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ORIGINAL ARTICLE

Comparison of five malnutrition screening tools in one hospital inpatient sample

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Aims and objectives. The purpose of this study is to compared five commonly used malnutrition screening tools against an acknowledged definition of malnutrition in one hospital inpatient sample.

Background. Early identification and intervention of malnutrition in hospital patients may prevent later complications. Several screening tools have reported their diagnostic accuracy, but the criterion validity of these tools is unknown.

Design. A cross sectional study.

Methods. We compared quick-and easy screening tools [Malnutrition Screening Tool (MST), Short Nutritional Assessment Questionnaire (SNAQ) and Mini-Nutritional Assessment Short Form (MNA-SF)] and more comprehensive malnutrition screening tools [Malnutrition Universal Screening Tool (MUST) and Nutritional Risk Screening 2002 (NRS-2002)] to an acknowledged definition of malnutrition (including low Body Mass Index and unintentional weight loss) in one sample of 275 adult hospital inpatients. Sensitivity, specificity, positive predictive value and negative predictive value were determined. A sensitivity and specificity of ≥70% was set as a prerequisite for adequate performance of a screening tool.

Results. According to the acknowledged definition of malnutrition 5% of patients were at moderate risk of malnutrition and 25% were at severe risk. The comprehensive malnutrition screening tools (MUST, NRS-2002) and the quick-and-easy malnutrition screening tools (MST and SNAQ) showed sensitivities and specificities of ≥70%. However, 47% of data were missing on the MUST questionnaire and 41% were missing on MNA-SF. The MNA-SF showed excellent sensitivity, but poor specificity for the older subpopulation.

Conclusions. The quick-and-easy malnutrition screening tools (MST and SNAQ) are suitable for use in an hospital inpatient setting. They performed as well as the comprehensive malnutrition screening tools (MUST and NRS-2002) on criterion validity. However, MUST was found to be less applicable due to the high rate of missing values. The MNA-SF appeared to be not useful because of it low specificity.

Relevance to clinical practice. Insight in what is the most valid and practical nutritional screening tool to use in hospital practice will increase effective recognition and treatment of malnutrition.

Key words: malnutrition, nurses, nursing, nutrition, older people, screening

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Introduction

Background

Prevalence of disease-related malnutrition in hospital inpatients varies from 25–40% (Edington *et al.* 2000, Kelly *et al.* 2000, Corish & Kennedy 2001, Kyle *et al.* 2003). Many studies have demonstrated the negative consequences of malnutrition on morbidity and mortality (Green 1999, Humphreys *et al.* 2002, Correia & Waitzberg 2003, Pichard *et al.* 2004, Kyle *et al.* 2005, Norman *et al.* 2008). However, the recognition and treatment of malnutrition in inpatients often still fails (Kruizenga *et al.* 2005a,b). In the absence of formal screening procedures, more than half the patients at risk of malnutrition in various settings are not identified and/or referred for treatment (Kruizenga *et al.* 2005a,b) The lack of a widely accepted malnutrition screening tool for detecting patients at risk of malnutrition is frequently seen as a factor that hinders both effective recognition and treatment. Kruizenga *et al.* pointed out that using a screening instrument at the time of hospital admission may improve the recognition of malnourished patients from 50–80% and that early screening and treatment may reduce the length of the hospital stay (Kruizenga *et al.* 2005a,b).

To perform adequate nutritional screening, selecting a uniform and validated screening tool is clearly an important issue. Even though no gold standard exists (Meijers *et al.* 2010), low Body Mass Index (BMI, kg/m^2) and unintentional weight loss are often used criteria in defining patients' nutritional status. The BMI mortality curves suggest that for the general adult population, a cut-off point of BMI $<18{\cdot}5$ kg/m^2 is associated with increased mortality (FAO/WHO/UNU, 1985, Detsky *et al.* 1994, Kruizenga *et al.* 2003, 2005a,b, Pablo *et al.* 2003, Stratton *et al.* 2003, 2003). For older patients, given their changes in body composition, a cut-off point of BMI <20 kg/m^2 is considered to be more appropriate (FAO/WHO/UNU, 1985, Beck & Ovesen 1998, 1999, Omran & Morley 2000, Volkert *et al.* 2006). A low BMI indicates chronic malnutrition, whereas unintentional weight loss indicates a more acute deterioration of nutritional status. To facilitate early identification of malnutrition, nutritional screening tools have been developed over the past years.

