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Comparison of nutritional risk screening tools for predicting clinical outcomes in hospitalized patients

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ABSTRACT

Objective: International nutritional screening tools are recommended for screening hospitalized patients for nutritional risk, but no tool has been specifically evaluated in the Brazilian population. The aim of this study was to identify the most appropriate nutritional screening tool for predicting unfavorable clinical outcomes in patients admitted to a Brazilian public university hospital.
Methods: The Nutritional Risk Screening 2002 (NRS 2002), Mini-Nutritional Assessment–Short Form (MNA-SF), and Malnutrition Universal Screening Tool (MUST) were administered to 705 patients within 48 h of hospital admission. Tool performance in predicting complications, hospital stay time, and death was analyzed using receiver operating characteristic curves.
Results: The NRS 2002, MUST, and MNA-SF identified nutritional risk in 27.9%, 39.6%, and 73.2% of patients, respectively. The NRS 2002 had the largest area under the receiver operating characteristic curve for predicting clinical outcomes (complications 0.6531, very long hospital stay 0.6508, death 0.7948) compared with the MNA-SF (complications 0.3505, very long hospital stay 0.3802, death 0.2417) and MUST (complications 0.6036, very long hospital stay 0.6109, death 0.6363). For elderly patients, the NRS 2002 performed better than the MNA-SF for predicting clinical outcomes (complications 0.6500 versus 0.3440, very long hospital stay 0.6317 versus 0.3552, death 0.7932 versus 0.1617).
Conclusion: The NRS 2002 was the best nutritional screening tool for predicting clinical outcomes in a Brazilian public university hospital.

Introduction

Disease-related malnutrition is present in 20–50% of hospitalized patients and may increase during the hospital stay [1–3]. In hospital settings, malnutrition can be addressed if patients are screened for nutritional risk using specific screening approaches and special nutritional care is provided within 72 h of hospital admission [4,5].

Although there are several nutritional screening tools available, there is still no consensus on which is the most recommended for screening hospitalized patients for nutritional risk [4,6–8]. In addition, different approaches have been validated and recommended by European and American societies and applied in Brazil, but none has been specifically evaluated in the Brazilian population.

The lack of a well-defined concept of "nutritional risk" and standardized screening methods makes it difficult to compare the available tests and their application. The most suitable nutritional screening tool for patients is the one that best predicts clinical outcomes during a hospital stay [9].

Few studies have looked at the association of nutritional risk and clinical outcomes [2,10–13]. Most have focused on specific groups, such as the elderly [14,15], patients with cancer [16], or those undergoing surgical treatment [5,9], but have rarely included clinical outcome measurements such as disease complications, death, and length of hospital stay.

The purpose of the present study was to determine whether the Nutritional Risk Screening 2002 (NRS 2002) [4], the Mini-Nutritional Assessment–Short Form (MNA-SF) [17], or the

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Malnutrition Universal Screening Tool (MUST) [18] was the most effective nutritional screening tool for predicting unfavorable clinical outcomes in Brazilian hospitalized patients.

Materials and methods

A prospective clinical study was conducted at the Central Institute (ICHC), the main hospital of the University of São Paulo Medical School (FMUSP), which is a tertiary general hospital with a 1200-bed capacity. After a consensus was reached among the study investigators, diseases requiring surgical treatment were classified according to the surgical procedure as minor, moderate, or major. Diseases requiring non-surgical treatment were classified as inflammatory and immunologic, infectious, endocrine-metabolic, cancer, and others.

There were 23 883 patients admitted to the ICHC from February to August 2007. The following patients were not included in the study: those <18 y old, pregnant and breast-feeding women, and those who could not be interviewed or provide informed consent (due to admission to an intensive care ward or emergency department, neurologic or psychiatric conditions, or the need for isolation). Of the remaining patients, one in every five consecutively admitted patients was systematically selected to participate in the study. When a selected patient was not able to participate or did not provide informed consent, the next patient in the list of consecutive admissions was selected. All study procedures were approved by the research ethics committee of the FMUSP gastroenterology department and the ethics committee for the Analysis of Research Projects (CAPPesq) of the Hospital das Clínicas board and FMUSP.

