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Comparison of 4 Nutritional Screening Tools to Detect Nutritional Risk in Hospitalized Patients. A Multicentre Study

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Running title: Comparison of nutritional screening tools

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ABSTRACT

Background

The prevalence of malnutrition in hospitals is high. No nutritional screening tool is considered the gold standard for identifying nutritional risk. The aims of this study were to evaluate nutritional risk in hospitalized patients using 4 nutritional screening tools.

Methods

Four nutritional screening tools were evaluated: Nutritional Risk Screening (NRS-2002), the Malnutrition Universal Screening Tool (MUST), the Subjective Global Assessment (SGA), and the Mini Nutritional Assessment (MNA). Patients were assessed within the first 36 hours after hospital admission. Date of admission, diagnosis, complications, and date of discharge were collected. To compare the tools, the results were reorganized into: patients at risk and patients with a good nutritional status. The statistical analysis included the $\chi^2$ test to assess differences between the tests and the $\kappa$ statistic to assess agreement between the tests.

Results

The study sample comprised 400 patients (159 F, 241 M), mean age 67.3 (16.1) years. The prevalence of patients at nutritional risk with the NRS-2002, MUST, SGA, and MNA was 34.5%, 31.5%, 35.3%, and 58.5%, respectively. Statistically significant differences were observed between the 4 nutritional screening tools ($p<0.001$). The agreement between the tools was quite good except for the MNA (MNA-SGA $\kappa=0.491$, NRS-2002-SGA $\kappa=0.620$ and MUST-SGA $\kappa=0.635$)

Patients at nutritional risk developed more complications during admission and had an increased length of stay.

Conclusions
The prevalence of nutritional risk in hospitalized patients was high with all the tools used. The best agreement between the tools was for NRS-2002 with SGA and MUST with SGA. At admission, NRS-2002 and MUST should be used to screen for nutritional status.

**KEY WORDS**

Nutritional screening tools, nutritional risk, hospital admission.
INTRODUCTION

Malnutrition is still an important problem in hospitals, and its prevalence among hospitalized patients ranges from 10% to 60% (von Bokhorst-de van der Schueren et al., 2004; Valero et al., 2005; Cereceda et al., 2003; Edington et al., 2000; Bruun et al. 1999; Waitzberg et al., 2001) depending on the population, pathology, and test used. These rates increase during admission as a result of adverse hospital routines that lead to insufficient intake (Dupertuis et al., 2003) and of the anorexia these patients present (Kondrup et al., 2002).

Malnutrition has been associated with complications such as higher rates of infection, increased length of stay, and increased morbidity and mortality (Sorensen J et al., 2008; Norman et al., 2008). The increased energy requirements due to disease-associated stress produce a negative energy balance, which also plays a role in malnutrition.

Nutritional intervention (dietary counselling, oral nutritional supplements, enteral nutrition, and parenteral nutrition) has a positive effect on outcome (Stanga et al., 2007; Odelli et al., 2005; O’Flynn et al., 2005) by reducing complication rates, length of stay, and costs of admission (Kruizenga et al., 2005; Elia et al., 2005).

Malnutrition has to be identified before it can be treated. According to Resolution ResAp (2003)3 of the Council of Europe on food and nutritional care in hospitals (Council of Europe, 2003), the nutritional risk of all patients should be routinely assessed either prior to or at admission, so that a nutritional intervention can be prepared. This assessment should be repeated regularly (the intervals will depend on the level of nutritional risk) during the stay.

There is neither a universally accepted definition of malnutrition, nor a screening tool accepted as the gold-standard to detect patients at risk of malnutrition. A screening tool
needs to be simple, easy to use, and patient-friendly (Green et al., 2005). Over 70 nutritional screening tools have been described in different populations (Green et al., 2006), but they present differences in validity, reliability, ease of use, and acceptability (Elia et al., 2005). Most screening tools are based on variables such as recent weight loss, food intake, body mass index, and severity of disease.

The aim of this study was to compare different screening tools to determine the prevalence of nutritional risk in hospitalized patients.
METHODS

Three university hospitals participated in this observational multicentre study; 2 included patients admitted to the internal medicine and surgery departments and the third included patients admitted to the internal medicine department only.

Patients were randomly selected from the hospital admission register using a random number generator. Each hospital decided how many patients were to be included daily based on the maximum number of patients that could reasonably be followed by staff, the admission rate, and the average length of stay. The exclusion criteria were same-day surgery, chronic haemodialysis, 1-day admission, terminal care, and age less than 18 years.