Malnutrition screening tools can be divided into quick-and-easy screening tools and more comprehensive screening tools. Quick-and-easy screening tools are developed for nurses to screen the nutritional status in a quick and easy way. These tools consist of questions that are most predictive of malnutrition. However, after positive screening, further assessment of nutritional status by a professional is necessary.

In a recent review (Van Venrooij *et al.* 2007), the Malnutrition Screening Tool (MST) (Ferguson *et al.* 1999) and Short Nutritional Assessment Questionnaire (SNAQ) (Kruizenga *et al.* 2005a,b) were selected the two most accurate and applicable quick-and-easy tools readily available for employing in the general hospital inpatient population. Comprehensive screening tools require more time and skills from nurses because of measuring weight and height, calculating BMI and percentage unintentional weight loss and evaluating disease severity.

Both Malnutrition Universal Screening Tool (MUST) (Elia 2003) and NRS-2002 (Nutritional Risk Screening 2002) (Kondrup *et al.* 2003b) are recommended by the European Society for Clinical Nutrition and Metabolism (ESPEN) for the hospital setting (Kondrup *et al.* 2003a, Kyle *et al.* 2006). For older patients, the Mini-Nutritional Assessment Short Form (MNA-SF) (Rubenstein *et al.* 2001) is the tool recommended by ESPEN.

Until now no consensus has been reached on the best malnutrition screening tool to identify hospitalised patients at risk of malnutrition. Various studies have pointed out different proportions of patients at risk of malnutrition. The use of a diversity of screening tools can be an explanation for the wide range of findings. Applying different tools hampers the comparison of malnutrition prevalences between different settings, patients groups and countries.

Objective

This study compares comprehensive screening tools (MUST, NRS 2002) and quick-and-easy malnutrition screening tools (MST, SNAQ and MNA-SF) to an often used definition of malnutrition – low BMI and unintentional weight loss – in one hospital inpatient sample. The performance of these five measures was assessed on their criterion validity and the estimated risk of malnutrition.

Methods

Research design and patients

On 4 April 2006, all adult inpatients (≥18 years of age) admitted to the VU University Medical Center, were asked to participate in the annual Dutch National Prevalence Measurement of Care Problems (LPZ), which is a cross sectional screening including disease-related malnutrition (Meijers *et al.* 2008).

Patients were excluded from participation if it was impossible to weigh them, if they were pregnant, demented, unconscious, clinically unstable or if they had insufficient knowledge of the Dutch language. Patients suffering from oedema or dehydration were also excluded because of expected unreliable data on actual weight. We defined patients of 60 years or older as being an older patient. A couple of a trained nurse and a trained dietician measured each patient using quick-and-easy malnutrition screening tools (MST, SNAQ and MNA-SF) and comprehensive malnutrition screening tools (MUST and NRS 2002). The study design was in accordance with the Declaration of Helsinki and was approved by the institutional review board of VU University Medical Center.

Nutritional status

Nutritional status was measured similar to daily practice: we weighed all patients (wearing light indoor clothes and no shoes) on a calibrated scale (SECA 880, in kilograms to the nearest decimal). Patients were also asked to report their usual weight (one, three and six months ago) and height. If patients did not know their height it was measured (SECA 220, in centimetres to the nearest decimal). If patients reported to have lost weight we asked whether the weight loss was unintentional. On the basis of these data we defined our definition of malnutrition:

Patients were defined at severe risk of malnutrition when the following conditions were present: BMI $<18{\cdot}5$ kg/m^2, unintentional weight loss of more than 5% during the last month or unintentional weight loss of more than 10% during the last six months. Patients were defined at moderate risk of malnutrition with 5–10% unintentional weight loss during the last six months, independent of BMI. For older patients (≥60) a cut-off point for BMI $<20{\cdot}0$ kg/m^2 was applied (FAO/WHO/UNU, 1985, Detsky *et al.* 1994, Kruizenga *et al.* 2003, Stratton *et al.* 2003).

Prevalence of risk of malnutrition

The prevalence of risk of malnutrition was measured by using the pre-set definition of malnutrition, but also by using five malnutrition screening tools: MNA-SF, MST, MUST, NRS-2002 and SNAQ.