Body weight and height were measured using electronic scales with a stadiometer (Filizola, Toledo, Arja, Lucastec, and Welmy, São Paulo, Brazil) within 48 h of hospital admission. Self-reported recent weight loss was assessed in every patient. Weight loss ≥10% in the 6 mo before hospital admission was associated with length of hospital stay using Student's *t* test. Nutritional risk assessment was conducted by a single investigator (M. R.) using the following three screening tools: MNA-SF [17], NRS 2002 [4], and MUST [18]. After undergoing nutritional risk screening, all subjects were followed up clinically throughout their hospital stay until discharge or death by participating physicians who were members of a multidisciplinary nutrition support team (M. C., M. N., P. M., and S. S.). The total length of hospital stay, occurrence of infectious and non-infectious complications, and death (yes/no) were recorded for each subject. Complications were divided into groups according to the modified criteria of Buzby et al. [19] and classified according to severity as mild (cutaneous, catheter, and urinary infections; cellulitis; oral and esophageal candidiasis; lobar atelectasis; and infectious diarrhea), moderate (pulmonary infection; extra- and intra-abdominal abscesses; spontaneous bacterial peritonitis; venous thrombosis; liver dysfunction; cardiac arrhythmia; pancreatic or biliary gastrointestinal fistula; renal and congestive heart failure; wound dehiscence; gastrointestinal bleeding; decubitus ulcers; postoperative bleeding; and empyema), or severe (sepsis or bacteremia; septic shock; coagulopathy or septic coagulopathy; cholangitis; cardiac arrest; rejection of transplanted organ; respiratory failure; myocardial infarction; pancreatitis; osteomyelitis; and pulmonary embolism).

The MUST screening [18] normally provides three alternative scores for nutritional risk classification: 0 = low risk, 1 = intermediate risk, ≥2 = high risk. To facilitate result analysis and to allow comparison with the NRS 2002 and MNA-SF, the MUST scores were converted into two alternative scores: "nutritional risk" (≥1) and "no nutritional risk" (0). The length of hospital stay (in days) was classified as intermediate (0 to 15 d) or very long (≥16 d).

Receiver operating characteristic (ROC) curves were used for assessing the performance of the NRS 2002, MNA-SF, and MUST nutritional screening tools in predicting clinical outcomes of complications, length of hospital stay, and death [20]. The ROC curve analyses of length of hospital stay excluded the 24 patients who died during the study. The performance of the NRS 2002 and MNA-SF was also assessed in 169 patients ≥65 y old.

Agreement among the three screening tools was achieved using the κ-index of agreement. The results were interpreted as follows: <0, no agreement; 0 to 0.19, poor agreement; 0.20 to 0.39, fair agreement; 0.40 to 0.59, moderate agreement; 0.60 to 0.79, substantial agreement; and 0.80 to 1.00, almost perfect agreement [21].

The following software packages were used for statistical analyses: Medcalc 9.5.2.0 (MedCalc Software, Mariakerke, Belgium), R 2.8.0 (Vienna, Austria), SPSS 13.0 (SPSS Inc., Chicago, IL, USA), and STATA 9.1 (STATA Corp. LP, College Station, TX, USA). Results were reported as mean ± standard deviation at the 5% significance level.

Results

The characteristics of the 705 patients evaluated in this study are listed in Table 1. Of the 705 patients, 16.2% ($n = 114$) had lost ≥10% of their body weight in the 6 mo before hospital admission. The mean length of the hospital stay of those patients was 16.7 ± 17.8 d, longer than the mean 9.7 ± 12.5 d of hospitalization for patients who had not lost ≥10% of their body weight (Student's *t* test, $P < 0.0001$).