Patients were evaluated within the first 36 hours after admission. The data collected from patients’ records were date of admission, sex, height, weight, presence of oedema, and diagnosis. All patients were monitored daily during admission. Infectious and non-infectious complications and date of discharge were recorded. Complications were categorised according to definitions given by Buzby 1988 and Gaynes 1999.

Patients were weighed and measured when possible; if not, patients gave their own estimation of weight and height.

Nutritional risk was evaluated using 4 nutritional screening tools: the Subjective Global Assessment (SGA), recommended by ASPEN (American Society for Parenteral and Enteral Nutrition); the Malnutrition Universal Screening Tool (MUST), recommended by BAPEN (British Association for Parenteral and Enteral Nutrition); the Nutrition Risk Screening-2002 (NRS-2002), recommended by ESPEN (The European Society for Clinical Nutrition and Metabolism); and the Mini Nutritional Assessment (MNA), recommended by ESPEN for the elderly. All the evaluations were performed by the same investigator at each hospital.
Nutritional Screening Tools

NRS-2002

The NRS-2002 (Kondrup et al., 2002) consists of a nutritional score based on weight loss, food intake, body mass index (BMI) (1-3 points), a severity of disease score (1-3 points), and an age adjustment for patients aged >70 years (+1 point). Patients are classified as no risk (≤3) or as nutritional risk (>3).

MUST

The MUST (Malnutrition Advisory Group, 2000) examines 3 independent criteria: weight, unintentional weight loss, and presence of acute disease. Each parameter is scored as 0, 1, or 2. Patients are classified as low-risk (0), medium-risk (1), and high-risk (≥2).

MNA

The MNA (Vellas et al., 1999) is a tool used to evaluate the nutritional status of the elderly. It is composed of 18 items that cover anthropometric variables (weight, height, and weight loss), general variables (lifestyle, medication, and mobility), dietary variables (number of meals, food and fluid intake), and autonomy of eating (self-perception of health and nutrition). Patients are classified as having a good nutritional status (≥24 points), nutritional risk (17 to 23.5 points), or poor nutritional status (<17 points).

SGA
The SGA (Detsky et al., 1987) is a questionnaire covering the patient’s history (weight loss, changes in food intake, gastrointestinal symptoms, functional capacity, and underlying diseases), physical examination (muscle, subcutaneous fat, oedema, ascites), and the clinician’s overall judgement of the patient’s status. Patients are classified as follows: A, well nourished; B, suspected malnourished; and C, severely malnourished.

**Statistical Analysis**

The results are expressed as mean (standard deviation). Categorical variables are expressed as a percentage. MUST, MNA, and SGA classify patients into 3 categories. To compare the tools, the results were reorganized into 2 variables: at nutritional risk (MUST, medium risk and high risk; MNA, at nutritional risk and poor nutritional status; and SGA, suspected malnourished and severely malnourished) and good nutritional status (MUST, low risk; MNA, good nutritional status; and SGA, well nourished).

SGA was considered the gold standard for evaluation of sensitivity, specificity, and predictive values for tools. The κ statistic was calculated to measure agreement between tools (STAT 509. Design and Analysis of Clinical Trials), and the Shrout classification (Shrout, 1998) was used to interpret the κ values as follows: 0-0.1, virtually none; 0.11-0.4, slight; 0.41-0.6, fair; 0.61-0.8, moderate; and 0.81-1, substantial. ROC curves were used to measure the accuracy of the nutritional screening tools.

The χ² test was used to compare differences between the screening tools and complications. The Mann-Whitney test was used to analyse length of stay (LOS).

The local ethics committee was informed that the study was to be undertaken and all patients gave their informed consent to participate in the study. Statistical significance was set at p≤0.05. Data were analyzed using the statistical package SPSS (SPSS Inc, Chicago, IL, USA), version 12.0 for Windows.
RESULTS

The study sample comprised 400 patients (159 F, 241 M), with a mean age of 67.4 (16.1) years and a mean BMI of 26.3 (5.5) kg/m² from February 2005 to June 2005. Sixty-six percent were admitted to the internal medicine department and 34% to the surgery department. The mean LOS was 10.6 (8.7) days.

The main diagnoses were pneumonia (12%), uncompensated heart failure (11%), chronic obstructive pulmonary disease (9.8%), major and minor abdominal surgery (9.6%), other types of surgery (12.5%), solid tumour (7%), neurological vascular disease (6%), and other medical diagnoses (11.5%).