Criterion validity

The study population was categorized into three groups, based on the pre-set definition of malnutrition as described above: not at risk of malnutrition, at moderate risk of malnutrition and at severe risk of malnutrition. The criterion validity of the screening tools was determined by comparing the score of each of the five tools with the mentioned pre-set definition of malnutrition. As MST, NRS-2002 and MNA-SF consist of only two categories (not at risk of malnutrition and at risk of malnutrition) and MUST and SNAQ of three categories (not at risk of malnutrition, at moderate risk of malnutrition and at severe risk of malnutrition), – two comparisons were made – (1) patients not at risk of malnutrition and patients at moderate risk of malnutrition vs. patients at severe risk of malnutrition and (2) patients not at risk of malnutrition vs. patients at moderate risk and severe risk of malnutrition.

The MNA-SF was performed only in the sample of older (>60 years) patients, because the tool has been developed for this population only. The sensitivity, specificity, positive predictive value and negative predictive value were determined. Sensitivity represents the probability (0–100%) that the screening tool correctly identifies moderately and severely malnourished patients. Specificity represents the probability (0–100%) that the screening tool score correctly identifies well nourished patients. Positive predictive value (0–100%) represents the probability that a patient with a screening tool score for moderate or severe malnutrition is indeed malnourished according to the mentioned definition of malnutrition. Negative predictive value (0–100%) represents the probability that a patient with a screening tool score for well nutrition is indeed well nourished according to the pre-set definition of malnutrition.

The cut-off points of the diagnostic values are: 90–100% excellent; 80–90% good; 70–80% fair; 60–70% insufficient and 50–60% poor (The Academical Point System, http://gim.unmc.edu/dx/tests). A sensitivity and specificity of 70% was set as a prerequisite for adequate performance of a screening tool.

Statistical methods

Data were checked for the presence of possible outliers, but these were absent in this database. Standard descriptive statistical methods were used to express means, standard deviations, percentages, frequencies and minimum and maximum values. Differences in gender between the three groups were tested by chi-square tests. ANOVA with *post hoc* analysis using the Tukey method, was used for continuous variables. p-Values were based on two-sided tests, a $p < 0{\cdot}05$ being considered to indicate statistical significance.

Cross-tabulations were used to present sensitivity, specificity and positive and negative predictive values, as described in the previous section. A 95% confidence interval was assessed. All analyses were performed for the group as a total and for the subpopulation of older patients separately. Statistical analyses were performed using the SPSS-system for Windows, version 16.0 (SPSS, Chicago, IL, USA) and StatXAct4 for Windows, version 4.0.1 (Cytel Software Corporation, Cambridge, MA, USA).

Results

In this study 275 patients participated, of whom 171 (62%) were 60 years and older. The nutritional status according to the pre-set definition of malnutrition could be determined for 205 patients (75%). Seventy patients had incomplete data: on weight (n = 24), height (n = 27), weight loss during the last month (n = 62) and/or weight loss during the last six months (n = 66). Screening tools were complete for minimum n = 168 (61%) (MUST) to maximum n = 198 (72%) (NRS-2002 and SNAQ) patients. Within MUST, especially questions on disease severity were missing. In the older subpopulation the preset definition of malnutrition could be determined in 129 patients (75%) and data for MNA-SF were complete for 101 patients (59%).

According to the pre-set definition of malnutrition 70% of the study population was not at risk of malnutrition, 5% was at moderate risk of malnutrition and 25% was at severe risk of malnutrition. The prevalence of malnutrition risk in the sample of older patients (≥60 years of age) did not differ from these figures. Figure 1 shows the prevalence of malnutrition scores according to the five malnutrition screening tools. The MNA-SF score was only determined in the sample of older patients (n = 171). The MUST and NRS-2002 demonstrate the highest percentage of patients at risk of malnutrition and the MST the lowest percentage of patients at risk of malnutrition. For all tools the prevalence of malnutrition risk in the total group was not different from the prevalence of malnutrition risk in the sample of older patients (data not shown).

There were no differences in age between malnutrition risk categories. BMI was significantly lower in the group of patients at severe risk of malnutrition vs. the patients not at risk of malnutrition and the group of patients at moderate risk of malnutrition. (Table 1). Table 2 shows the sensitivities, specificities, positive and negative predictive values of the quick- and-easy malnutrition screening tools. Table 3 shows the sensitivities, specificities, positive and negative predictive values of the comprehensive malnutrition screening tools.

All results are split up according to the two comparisons: (1) patients not at risk of malnutrition and patient at moderate risk of malnutrition vs. patients at severe risk of malnutrition; (2) patients not at risk of malnutrition vs. patients at moderate risk and at severe risk of malnutrition. The overall results reveal that the malnutrition screening tools MST, MUST, NRS-2002 and SNAQ all show sensitivities and specificities of at least 70% when comparing the patients at moderate or severe risk of malnutrition vs. patients not at risk of malnutrition. When combining 'not at risk' with 'at moderate risk' and comparing this with 'at severe risk' sensitivities and specificities of SNAQ dropped just below 70%. The MNA-SF had a sensitivity of 100%, but specificity was only around 40%.