Table 1
Patient characteristics*

Evaluated data	Obtained value
Women	54.9 (387)
Age (y)	56.6 ± 15.3
Age ≥65 y	24 (169)
Average body weight	67 ± 16.8
Mean body mass index (kg/m^2)	25.2 ± 5.3
Mean weight loss in previous 6 mo (%)	7.5 ± 5.3
Non-surgical treatment	52.2 (368)
Cancer diagnosis	28.3 (104)
Inflammatory and immunologic diseases	27.4 (101)
Infectious disease	8.2 (30)
Endocrine/metabolic disease	6.5 (24)
Other medical conditions	29.6 (109)
Surgical treatment	47.8 (337)
Minor surgical procedures	57.3 (193)
Moderate surgical procedures	31.8 (107)
Major surgical procedures	11 (37)
Death†	3.4 (24)
Intermediate LOS	78.7 (555)
Very long LOS	21.3 (150)

LOS, length of hospital stay
* Values are percentages of subjects (numbers) or averages/means ± SDs.
† Disease progression caused 50% of the deaths, and septic shock and multiple organ failure caused all other deaths.

The nutritional risk rates differed depending on the screening tool used. The NRS 2002 identified 27.9% of patients to be at nutritional risk ($n = 197$), the MUST identified 39.6% ($n = 279$), and the MNA-SF identified 73.2% ($n = 516$). The κ-index showed agreements of 0.230 ($P < 0.001$, fair agreement) between NRS 2002 and MNA-SF and 0.519 ($P < 0.001$, moderate agreement) between NRS 2002 and MUST.

Of the 705 subjects studied, 16% ($n = 113$) had infectious or non-infectious complications. Of these, 55% ($n = 62$) had only one complication, 16.8% ($n = 19$) had two, 9.7% ($n = 11$) had three, 3.5% ($n = 4$) had four, 7.1% ($n = 8$) had five, 3.5% ($n = 4$) had six, and 4.4% ($n = 5$) had seven complications during hospitalization. In terms of complication severity, there were mild ($n = 73$), moderate ($n = 95$), and severe ($n = 80$) complications that were non-surgically treated in 58.4% (66) of cases, surgically treated in 15% (17) of cases, and non-surgically and surgically treated in 26.6% (30). Clinical outcome data are presented in Table 2 for the patients identified by the NRS 2002, MUST, and MNA-SF tools as being nutritionally at risk.

Comparison of the NRS 2002, MNA-SF, and MUST and their ability to predict unfavorable clinical outcomes showed that the NRS 2002 was the best screening tool (Fig. 1, Table 3). In the elderly, who comprised 24% ($n = 169$) of patients, the NRS 2002 identified 42% ($n = 71$) as being at nutritional risk, whereas the MNA-SF identified 72.8% ($n = 123$). The comparison between the NRS 2002 and MNA-SF in those patients revealed the area under ROC curve values for the NRS 2002 (0.6500, complications; 0.6317, very long hospital stay; 0.7932, death) and the MNA-SF (0.3440, complications; 0.3552, very long hospital stay; 0.1617, death). The comparison between the area under the ROC curve values for the NRS 2002 and MNA-SF showed that the NRS 2002 was the best screening tool for predicting complications, very long hospital stay, and death ($P \leq 0.0001$), even in elderly patients.

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Discussion

This study is the first to compare three nutritional screening tools that are commonly used in medical institutions worldwide. We evaluated the ability of the NRS 2002, MNA-SF, and MUST to predict unfavorable clinical outcomes (complications, very long hospital stay, and death) in a Brazilian patient population. It is one of the few studies to include hospitalized adult patients with a variety of conditions that were treated non-surgically and surgically. Furthermore, this is, to our knowledge, the first study to evaluate the effectiveness of these nutritional tools specifically in Brazilian patients.

To choose a screening tool for use in a hospital setting, it is helpful to verify its performance by comparing nutritional risk frequency with clinical outcomes [9]. The interpretation of nutritional marker predictor values is difficult. However, the desire to establish prediction measurements associated with nutritional status is not new: the association between nutritional status and increased morbidity/mortality in at-risk patients has been studied for years [19,22,23]. Recently, many studies have used nutritional screening and nutritional assessment tools to predict unfavorable clinical outcome, particularly length of hospital stay [2,10–13,24–26].

