risk and death (data not shown). However, when the analysis was adjusted for age, sex, and stress of disease, such an association was observed only by the MUST, which identified a 2.34-fold increase in the risk of mortality by the presence of nutrition risk (Table 5).

Discussion

In the current study, the performance of 3 screening tools to identify patients at nutrition risk was compared with that of the NRS-2002. All tools had good accuracy (>75%), and the MUST showed the highest sensitivity and specificity (>80%). In addition, the presence of nutrition risk detected by all instruments was positively associated with LOS: an increase of 5.4–6.6 days of hospitalization was observed among patients at nutrition risk. The MUST was the only nutrition screening tool able to predict the incidence of death: the hazard ratio for the mortality of patients at nutrition risk was 2.34 times greater than that for patients not at nutrition risk.

The highest and lowest prevalence rates of nutrition risk in the current study were identified from the MUST (37.1%) and NRS-2002 (29.4%), lower than those described by Kami et al, who found nutrition risk for 48.7% (NRS-2002) of the inpatients admitted to an emergency service in a Brazilian hospital.[28] Another study conducted in Brazilian hospitals detected similar proportions of patients at nutrition risk via the same instruments: 39.6% with the MUST and 27.1% with the NRS-2002 (27.1%).[23] In a cross-sectional study performed in Amsterdam, a similar prevalence for risk of malnutrition was identified by the SNAQ (33%) and MST (27%), and a higher prevalence was detected by the MUST criteria (44%) and NRS-2002 (38%).[24] Nutrition risk was prospectively determined by the MNA–Short Form, MUST, and NRS-2002 in a study conducted in Israel involving 215 elderly patients who underwent a hip fracture operation. The lowest prevalence of nutrition risk was observed with the MUST (20.4%), which was lower than that identified by the NRS-2002 (37.6%).[29] Differences in their results as compared with ours may be explained by the different age of the study populations. Velasco et al[20] conducted a multicentric study in 3 Spanish hospitals, including 400 inpatients, and evaluated the nutrition risk according to the NRS-2002, MUST, SGA, and MNA. The highest prevalence of malnutrition risk was detected by the SGA (58.5%), whereas similar prevalence was detected by the

Table 3. Agreement and Accuracy of the MUST, MST, and SNAQ in Relation to the NRS-2002.

Nutrition Screening Tool	Kappa (*P* Value)	Sensitivity, %	Specificity, %	Performance (ROC–AUC)
MUST	0.581 (<.001)	82.6	84.5	0.765 (0.723–0.808)
MST	0.592 (<.001)	76.8	84.7	0.808 (0.771–0.845)
SNAQ	0.599 (<.001)	73.2	87.4	0.802 (0.764–0.800)

AUC, area under the curve; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NRS-2002, Nutritional Risk Screening 2002; ROC, receiver operating characteristic; SNAQ, Short Nutritional Assessment Questionnaire.

Table 4. Association Between Presence of Nutrition Risk and Outcome Measures.[a]

Nutrition Screening Tool	Infection (n = 230)	Very Long Hospital Stay (n = 207)	Death (n = 28)
NRS-2002			
At risk	29.8	38.7	8.2
No risk	31.5	23.0	1.9
P value	.664	**<.001**	**<.001**
MUST			
At risk	32.1	42.6	10.2
No risk	30.6	23.9	2.0
P value	.770	**<.001**	**<.001**
MST			
At risk	32.7	40.5	7.9
No risk	30.0	21.5	1.6
P value	.501	**<.001**	**<.001**
SNAQ			
At risk	31.1	39.3	7.4
No risk	30.9	22.9	2.1
P value	.798	**<.001**	**.002**

MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NRS-2002, Nutritional Risk Screening 2002; SNAQ, Short Nutritional Assessment Questionnaire.
[a]Data analyzed by the chi-square test and presented as relative frequency (%). Bold indicates significance, $P < .05$.