Discussion

This study compares the malnutrition screening tools MST, MUST, NRS-2002, SNAQ and MNA-SF in one hospital inpatients sample. Criterion validity of MST, MUST, NRS-2002 and SNAQ seems to be adequate for screening malnutrition in hospital inpatient. In contrast, we consider MNA-SF not suitable for older hospital inpatients because of its very poor specificity and positive predictive value. According to the pre-set definition of malnutrition 70% of all admitted patients were considered not to be at risk of malnutrition, 5% at moderate risk of malnourished and 25% at severe risk of malnutrition. This is in line with previous studies (Edington *et al.* 2000, Kelly *et al.* 2000, Corish &

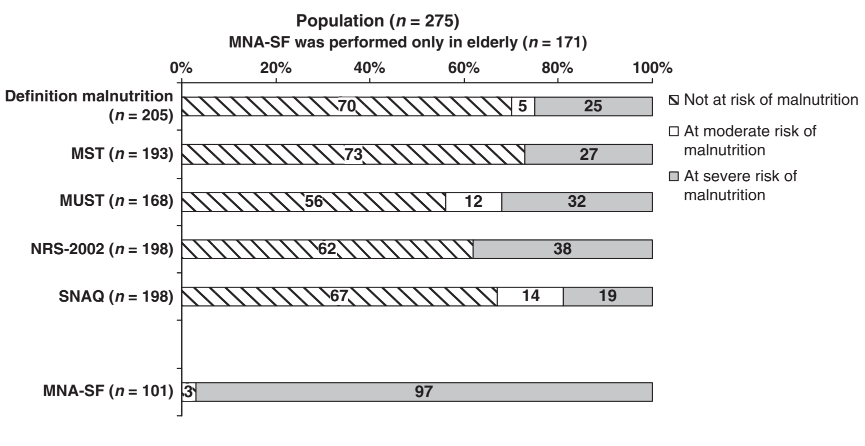

Figure 1 Prevalence of risk of malnutrition using the pre-set definition and five malnutrition screening tools.

Table 1 Characteristics of well nourished, moderately malnourished and severely malnourished patients applying the commonly used definition of malnutrition

	Not at risk of malnutrition	At moderate risk of malnutrition	At severe risk of malnutrition	*p*-value
All patients *n* (%) *n* = 205	144 (70)	10 (5)	51 (25)	–
Sex, % woman	47	60	53	0·612*
Age in years (±SD)	63 (±15)	62 (±15)	62 (±20)	0·822†
BMI in kg/m^2 (±SD)	26·0 (±4·0)	26·8 (±5·8)	20·7 (±4·7)	<0·001†
Elderly *n* (%) *n* = 129	91 (70)	6 (5)	32 (25)	–
Sex, % woman	38	50	56	0·198*
Age in years (±SD)	73 (±8)	71 (±9)	75 (±11)	0·392†
BMI in kg/m^2 (±SD)	26·5 (±3·9)	26·5 (±2·6)	20·8 (±4·6)	<0·001†

BMI, Body Mass Index.
*Chi-square.
†ANOVA.
p-value and Tukey significance level: 0·05.

Table 2 Accuracies (95% CI) of the quick-and-easy malnutrition screening tools MST and SNAQ

	All patients		Older patients	
	MST (*n* = 193)	SNAQ (*n* = 198)	MST (*n* = 123)	SNAQ (*n* = 125)
Characteristics of all patients and older patients (≥60) (not at risk of malnutrition and at moderate risk of malnutrition) vs. (at severe risk of malnutrition)				
Sensitivity	76 (66–84)	68 (58–77)	74 (64–82)	63 (53–72)
Specificity	90 (82–95)	97 (91–99)	88 (80–94)	96 (90–99)
Positive predictive value	71 (61–80)	87 (79–93)	68 (58–77)	83 (74–90)
Negative predictive value	92 (85–96)	91 (84–96)	91 (84–96)	89 (81–94)
Characteristics of all patients and older patients (≥60) (not at risk of malnutrition) vs. (at moderate risk of malnutrition and at severe risk of malnutrition)				
Sensitivity	78 (69–86)	75 (65–83)	78 (69–86)	72 (62–81)
Specificity	96 (90–99)	84 (75–91)	94 (87–98)	83 (74–90)
Positive predictive value	89 (81–94)	66 (56–75)	85 (76–91)	63 (53–72)
Negative predictive value	91 (84–96)	90 (82–95)	91 (84–96)	88 (80–94)

MST, Malnutrition Screening Tool; SNAQ, Short Nutritional Assessment Questionnaire.