The association between nutritional status and length of hospital is not necessarily a causal relation; rather, the hospitalization period may be a reflection of the severity of the underlying disease. Malnutrition in a hospital setting cannot be considered an isolated problem [27]. It is worth noting that in our study, the patients (16.2%) who lost $\geq$10% of their body weight in the 6 mo before hospital admission were hospitalized significantly longer than patients who had not lost $\geq$10% of their body weight (Student's t test, $P < 0.0001$).

Our results are in agreement with results from the recent international multicenter EuroOOPS study involving 5,000 subjects that demonstrated an association between nutritional risk, as evaluated by the NRS 2002, and clinical outcome [28]. It is worth noting that in the present study, we not only tested the performance of the NRS 2002 (as in the EuroOOPS study) but also compared it with two other assessment tools in 705 hospitalized patients.

The three screening tools produced different nutritional risk results. The MNA-SF detected the highest risk prevalence in the entire study population (73.2%) and in the elderly (72.8%). These finding were similar to those reported by Persson et al. [15], who assessed 83 elderly patients in a geriatric hospital using the MNA-SF and found that 69% were at nutritional risk. In a study of 259 elderly patients in a university hospital, Feldblum et al. [14] found 81.5% to be at nutritional risk using the MNA-SF. Although the largest number of patients was found to be at nutritional risk using the MNA-SF in the present study, this tool did not perform well in predicting unfavorable clinical outcomes, indicating that the MNA-SF may overestimate nutritional risk. This may be because the MNA-SF was originally developed for use in the elderly [15], although some studies have applied the MNA-SF to a non-elderly adult population [8,27]. The high rates of nutritional risk indicated by the MNA-SF potentially could be due to its scoring system, which is based on six questions, the answers to which are graded as 0, 1, 2, or 3 points. Nutritional risk is indicated when the total sum is $\leq$11 points; therefore, the patient is considered without nutritional risk when the final score is $\geq$12 points. To reach a 12-point score, five answers must be favorable in terms of a patient's nutritional condition. In addition, the MNA-SF was designed to predict inadequate nutrition [27,29]. Unlike the MUST and NRS 2002, the MNA-SF does not take the effect of acute illness on nutritional status into account. We believe that the MNA-SF overestimates the contribution of psychological factors and changes in body weight to nutritional status. These may play a larger role in the nutritional status of elderly patients than in younger adult patients.

Because the MNA-SF was developed for the elderly, we compared its performance with that of the NRS 2002 in patients $\geq$65 y old. In this population, the NRS 2002 still predicted clinical outcomes better than the MNA-SF. In fact, the NRS 2002 does take advanced age into account: when a patient is >70 y old, 1 point is added to the tool's final score, which increases the risk classification [4,30].

The MUST did not perform well compared with the NRS 2002 in predicting unfavorable clinical outcomes. The MUST detected nutritional risk in 39.6% of patients. Another study found a similar nutritional risk by the MUST (44% in hospitalized patients) [31]. Notably, the MUST systematically classifies patients with an acute condition as being at high nutritional risk, whereas chronic conditions are not classified according to their severity. As a result, this tool tends to overestimate high nutritional risk and underestimate intermediate nutritional risk [26].

Of the three screening tools in the present study, the NRS 2002 best predicted unfavorable clinical outcomes despite finding the lowest rate of nutritional risk (27.9%). Our findings corroborate those of a study by Kyle et al. [26], who examined long hospital stays in 995 hospitalized patients and found that the NRS 2002 had higher specificity in screening for nutritional risk compared with other nutritional screening tools, including the MUST [26]. In our study, approximately 8% ($n = 25$) of 193 patients not considered to have severe disease impact, i.e., patients hospitalized in the otorhinolaryngology, ophthalmology, urology surgery, laparoscopic surgery, or plastic surgery departments, were diagnosed as being nutritionally at risk. We believe that despite their diagnoses, this population may reflect the nutritionally at-risk basal state rate of patients admitted to the Hospital das Clínicas.