Table 5. Risk of Mortality and Very Long LOS for Patients at Risk of Malnutrition.[a]

Nutrition Screening Tool	Mortality, HR (95% CI)	*P* Value[b]	Very Long LOS, RR (95% CI)	*P* Value[c]
NRS-2002	1.99 (0.89–4.45)	.091	1.54 (1.22–1.94)	<.001
MUST	2.34 (1.04–5.25)	.039	1.35 (1.19–1.53)	<.001
MST	2.01 (0.81–4.99)	.133	1.78 (1.43–2.21)	<.001
SNAQ	1.54 (0.67–3.52)	.306	1.63 (1.31–2.03)	<.001

HR, hazard ratio; LOS, length of hospital stay; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NRS-2002, Nutritional Risk Screening 2002; RR, relative risk; SNAQ, Short Nutritional Assessment Questionnaire.
[a]All analyses were adjusted for age, sex, and stress of disease.
[b]Cox regression.
[c]Poisson regression.

others tools (34.5%, 31.5%, and 35.3% according to the NRS-2002, MUST, and MNA, respectively).[20] All together, these data suggest a high prevalence (20%–50%) of patients at risk of malnutrition at hospital admission, without major discrepancies among the tools. Some discrepancies observed between the NRS-2002 and MUST in identifying patients at nutrition risk and regarding its prevalence may be partially explained by the cutoff of BMI, which is lower in the MUST tool[12] versus the NRS-2002.[11]

All screening tools evaluated in the current study had a moderate agreement with the NRS-2002 in identifying patients at risk of malnutrition, and the MUST demonstrated the highest sensitivity for predicting nutrition risk. In a multicentric study conducted in 3 Spanish hospitals, the MUST (kappa = 0.635) and NRS-2002 (kappa = 0.620) presented higher levels of agreement with the SGA than the MNA (kappa = 0.491), and the authors suggested that both the MUST and NRS-2002 could be used to identify malnutrition risk at hospital admission.[20] This is corroborated by an observational study involving 995 inpatients in Geneva, Switzerland, that evaluated the accuracy of different nutrition screening tools to predict the risk of malnutrition with the SGA as the reference method. The prevalence of malnutrition risk was 28% and 37% according to the NRS-2002 and MUST, respectively, and malnutrition was detected in 44% of patients according to the SGA. The sensitivity of the screening tools varied from 61%–62%, and the specificity was 93% and 76% for the NRS-2002 and MUST, respectively.[21] A cross-sectional study[24] conducted among a sample of 275 inpatients compared 5 nutrition screening tools with a preset definition of malnutrition that considered BMI and unintentional weight loss during the last month or the previous 6 months. The authors demonstrated that the MST and SNAQ are suitable for use in an inpatient setting because they performed as well as the MUST and NRS-2002 on criterion validity, with sensitivities and specificities ≥70%. However, the MNA–Short Form did not appear to be useful, owing to its low specificity. The MUST and NRS-2002 had the highest sensitivity values (96% and 92%, respectively).[24] Therefore, our findings agree with those reported in the literature demonstrating that the MUST, SNAQ, and MST have similar accuracy to the NRS-2002 in identifying patients at risk of malnutrition. Yet, our study differs from those reported in the literature because the SGA and MNA–Short Form were not included as nutrition screening tools. The SGA was not used for comparison in the current study, because it is more appropriate for nutrition assessment and, as far as we know, it is not validated to nutrition screening.[8,22] The MNA–Short Form was not included in the current study, because it is not a short and quick questionnaire and is not validated for older people.[15,16]

With respect to the ability of the nutrition screening tools to predict outcomes, we observed that, regardless of the screening tool, a higher proportion of patients at risk of malnutrition had a very long hospital stay in comparison with patients who were not at risk of malnutrition. In fact, patients at risk of malnutrition had an increase in hospital stay of 5.4–6.6 days. In the study by Raslan et al, the NRS-2002 was considered the most effective tool to predict a very long hospital stay. It is worth mentioning, though, that there is no difference between the MUST and NRS-2002 in the accuracy to predict hospital stay (61.97% vs 65.08%).[23] The risk of malnutrition assessed by the NRS-2002 and MUST in a study conducted with 682 patients in a Portuguese university hospital showed a similar validity between the methods in predicting the length of stay. The authors reported a significant association between nutrition risk identified by both the NRS-2002 and MUST and the probability of being discharged from the hospital.[23] Also, a prospective study conducted in London with 537 patients with stroke determined the ability of the MUST to predict poor outcomes after stroke. For those patients who survived, the median number of days spent in the hospital (in a follow-up of 6 months) was at least 3 times higher for patients at high risk of malnutrition as compared with patients at low risk of malnutrition, reinforcing the association between nutrition risk and LOS.[26]