Table 3 Accuracies (95% CI) of the diagnostic malnutrition screening tools MUST, NRS-2002 and MNA-SF

	All patients		Older patients		
	MUST (*n* = 168)	NRS-2002 (*n* = 198)	MUST (*n* = 103)	NRS-2002 (*n* = 126)	MNA-SF (*n* = 91)
Characteristics of all patients and older patients (≥60) (not at risk of malnutrition and at moderate risk of malnutrition) vs. and at severe risk of malnutrition)					
Sensitivity	73 (63–81)	94 (87–98)	67 (57–76)	94 (87–98)	100 (96–100)
Specificity	82 (73–89)	80 (71–87)	82 (73–89)	79 (70–87)	39 (29–49)
Positive predictive value	58 (48–68)	62 (52–72)	56 (46–66)	60 (50–70)	37 (28–47)
Negative predictive value	89 (81–94)	98 (93–100)	87 (79–93)	97 (91–99)	100 (96–100)
Characteristics of all patients and older patients (≥60) (not at risk of malnutrition) vs. (at moderate risk of malnutrition and at severe risk of malnutrition)					
Sensitivity	96 (90–99)	92 (85–96)	97 (91–99)	92 (85–96)	100 (96–100)
Specificity	80 (71–87)	85 (76–91)	79 (70–87)	83 (74–90)	41 (31–51)
Positive predictive value	69 (59–78)	72 (62–81)	68 (58–77)	70 (60–79)	42 (32–52)
Negative predictive value	98 (93–100)	96 (90–99)	98 (93–100)	96 (90–99)	100 (96–100)

MNA-SF, Mini-Nutritional Assessment Short Form; MUST, Malnutrition Universal Screening Tool; NRS-2002, Nutritional Risk Screening 2002.

Kennedy 2001, Kyle *et al.* 2003). We, therefore, assume that this hospital inpatient population is representative for other hospital populations.

Until now, only a few earlier studies had compared different screening tools: NRS-2002, Subjective Global Assessment (SGA), MNA-SF, MUST and Nutritional Risk Index (NRI) (Kyle *et al.* 2006, Raslan *et al.* 2009). In contrast to our study, these studies did not use an objective measure of nutritional status as a reference tool, but another screening tool (nutritional assessment tool named SGA) or nutritional unfavorable clinical outcomes like death and length of stay. Kyle's study showed lower sensitivities and specificities than ours which might be explained by the different reference tool. NRS-2002 was found to have higher sensitivities (62%) and specificities (93%) than MUST (sensitivity 61%, specificity 76%) and NRI (sensitivity 43%, specificity 89%), compared with SGA. Moreover, Raslan *et al.* pointed out that NRS 2002 was the best yield for predicting unfavourable clinical outcomes. Quick-and-easy tools were not applied in Kyle's and Raslan's study. A comparison of quick-and-easy malnutrition screening tools vs. comprehensive tools was therefore not possible. The additional value of Kyle's and Raslan's study is that the authors studied the relation between outcome of screening and unfavourable outcomes like length of hospital stay. We omitted to do so because of the cross-sectional character of our study, which was part of a larger study. Concerning MUST, Raslan's study moreover pointed out that the MUST systematically categorises patients with an acute state as being at high nutritional risk, whereas chronic conditions are not categorized according to their severity.

In our study, the definition of risk categories of malnutrition may have influenced the results. MNA-SF, MST and NRS-2002 categorise patients into two categories of nutritional status: not at risk of malnutrition and at risk of malnutrition. However, MUST and SNAQ categorise patients into three categories of nutritional status: not at risk of malnutrition, at moderate risk of malnutrition and at severe risk of malnutrition. For comparison reasons, the three risk categories of MUST and SNAQ were combined into two risk categories like in Raslan's study (Raslan *et al.* 2009). We realise this does not do justice to the original intention of these tools. The accuracies of MUST and SNAQ were ≥70% when the group at moderate risk of malnutrition was combined with the group at severe risk of malnutrition, but dropped slightly below 70% when comparing patients not at risk of malnutrition with patients who where at moderate risk of malnutrition. This may be explained by the artificial subdivision into two categories.