Nearly 34% of patients reported an important decrease in energy intake during the week before admission.

All patients were evaluated with the 4 nutritional screening tools. The prevalence of patients at nutritional risk according to the different tools was as follows: NRS-2002 (at risk, 34.5%), MUST (medium risk, 14%; high risk, 17.5%), MNA (at nutritional risk, 44%; poor nutritional status, 14.5%), and SGA (suspected malnourished, 28.5%; severely malnourished, 6.8%).

For purposes of comparison, the results were reorganized into 2 categories: patients at nutritional risk and patients with good nutritional status (Table 1). The differences between the 4 nutritional screening tools were statistically significant (p<0.001, χ² test).

Reasonable agreement was observed between the tools (Table 2). Area under the curve (AUC) for each test was: NRS-2002 0.809, MUST 0.810 and MNA 0.782. Specificity with MUST and NRS-2002 was high (90.3% and 87.2%, respectively), but they showed lower sensitivity (71.6% and 74.4%, respectively). MNA had a poor specificity (61.3%) and a high sensitivity (95%) (Table 3).
NRS-2002, MNA, and SGA showed statistically significant differences when results were stratified by age; patients over 65 years had a greater nutritional risk (Figure 1). Statistically significant differences were observed in the prevalence of nutritional risk depending on the admission department (p<0.001) (Figure 1b).

Sensitivity, specificity, positive predicted value (PPV) and negative predicted value (NPV) were calculated of each test according to age and hospital setting (Table 4).

Patients at nutritional risk developed more complications than those with a good nutritional status. These results were statistically significant with all the screening tools (NRS-2002 21.7% vs 5.7%, p<0.001; MUST 15.8% vs 9.1%, p=0.047; MNA 14.1% vs 7.2%, p=0.032; SGA 19.1% vs 6.9%, p<0.001).

There was a significant association between LOS and patients at nutritional risk with all the screening tools (p<0.001) (Table 5).
DISCUSSION

Nutritional screening is the first step in the design of a nutritional plan during admission. The World Health Organization describes screening as a simple test to identify individuals who have disease but do not have symptoms. In 2002, ESPEN defined nutrition screening as a rapid and simple process conducted by admitting staff to identify individuals at risk for malnutrition (Kondrup et al., 2002). It is important to distinguish this from the nutritional assessment that provides the clinician additional data on patient nutritional status through a detailed examination of metabolic, nutritional, or functional variables by an expert clinician, dietician, or nutrition nurse (Kondrup et al., 2002).

Four nutritional screening tests were evaluated to determine their appropriateness for hospitalized patients.

Our results are consistent with the high prevalence of malnutrition found in hospitalized patients in other studies (von Bokhorst-de van der Schueren et al., 2004; Valero et al., 2005; Cereceda et al., 2003; Edington et al., 2000; Bruun et al. 1999; Waitzberg et al., 2001). The prevalence observed varied between 31.5% and 58.5% depending on the tool used. The 4 nutritional screening tools showed statistically significant differences in the classification of patients as at nutritional risk.

Other authors showed similar results. Kyle et al (Kyle et al., 2006) compared the SGA, Nutrition Risk Index (NRI), MUST, and NRS-2002 in 995 hospitalized patients and found statistically significant differences between the tools (39%, 25%, 37%, and 28% of patients at nutritional risk, respectively). Bauer et al (Bauer et al., 2005) studied the prevalence of malnutrition in geriatric hospital patients by comparing MNA, SGA, and NRS. MNA revealed that 70% of patients were malnourished, a percentage that is higher than SGA (45%) and NRS (40%). In our study, MNA detected nearly 60% of
patients at nutritional risk or with poor nutritional status. MNA is a complex test that was developed to assess elderly individuals and takes into account factors that can confuse the real rates of malnutrition; therefore, it is only suitable for certain age groups and diseases.

Our results revealed better agreement between the tools than did those of other studies (Kyle et al., 2006). Moderate agreement was observed between NRS-2002 and MUST with SGA (κ statistic, 0.620 and 0.635, respectively). Thus, MNA showed fair agreement with SGA (κ statistic, 0.491).