Using the NRS 2002, Amaral et al. [2] and Bauer et al. [11] reported a higher nutritional risk rate (42% and 40.3%, respectively) and greater sensitivity than we found in the present study. Given that elderly patients are at increased nutritional risk [4], the higher risk rates found in those two studies may be due to the slightly older patient populations: the mean ages were 67.4 y [2] and >65 y [11] compared with 56.6 y (present study).

Others have observed that a good nutritional screening tool must take into account changes in food intake and metabolic stress to detect acute nutritional changes [12,32]. It is worth noting that the NRS 2002 considers a patient's disease severity

Table 2
Clinical outcome data of patients identified by the NRS 2002, MUST, and MNA-SF nutritional assessment tools as being nutritionally at risk

Patient characteristic/outcome	Tool used for nutritional assessment		
	NRS 2002, % (n)	MUST, % (n)	MNA-SF, % (n)
Nutritionally at risk	27.9 (197)	39.6 (279)	73.2 (516)
Complications	29.9 (59)	22.2 (62)	18.6 (96)
No complications	70.1 (138)	77.8 (217)	81.4 (420)
Death	9.1 (18)	5 (14)	4.5 (23)
No death	90.1 (179)	95 (265)	95.5 (493)
Intermediate LOS ($\leq$15 d)	63.4 (125)	71.3 (199)	75.8 (391)
Very long LOS (>15 d)	36.6 (72)	28.7 (80)	24.2 (125)

LOS, length of hospital stay; MNA-SF, Mini-Nutritional Assessment–Short Form; MUST, Malnutrition Universal Screening Tool; NRS 2002, Nutritional Risk Screening 2002

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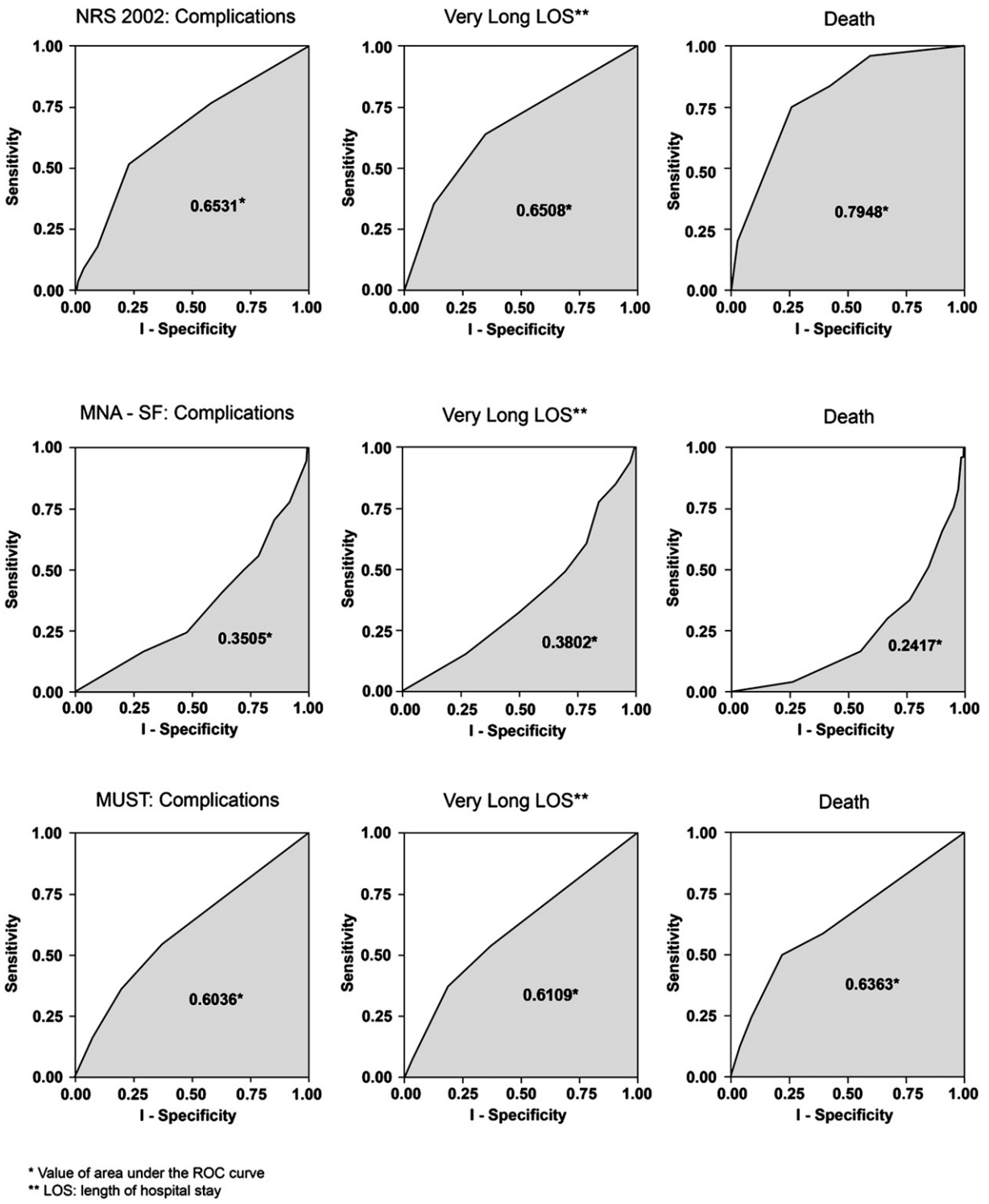