Regarding mortality, the current study demonstrated an association between the risk of malnutrition and this outcome when only the MUST was applied, with a hazard ratio for death 2.38 times higher among patients at nutrition risk than those not at nutrition risk. Different results were found by Raslan et al, who reported that the accuracy of the MUST (75.83%) in predicting death was not different from that of the NRS-2002 (79.48%).[23] However, the authors did not evaluate the magnitude of such association, which makes the comparison between their findings and ours difficult. However, our results are in agreement with those demonstrated by Gomes et al in the study conducted with 537 patients with stroke: the relative frequencies of patients at medium and high risk of malnutrition were 7% and 29%, respectively, and there was a significant increase in mortality in a follow-up period of 6 months after stroke with the increase of risk of malnutrition: medium risk (hazard ratio, 3.51; 95% CI, 1.59–7.73) and high risk (hazard ratio, 5.60; 95% CI, 3.23–9.96).[26]

Our study has some limitations. The sample was composed of a large number of hospitalized patients with a wide range of age (including adults and elderly) and diseases. Furthermore, it was conducted in an emergency service of a public hospital: Patients are admitted to the hospital and stay for a couple of days (median, 3.0 days in our study), and this is where nutrition screening should be performed. However, since our sample included only patients who were conscious and able to move, our results cannot be extrapolated to all hospitalized patients. Furthermore, we can consider as a limitation the fact that we did not apply other screening tools in the current study. However, there is considerable variability in use of nutrition screen tools around the world, as demonstrated by Patel et al in a study that asked members of the American Society for Parenteral and Enteral Nutrition about which screening tools have been used in clinical practice.[30]

Considering our results and those reported by similar studies, we could conclude the following: (1) All nutrition risk tools evaluated in this study have good accuracy to identify risk of malnutrition. (2) Risk of malnutrition is an independent determinant of very long length of stay. (3) According to the MUST, the risk of malnutrition is associated with a higher chance of death. (4) The MUST, MST, SNAQ, and NRS-2002 are quick, easy-to-apply instruments that health professionals should consider in their clinical practice to identify which patients are at risk of malnutrition and will probably have a longer hospital stay. The particularities of each service will determine which tool is more appropriated. Independent of which tool is used, it is important that the nutrition risk screening be performed early (24–72 hours after hospital admission).

Conclusions

The nutrition screening tools MUST, MST, and SNAQ share similar accuracy to the NRS-2002 in identifying patients at risk of malnutrition. All instruments were positively associated with very long hospital stay, with an increase of 5.4–6.6 days of hospitalization among patients at nutrition risk. In clinical practice, health professionals can choose one of them to screen patients regarding nutrition risk when they are admitted at hospital, preferentially in the first 24–72 hours.

Author Contribution

F. M. Silva contributed to the conception and design of the study; F. M. Silva and A. Marcadenti contributed to the analysis; and F. M. Silva, J. S. Fink, E. I. Rabito, and L. Figueira drafted the manuscript. All authors contributed to the interpretation of the results, critically revised the manuscript, gave final approval, and agree to be accountable for all aspects of work ensuring integrity and accuracy.

References

1. McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. *BMJ*. 1994;308:945.
2. Waitzberg DL, Caiaffa WT, Correia MSTD. Hospital malnutrition: the Brazilian National Survey (IBRANUTRI). A study of 4000 patients. *Nutrition*. 2001;17:573-580.
3. Correia MSTD, Campos ACL; for the ELAN Cooperative Group. Prevalence of hospital malnutrition in Latin America: the Multicenter ELAN Study. *Nutrition*. 2003;19:823-825.
4. Felder S, Braun N, Stanga Z, et al. Unraveling the link between malnutrition and adverse clinical outcomes: association of acute and chronic malnutrition measures with blood biomarkers from different pathophysiological states. *Ann Nutr Metab*. 2016;68:164-172.

