



Validation of the Malnutrition Universal Screening Tool (MUST) in cancer

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Abstract

In the present study, we aimed to validate the Malnutrition Universal Screening Tool (MUST) for routine nutritional screening in the radiation oncology setting, thus enabling timely and adequate referrals of patients at risk for individualised or advanced intervention. Towards this objective, we conducted a prospective cross-sectional study in 450 non-selected cancer patients (18–95 years) referred for radiotherapy. The following were the nutritional parameters: BMI (categorised by WHO's age/sex criteria), weight loss >5% in the previous 3–6 months, Patient-Generated Subjective Global Assessment (PG-SGA – validated/specific for oncology) and nutritional risk by MUST. Sensitivity, specificity, predictive values and concordance were calculated to validate MUST *v.* PG-SGA and compare single parameters *v.* PG-SGA/MUST. BMI *v.* PG-SGA showed a negligible capacity to detect undernutrition: 0.27 sensitivity, 0.23 specificity, 0.35 positive predictive value and 0.31 negative predictive value. Conversely, percentage weight loss *v.* PG-SGA was highly effective: 0.76 sensitivity, 0.85 specificity, 0.79 positive predictive value and 0.85 negative predictive value. MUST *v.* PG-SGA successfully detected patients at risk: 0.80 sensitivity, 0.89 specificity, 0.87 positive predictive value and 1.0 negative predictive value; percentage weight loss *v.* MUST proved able to identify patients likely to be at risk: 0.85 sensitivity, 0.91 specificity, 0.90 positive predictive value and 1.0 negative predictive value. This is the first study in the radiation oncology setting to validate MUST: a simple and quick method applicable by any health professional, with a high validity for early screening, ideally to antedate a comprehensive nutritional assessment and guide for intervention. In this study, percentage weight loss in the previous 3–6 months does seem valid to predict nutritional risk, and may be the minimum in a busy routine.

Key words: Oncology: Nutrition screening: Nutritional risk: Malnutrition Universal Screening Tool: Patient-Generated Subjective Global Assessment

Undernutrition in cancer increases morbidity and treatment toxicity, decreases response to treatment, quality of life and almost certainly worsens prognosis^(1–5), thus increasing healthcare costs⁽⁶⁾. However, undernutrition continues to be neither screened/diagnosed nor integrated in overall patient care; hence, timely and dynamic adjustments to patients' needs are still theoretical⁽⁷⁾.

Although routine nutritional screening is acknowledged as an essential component of modern cancer care, early risk assessment is still missing presumably due to the lack of a simple, validated and reproducible method⁽⁸⁾. In order to overcome this drawback, we selected to compare a validated tool used to diagnose undernutrition in oncology, the scored Patient-Generated Subjective Global Assessment (PG-SGA)⁽²⁾ with an easy and simple tool to screen patients at nutritional risk. The mandatory integration of PG-SGA can only be effective if antedated by nutritional risk screening. This enables the

identification of those patients in need of a full nutritional status assessment by PG-SGA which requires a trained nutrition professional. Those who are not considered to be at risk do not require the full assessment and should be re-screened periodically. In the absence of a 'gold standard' for nutritional risk screening, the Malnutrition Universal Screening Tool (MUST)^(9,10) was chosen because it has content validity (comprehensiveness of the tool), face validity (issues which are relevant to the purpose of the test) and internal consistency. MUST is a screening tool that has shown its strength for application to adult patients across all healthcare settings including oncology⁽¹⁰⁾. Despite MUST's excellent agreement with dietitians' assessment of undernutrition⁽⁹⁾, so far no studies comparing MUST and PG-SGA have been published.

Therefore, the present study aimed to: (1) classify nutritional risk and status categories in patients with different types of tumours; (2) compare results between nutritional

Abbreviations: MUST, Malnutrition Universal Screening Tool; PG-SGA, Patient-Generated Subjective Global Assessment.

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parameters, primarily MUST and PG-SGA; and (3) validate MUST as a feasible screening method for routine use in the radiation oncology setting, by comparison with the validated PG-SGA.