We consider MNA-SF, developed for the older population, not suitable for older hospital inpatients because of its very low specificity and positive predictive value, resulting in referring too many false positive malnourished patients to the dietician. Bauer *et al.* and Raslan *et al.* reached the same conclusion (Raslan *et al.* 2009). They stated that the MNA-SF should be preferred for geriatric outpatients and institutionalised living home patients since it was validated in this setting but not for acute geriatric medicine.

A possible explanation for the poor specificity of the MNA-SF could be that the study population where this tool was developed consisted not only hospitalised geriatric patients, but also of healthy community-dwelling older persons.

The absence of a generally accepted gold standard is a point of discussion in every study on disease-related malnutrition (Stratton *et al.* 2003, Meijers *et al.* 2010). Therefore, in this study, we applied an often used and acknowledged definition of disease-related malnutrition by using both percentage unintentional weight loss and low BMI. Percentage weight loss was used to indicate acute malnutrition whereas a low BMI was used to indicate chronic malnutrition. For feasibility reasons we had chosen not to extend the criteria to measure nutritional status with i.e. biochemical markers, patients history and physical examination in this one-day cross-sectional study.

Unfortunately even this 'simple' pre-set definition of nutritional status (consisting of only BMI and unintentional weight loss) could not be determined in all patients. Even though each patient was assessed by a couple of a trained nurse and a trained dietician, still 25% of the patients had incomplete data on weight, height and/or weight loss. For these patients no definition of nutritional status could be determined. Therefore selection bias can not be excluded. It is plausible that patients at the highest risk of malnutrition were excluded. Therefore the prevalence of malnutrition may have been higher in real than as presented in Fig. 1.

Based on individual hospital preferences, each hospital should implement the most appropriate screening tool for its setting, either a comprehensive or a quick-and-easy tool. Comprehensive screening tools – like MUST and NRS-2002 – require more time and skills from nurses because of measuring height and weight, calculating BMI and percentage unintentional weight loss and evaluating disease severity. Implementing MUST or NRS-2002 in an electronical medical chart solves the problem of calculating BMI and percentage unintentional weight loss. MST and SNAQ are quick-and-easy screening tools, not developed for diagnostic purposes and not suitable for monitoring the patients' nutritional status in time. In this study they appear to perform as well as the comprehensive tools. They feature easy questions that are most indicative of risk of malnutrition. A disadvantage of these tools is that further nutritional assessment is required for patients who have been identified at severe risk of malnutrition. Although for the more comprehensive screening tools MUST, NRS-2002 a more detailed nutritional assessment by a dietician is also recommendable.

As for the studied tools, for both quick-and-easy tools (MST and SNAQ) more complete data were available than for the comprehensive tools. For MUST as many of 47% of the questionnaires were incomplete. This could support the idea that quick-and-easy screening tools may be easier to fill-out for nurses and more practical to use in a clinical setting. Since this study reveals that, based on diagnostic performance, the one category has no advantages over the other. It is up to each individual hospital to implement either a more comprehensive or a quick-and-easy malnutrition screening tool.

Conclusion

This study reveals that the criterion validity of the two comprehensive malnutrition screening tools (MUST and NRS-2002) and the two quick-and-easy malnutrition screening tools (MST and SNAQ) seems to be adequate for malnutrition risk screening of adult hospital inpatients. However, MUST was found to be less applicable due to the high rate of missing values in the questionnaire. Due to its poor specificity, the MNA-SF should not be applied to older hospital inpatients. Our advice is to introduce screening all hospital inpatients on malnutrition with either MST, MUST, NRS-2002 or SNAQ instead of discussing which tool is best to use and at the same time doing nothing.

Relevance to clinical practice

In the absence of formal screening procedures, more than half the patients at risk of malnutrition are not identified and/or referred for treatment. Optimising the identification and treatment of malnutrition should improve patient outcomes such as faster wound healing, shorter hospital stays, lower pressure ulcer incidence, better quality of life, lower mortality and so on. Nutritional screening should therefore be performed in every healthcare setting with either MST, MUST, NRS-2002 or SNAQ. It should be part of regular care, just like assessing body temperature and blood pressure and should start from the moment the patient enters the healthcare setting.

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Contributions

Study design: FN, JM, HK, MB; data collection and analysis: FN, JM, HK, AB, MB and manuscript preparation: FN, JM, HK, MB.

Conflict of interest

None.

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