5. Lim SL, Ong KC, Chan YH, Loke WC, Ferguson M, Daniels L. Malnutrition and its impact on cost of hospitalization, length of stay, readmission and 3-year mortality. *Clin Nutr*. 2012;31:345-350.
6. Meyer R, Stratton R. Basic concepts in nutrition: epidemiology of malnutrition. *e-ESPEN Journal*. 2008;3:167-170.
7. Mueller C, Compher C, Ellen DM; and the American Society for Parenteral and Enteral Nutrition Board of Directors. ASPEN clinical guidelines: nutrition screening, assessment, and intervention in adults. *JPEN J Parenter Enteral Nutr*. 2011;35:16-24.
8. Charney P. Nutrition screening vs nutrition assessment: how do they differ? *Nutr Clin Pract*. 2008;28:366-372.
9. Lacey K, Pritchett E. Nutrition care process and model: ADA adopts road map to quality care and outcomes management. *J Am Diet Assoc*. 2003;103:1061-1072.
10. Da Silva Fink J, Daniel de Mello P, Daniel de Mello E. Subjective global assessment of nutritional status: a systematic review of the literature. *Clin Nutr*. 2015;34:785-792.
11. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z; ESPEN Working Group. Nutritional Risk Screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr*. 2003;22:321-336.
12. Stratton RJ, Hackston A, Longmore D, et al. Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the "Malnutrition Universal Screening Tool" ("MUST") for adults. *Brit J Nutr*. 2004;92:799-808.
13. Ferguson M, Capra S, Bauer J, Banks M. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. *Nutrition*. 1999;6:458-464.
14. Kruizenga HM, Seidell JC, de Vet HC, Wierdsma NJ, van Bokhorst-de van der Schueren MA. Development and validation of a hospital screening tool for malnutrition: the Short Nutritional Assessment Questionnaire (SNAQ). *Clin Nutr*. 2005;24:75-82.
15. Guigoz Y. The Mini Nutritional Assessment (MNA) review of the literature: what does it tell us? *J Nutr Health Aging*. 2006;10:466-487.
16. Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the Short-Form Mini-nutritional Assessment (MNA-SF). *J Geront*. 2001;56:366-377.
17. Bounoure L, Gomes F, Stanga Z, et al. Detection and treatment of medical inpatients with or at risk of malnutrition: suggested procedures based on validated guidelines. *Nutrition*. 2016;32:790-798.
18. Johasen N, Kondrup J, Plum LM, et al. Effect of nutrition support on clinical outcome in patients at nutritional risk. *Clin Nutr*. 2004;23:539-550.
19. Bauer JM, Vogl T, Wicklein S, Trögner J, Mühlberg W, Sieber CC. Comparison of the Mini Nutritional Assessment, Subjective Global Assessment and Nutritional Risk Screening (NRS 2002) for nutritional screening and assessment in geriatric hospital patients. *Z Gerontol Geriatr*. 2005;38:322-327.
20. Velasco C, García E, Rodríguez V, et al. Comparison of four nutritional screening tools to detect nutritional risk in hospitalized patients: a multicentre study. *Eur J Clin Nutr*. 2011;65:269-274.
21. Kyle UG, Kossovsky MP, Karsegarda VL, Picharda C. Comparison of tools for nutritional assessment and screening at hospital admission: a population study. *Clin Nutr*. 2006;25:409-417.
22. Detsky AS, McLaughlin JR, Baker JP, et al. What is subjective global assessment of nutritional status? *JPEN J Parenter Enteral Nutr*. 1987;11:8-13.
23. Raslan M, Gonzalez MC, Dias MCG, et al. Comparison of nutritional risk screening tools for predicting clinical outcomes in hospitalized patients. *Nutrition*. 2010;26:721-726.
24. Neelemaat F, Meijers J, Kruizenga H, van Ballegooijen H, van Bokhorst-de van der Schueren M. Comparison of five malnutrition screening tools in one hospital inpatient sample. *J Clin Nurs*. 2011;20:2144-2152.
25. Guerra RS, Fonseca I, Pichel F, Restivo MT, Amaral TF. Usefulness of six diagnostic and screening measures for undernutrition in predicting length of hospital stay: a comparative analysis. *J Acad Nutr Diet*. 2015;115:927-938.
26. Gomes F, Emery PW, Weekes CE. Risk of malnutrition is an independent predictor of mortality, length of hospital stay, and hospitalization costs in stroke patients. *J Stroke Cerebrovasc Dis*. 2016;25:799-780.
27. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33:159-174.
28. Kami AA, Fernandes R, Camargo CQ, et al. Nutrition risk screening in patients admitted to an emergency department of Brazilian university hospital [published online July 5, 2016]. *Nutr Clin Pract*.
29. Koren Hakin T, Weiss A, Hershkovitz A, et al. Comparing the adequacy of the MNA-SF, NRS-2002 and MUST nutritional tools in assessing malnutrition in hip fracture operated elderly patients. *Nutrition*. 2015;35:1053-1058.
30. Patel V, Romano M, Corkins MR, et al. Nutrition screening and assessment in hospitalized patients: a survey of current practice in the United States. *Nutr Clin Pract*. 2014;4:483-490.