Material and methods

Study design and patient population

This prospective cross-sectional study was approved by the University Hospital Ethics Committee and was conducted in accordance with the Helsinki Declaration, adopted by the World Medical Association in 1964, amended in 1975, revised in 1983 and updated in 2002. Between March 2008 and January 2009, all consecutive patients with diverse cancers referred to the outpatient Radiotherapy Department were considered eligible. Exclusion criteria comprised rare tumours⁽¹¹⁾, and uncooperative patients unable to communicate or to be properly weighed. Before radiotherapy planning, the medical staff registered, for every patient, clinical variables, the location of cancer and burden according to TNM classification⁽¹²⁾ as determined by local and whole-body imaging methods. Of the total 450 patients, 165 underwent palliative radiotherapy *v.* 285 who underwent curative radiotherapy. All patients included in the study provided written informed consent. Data were recorded in individual forms pre-designed for statistical analysis.

The cohort included 450 adult patients (60%, *n* 269/450 men; 40%, *n* 181/450 women), with a mean age of 62 (SD 13) (range: 18–95) years, with different types of cancers and stages. Tumours in advanced stages (III and IV) were predominant (*n* 273); the most frequent types of cancers were: breast (*n* 94), prostate (*n* 86), lung (*n* 73) and colorectal (*n* 61); full details of these are given elsewhere⁽¹³⁾.

Study measures

Data collection and nutritional assessment were obtained at the onset of radiotherapy by a trained research dietitian (C. B.-T.).

Nutritional status

BMI. Height was measured in the standing position using a stadiometer and weight was determined with a calibrated SECA® floor scale (Seca, Birmingham, UK); both measures were used to calculate BMI (weight (kg)/height (m)²), further classified as undernutrition if <18.5 kg/m², normal weight if 18.5–24.9 kg/m², overweight if 25–29.9 kg/m² or obese if ≥30 kg/m², in line with age- and sex-adjusted criteria established by the World Health Organization⁽¹⁴⁾.

Percentage of weight loss. Percentage of weight loss was calculated by comparison with the patient's reported usual weight before symptoms, and classified as clinically significant and indicative of undernutrition or high nutritional risk if >5% over the previous 3–6 months⁽¹⁵⁾.

Patient Generated-Subjective Global Assessment. PG-SGA is a validated nutritional assessment tool, which has

been accepted by the Oncology Nutrition Dietetic Practice Group of the American Dietetic Association as the 'gold standard' for cancer patients⁽²⁾. PG-SGA consists of two sections: (1) weight history, food intake, nutrition impact symptoms and functional capacity; (2) diagnosis, disease stage, age, components of metabolic demand (sepsis, neutropenic or tumour fever, corticosteroids) and physical examination. The patient's nutritional status is then classified into three categories: (A) well-nourished, (B) moderately undernourished or suspected of being undernourished, and (C) severely undernourished. For the present study, and for between-methods comparisons, two categories of the PG-SGA results were created⁽¹⁰⁾: well nourished *v.* moderately + severely undernourished, to enable comparisons with MUST (details are outlined in the following paragraph).

Nutritional risk. Nutritional risk was assessed by the MUST that addresses: (1) current weight status using BMI, which is scored as 0 if >20 kg/m², 1 if between 18.5 and 20 kg/m² and 2 if <18.5 kg/m²; (2) percentage weight loss over the previous 3–6 months is scored as 0 if <5%, 1 if between 5 and 10% and 2 if >10%; and (3) the acute disease effect is scored with 2 points if there has been, or if it is likely to be, no nutritional intake for >5 d. The scores given to each component are summed up and the total allows the categorisation of patients as in low, moderate or high risk of undernutrition; this score is used to guide patients' reassessment plan as well as the appropriate nutritional care plan⁽⁹⁾. For the present study, and for between-methods comparisons with the PG-SGA, two categories of MUST were created: low risk *v.* medium + high risk of undernutrition⁽¹⁰⁾. A Portuguese version of MUST was created with the translation of the original technical terms.