The objective of nutritional screening is to identify accurately those patients who are malnourished or at nutritional risk and who could benefit from nutritional treatment. Good nutritional screening should be highly sensitive and specific (Anthony, 2008). In the present study, NRS-2002 and MUST showed higher specificity than MNA; therefore, non-malnourished patients were classified as not being at nutritional risk. MNA showed a high sensitivity, which means that patients at nutritional risk were correctly identified. MNA showed a lower specificity than NRS-2002 and MUST. Kyle (Kyle et al., 2006) found that NRS-2002 was more sensitive (62%) and specific (93%) than MUST (61% and 76%, respectively). NRS-2002 and MUST had good positive and negative predictive values.

All the screening tools identified more elderly patients at nutritional risk. This difference is particularly relevant with NRS-2002, as this tool has an age adjustment for patients over 70 years. Although the results were stratified by age, MNA detected more patients at nutritional risk than the other tools.

Vidal et al (Vidal et al., 2008) found no differences in the prevalence of malnutrition in medical and surgical wards. However, in our study, a lower prevalence was found in surgical patients than in medical patients with all the nutritional screening tools except
MNA. This low prevalence may be because most of these patients were admitted to hospital for elective surgery.

For elderly patients, MNA showed the highest sensitivity (98.1%) but the specificity was quite low (56.8%). NRS-2002 and MUST showed good sensibility and specificity. For surgical patients, MNA was more sensitive (89.3%) and specific (83.3%) than NRS-2002 and MUST.

Patients at risk presented more complications during admission. Several studies have demonstrated the effect of nutritional status on the development of complications and early readmissions (Sorensen et al., 2008; Lobo et al., 2009; Ozkalkanli et al., 2009). LOS in patients at nutritional risk was longer than in patients with good nutritional status. Several authors have found similar results (Sorensen et al., 2008, de Luis et al., 2006).

Our study suggests that NRS-2002, MUST, and SGA can be used to screen nutritional risk at admission. NRS-2002 and MUST can be completed in a few minutes, unlike MNA, which is the most time-consuming tool (more than 10 minutes). Examiner training may be necessary to improve competency before using SGA properly. NRS-2002 and MUST are more rapid and require less examiner training than the SGA and MNA.

In conclusion, this study shows a high prevalence of nutritional risk in hospitalized patients with all the nutritional screening tools applied. MNA detected more patients at nutritional risk than the other tools. The best agreement between the tools was for NRS-2002 and MUST with for SGA. At admission, NRS-2002 and MUST should be used to screen nutritional status.
Acknowledgements

The authors are grateful to Thomas O’Boyle for editorial assistance. The study was performed without funding. The authors declare no conflicts of interest.
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TABLES

Table 1. Nutritional status

<table>
<thead>
<tr>
<th>Test</th>
<th>At nutritional risk</th>
<th>Good nutritional status</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRS-2002</td>
<td>34.5%</td>
<td>65.5%</td>
</tr>
<tr>
<td>MUST</td>
<td>31.5%</td>
<td>68.5%</td>
</tr>
<tr>
<td>SGA</td>
<td>35.3%</td>
<td>64.7%</td>
</tr>
<tr>
<td>MNA</td>
<td>58.5%</td>
<td>41.5%</td>
</tr>
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</table>
Table 2. Agreement between the screening tools

<table>
<thead>
<tr>
<th></th>
<th>Agreement (%)</th>
<th>( \kappa ) statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUST-MNA</td>
<td>56.6%</td>
<td>0.388</td>
</tr>
<tr>
<td>MNA-SGA</td>
<td>64.1%</td>
<td>0.491</td>
</tr>
<tr>
<td>MNA- NRS-2002</td>
<td>68.1%</td>
<td>0.392</td>
</tr>
<tr>
<td>MUST-SGA</td>
<td>75.3%</td>
<td>0.635</td>
</tr>
<tr>
<td>MUST- NRS-2002</td>
<td>78.1%</td>
<td>0.503</td>
</tr>
<tr>
<td>NRS-2002-SGA</td>
<td>82.8%</td>
<td>0.620</td>
</tr>
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</table>
Table 3. Sensitivity, specificity, and predictive values of the nutritional risk screening tools

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRS-2002</td>
<td>74.4% (66.9-82)</td>
<td>87.2% (83-91.5)</td>
<td>76.1% (68.6-83.5)</td>
<td>86.2% (81.9-90.6)</td>
</tr>
<tr>
<td>MUST</td>
<td>71.6% (63.8-79.4)</td>
<td>90.3% (86.5-94.1)</td>
<td>80.1% (72.8-87.5)</td>
<td>85.4% (81-89.7)</td>
</tr>
<tr>
<td>MNA</td>
<td>95% (91.1-98.9)</td>
<td>61.3% (55.2-67.5)</td>
<td>57.2% (50.7-63.8)</td>
<td>95.7% (92.2-99.1)</td>
</tr>
</tbody>
</table>

*Values are shown with their 95% confidence intervals.