Fig. 1. Nutritional screening tools and clinical outcomes. The most effective tool in predicting unfavorable clinical outcomes is that with the largest area under the receiver operating characteristic curve (*). LOS, length of hospital stay; MNA-SF, Mini-Nutritional Assessment–Short Form; MUST, Malnutrition Universal Screening Tool; NRS 2002, Nutritional Risk Screening 2002.

and changes in food intake in the week before hospital admission. The higher specificity and sensitivity of the NRS 2002 compared with the MUST and MNA-SF may thus be due to the fact that the NRS 2002 takes into consideration the effect a disease may have on a patient's nutritional state.

Our study may have limitations due to its exclusion criteria. We excluded patients <18 y old because our aim was to evaluate nutritional screening tool performance in an adult population. Children and pregnant and breast-feeding women require specific nutritional assessment. Patients admitted directly to an

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Table 3
Clinical outcomes and area under ROC curve values of the three nutritional screening tools according to evaluated outcomes

Screening tool	Clinical outcome (area under ROC curve)		
	Complications	Very long LOS*	Death
NRS 2002	0.6531†‡	0.6508†‡	0.7948†‡
MUST	0.6036§	0.6109§	0.6363§
MNA-SF	0.3505	0.3802	0.2417

LOS, length of hospital stay; MNA-SF, Mini-Nutritional Assessment–Short Form; MUST, Malnutrition Universal Screening Tool; NRS 2002, Nutritional Risk Screening 2002; ROC, receiver operating characteristic

* Only performed for the 681 surviving patients. All comparisons among screening tests were significant ($P < 0.05$).

† NRS 2002 versus MNA-SF.

‡ NRS 2002 versus MUST.

§ MNA-SF versus MUST.

intensive care or trauma unit were not part of the present study because most could not be interviewed. Our primary aim was to screen hospitalized adult patients at admission. In addition, the screening tools can be used only when a patient is able to communicate or when there is a family member who can answer the interviewer's questions.

The NRS 2002 is a remarkably powerful nutritional screening tool: it is rapid, easy to administer, and does not require highly trained health care workers. Although we did not systematically measure this, it took our researcher 4 to 5 min to administer the MNA-SF, 2 to 3 min to administer the NRS 2002, and <2 min to administer the MUST, a shorter and simpler instrument. The NRS 2002 is thus an objective, modern instrument that was developed for hospital settings and is recommended by the European Society of Parenteral and Enteral Nutrition.

Conclusion

The NRS 2002 is a better nutritional screening tool than the MUST and MNA-SF for predicting hospital morbidity and mortality. Our findings support its use in hospitalized Brazilian adults. We recommend routine administration of the NRS 2002 nutritional screening tool to all adult patients on hospital admission.

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