Statistical analysis

Statistical analysis was conducted using SPSS 16.0 (SPSS, Inc., Chicago, IL, USA). Patient's age was expressed as number and percentage, median and standard deviation; cancer location and stage were expressed as number; BMI, percentage weight loss and nutritional risk/status were expressed as number and/or percentage of patients. Correlations were determined using the two-tailed Spearman's test. χ^2 Test was used to compare differences in the prevalence of nutritional risk.

Sensitivity, specificity and predictive values were calculated to evaluate whether MUST could be a valid nutritional screening tool in cancer. A receiver operating characteristic (ROC) curve interpreted by relative areas under the curves and Youden value confirmed the consistency of the validation. Sensitivity of a screening tool expresses index sensitiveness to a certain factor; in this study, test sensitivity was the proportion of 'undernourished' cases diagnosed by PG-SGA, also found to be at 'risk of undernutrition' by the screening tool MUST. A high sensitivity of a screening tool may give false positives, with more patients being classified as at risk of undernutrition. Specificity refers to the proportion of patients without nutritional deficiency by PG-SGA and corroborated by MUST; high specificity may give many false



negatives. The positive predictive value is the probability that a patient classified as at risk of undernutrition by a screening tool is effectively found to be undernourished by PG-SGA. The negative predictive value is the probability that a patient classified as not at risk of undernutrition by a screening tool is also defined as well nourished by the reference method. Concordance between MUST and PG-SGA was analysed using the κ coefficient, further classified according to Fleiss⁽¹⁶⁾, to assess the correspondence between the results achieved by PG-SGA and MUST – convergent validation test on the result. Statistical significance was determined for $P < 0.05$.

Results

Nutritional parameters

Overall, BMI revealed that 4% (n 17/450) of patients were undernourished whereas 63% (n 282/450) were overweight/obese ($BMI \geq 25 \text{ kg/m}^2$). A weight loss $> 5\%$ over the previous 3–6 months was found in 33% (n 101/450) and PG-SGA classified 29% (n 131/450) as moderately/severely undernourished patients; nutritional risk as evaluated by MUST showed a prevalence of 31% (n 139/450) of patients at moderate/high risk of undernutrition. Table 1 shows the results of three nutritional parameters, namely BMI, PG-SGA and MUST.

BMI v. Patient-Generated Subjective Global Assessment

BMI results when compared with PG-SGA showed that sixteen patients (94%) were correctly classified as undernourished (true positives) and 318 (73%) patients were correctly classified as well nourished (true negatives), though the latter included overweight/obese (Fig. 1). On the other hand, 115 patients (88%) were wrongly classified by BMI as well nourished (false negatives), despite being assessed as undernourished by PG-SGA. Thus, BMI alone was not a good predictor of undernutrition risk. Additionally, according to the Youden test, BMI had a poor performance by comparison with the standard, and a weak capacity to effectively detect undernourished patients, with a sensitivity of 0.27,

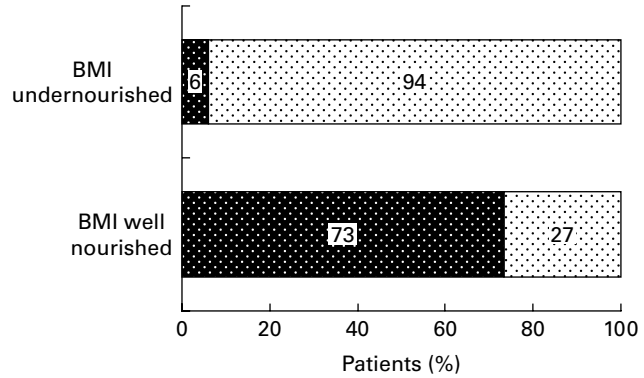


Fig. 1. BMI v. Patient-Generated Subjective Global Assessment (PG-SGA): well nourished (■)/undernourished (□) patients represented in percentages.

$P < 0.08$ (95% CI) and a specificity of 0.23, $P < 0.09$ (95% CI). BMI had a positive predictive value of 0.35, $P < 0.09$ and a negative predictive value of 0.31, $P < 0.08$ v. PG-SGA.