PPV: positive predictive value

NPV: negative predictive value
Table 4. Sensitivity, specificity, and predictive values of the nutritional risk screening tools stratified by age and hospital setting\textsuperscript{b}

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
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<tr>
<td></td>
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<tr>
<td>&lt; 65 years</td>
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<tr>
<td>NRS-2002</td>
<td>59.4% (40.8-77.9)</td>
<td>95.5% (90.7-100)</td>
<td>82.6% (64.9-100)</td>
<td>86.8% (79.7-94)</td>
</tr>
<tr>
<td>MUST</td>
<td>68.75% (51.1-86.3)</td>
<td>88.9% (81.8-95.7)</td>
<td>68.7% (51.1-86.3)</td>
<td>88.9% (81.8-95.7)</td>
</tr>
<tr>
<td>MNA</td>
<td>84.4% (70.2-98.5)</td>
<td>70% (59.9-80)</td>
<td>50% (35-7-64.2)</td>
<td>92.6% (85.7-99.5)</td>
</tr>
<tr>
<td>&gt; 65 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRS-2002</td>
<td>78.9% (70.8-87)</td>
<td>82.8% (76.8-88.8)</td>
<td>74.7% (66.4-83.1)</td>
<td>85.9% (80.2-91.5)</td>
</tr>
<tr>
<td>MUST</td>
<td>72.5% (63.6-81.3)</td>
<td>91.1% (86.5-95.7)</td>
<td>84% (76.1-91.9)</td>
<td>83.7% (78.1-89.3)</td>
</tr>
<tr>
<td>MNA</td>
<td>98.1% (85.2-100)</td>
<td>56.8% (49-64.5)</td>
<td>59.4% (51.9-66.9)</td>
<td>97.9% (94.6-100)</td>
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<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
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<tr>
<td>Internal Medicine</td>
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<tr>
<td>NRS-2002</td>
<td>77.8% (69.8-85.9)</td>
<td>80.8% (74.2-87.4)</td>
<td>75.2% (66.9-83.4)</td>
<td>82.9% (76.6-89.4)</td>
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<tr>
<td>MUST</td>
<td>72.5% (63.9-81.2)</td>
<td>87.4% (81.8-93)</td>
<td>81.2% (73.1-89.3)</td>
<td>80.9% (70.6-87.3)</td>
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<tr>
<td>MNA</td>
<td>94.6% (92.6-100)</td>
<td>45.7% (37.4-53.9)</td>
<td>57.1% (49.8-64.3)</td>
<td>94.5% (88.6-100)</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
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<tr>
<td>Surgery</td>
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<tr>
<td>NRS-2002</td>
<td>60.7% (40.8-80.6)</td>
<td>96.3% (92.3-100)</td>
<td>80.9% (61.8-100)</td>
<td>90.4% (84.6-96.2)</td>
</tr>
<tr>
<td>MUST</td>
<td>67.8% (48.7-86.9)</td>
<td>94.4% (89.6-99.2)</td>
<td>76% (57.2-94.7)</td>
<td>91.9% (86.3-97.4)</td>
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<tr>
<td>MNA</td>
<td>89.3% (76-100)</td>
<td>83.3% (75.8-90.8)</td>
<td>58.1% (42.2-74)</td>
<td>96.7% (92.6-100)</td>
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</tbody>
</table>

\textsuperscript{b}Values are shown with their 95% confidence intervals.

PPV: positive predictive value

NPV: negative predictive value
Table 5. Differences in length of stay (days)\textsuperscript{a}

<table>
<thead>
<tr>
<th></th>
<th>Patients not at risk</th>
<th>Patients at risk</th>
<th>p (Mann-Whitney test)</th>
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<tbody>
<tr>
<td>NRS-2002</td>
<td>8.9 (7.9)</td>
<td>13.7 (9.5)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>MUST</td>
<td>9.2 (7.8)</td>
<td>13.6 (9.8)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>MNA</td>
<td>8.1 (7.1)</td>
<td>12.4 (9.3)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>SGA</td>
<td>8.8 (7.7)</td>
<td>13.7 (9.7)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Values are expressed as the mean (SD)