Percentage weight loss v. Patient-Generated Subjective Global Assessment

By comparison with PG-SGA, percentage weight loss correctly classified 291 (84%) patients as well nourished (true positives) and correctly classified seventy-four (73%) as undernourished patients (true negatives) (Fig. 2). On the other hand, twenty-eight (27%) patients were falsely classified by percentage weight loss as undernourished, though assessed as well nourished by PG-SGA. Methods were compared by the Youden test. According to the results, percentage weight loss revealed a sensitivity of 0.76, $P < 0.002$ (95% CI) and a specificity of 0.85, $P < 0.001$ (95% CI). Thus, percentage weight loss had a positive predictive value of 0.79 ($P < 0.002$) and a negative predictive value of 0.85 ($P < 0.001$) v. PG-SGA.

Malnutrition Universal Screening Tool v. Patient-Generated Subjective Global Assessment

By comparison with PG-SGA, MUST correctly classified 275 patients (88%) as without risk of undernutrition

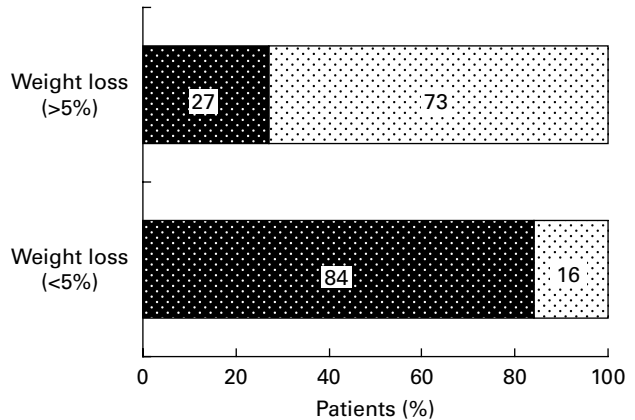


Fig. 2. Percentage weight loss v. Patient-Generated Subjective Global Assessment (PG-SGA): well nourished (■)/undernourished (□) patients represented in percentages.

Table 1. Nutritional assessment results: BMI categories, Patient-Generated Subjective Global Assessment (PG-SGA) categories and Malnutrition Universal Screening Tool (MUST) categories for all 450 patients (Total number and percentage of patients)

	Total (n)	Total (%)
BMI (kg/m²)		
< 18.5 (undernourished)	17	4
18.5–24.9 (normal)	151	33
25.0–29.9 (overweight/obese)	282	63
PG-SGA		
Well-nourished	319	70
Moderately undernourished	97	22
Severely undernourished	34	8
MUST		
Low risk of undernutrition	311	69
Moderate risk of undernutrition	64	14
High risk of undernutrition	75	17

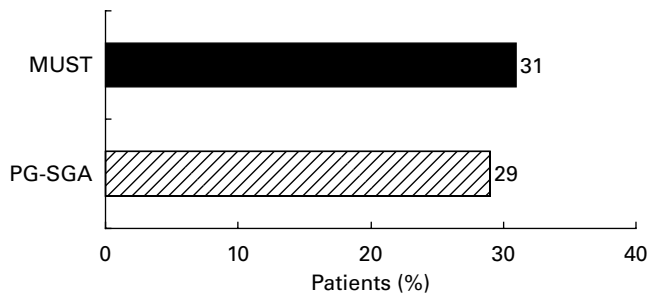


Fig. 3. Patients at nutritional risk (Malnutrition Universal Screening Tool (MUST)) and those undernourished by Patient-Generated Subjective Global Assessment (PG-SGA).

(true negatives) and ninety-five (68%) were correctly classified by MUST as being at risk (true positives). MUST misclassified thirty-six patients (12%) as without risk (false negatives) who were classified as undernourished by PG-SGA. Conversely, forty-four (32%) were falsely classified as at risk and were assessed as well nourished by PG-SGA (false positives) (Figs. 3 and 4).

Concordance analysis by the κ coefficient revealed a significant agreement between both methods, $\kappa = 0.86$ ($P < 0.002$). According to the Youden test, MUST had a high sensitivity of 0.80, $P < 0.001$ (95% CI) and a specificity of 0.89, $P < 0.001$ (95% CI), indicating a very high performance by comparison with the standard, and a strong capacity to effectively detect patients at nutritional risk. MUST when compared with PG-SGA had a 0.87 ($P < 0.002$) positive predictive value, and a negative predictive value of 1.0 ($P < 0.001$).

Percentage weight loss v. Malnutrition Universal Screening Tool

Given the previous results, to assess the value of significant percentage weight loss for routine use by comparison with the screening tool MUST turned out to be essential. By comparison with MUST, 304 patients (87%) were correctly classified by percentage weight loss as without nutritional risk (true positives) and ninety-five (93%) were correctly classified as being at risk (true negatives). Conversely, just seven (7%) patients were falsely classified as at risk by percentage weight loss, though not at risk when assessed by MUST

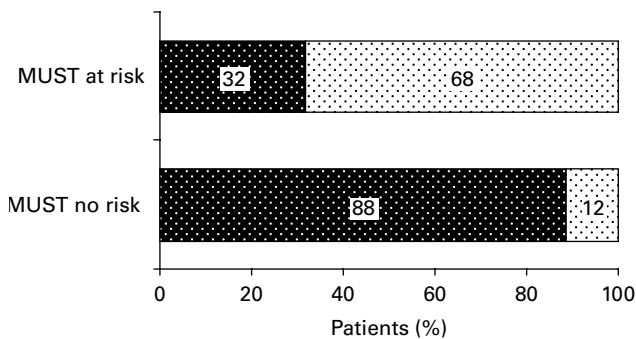


Fig. 4. Malnutrition Universal Screening Tool (MUST) v. Patient-Generated Subjective Global Assessment (PG-SGA): no risk/at risk patients represented in percentages. ■, PG-SGA well nourished; ▨, PG-SGA undernourished.

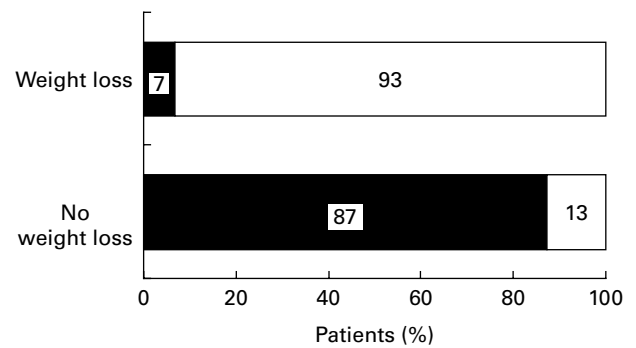


Fig. 5. Percentage weight loss v. Malnutrition Universal Screening Tool (MUST): no risk (■)/at risk (▨) patients represented in percentages.

(false negatives); likewise, forty-four (13%) were falsely classified as without risk by percentage weight loss, whereas they were assessed by MUST as at risk (false positives) (Fig. 5). According to the Youden test, percentage weight loss *per se* had a sensitivity of 0.85, $P < 0.001$ (95% CI) and a specificity of 0.91, $P < 0.001$ (95% CI) when compared with MUST. Thus, percentage weight loss had a positive predictive value of 0.90 ($P < 0.001$) and a negative predictive value of 1.0 ($P < 0.001$) v. MUST, hence showing a strong capacity to primarily identify patients likely to be at risk of undernutrition.

By ROC interpreted relative areas under the curves that incorporated the relative scores given to each of the three MUST components, results shared percentage weight loss with a consistently superior statistical performance than the other variables, as well as the ability to detect mild to extreme nutritional changes.

Discussion

This is the first study aiming to validate MUST in the radiation oncology setting. In this prospective study in a large cohort of 450 cancer patients with different tumours, in order to reach a proper validation, single parameters widely acknowledged in the early detection of patients at nutritional risk or likely to become undernourished were tested. Our results demonstrated the validity and effectiveness of MUST in correctly identifying patients at nutritional risk by comparison with PG-SGA validated for nutritional status assessment in oncology, with a high sensitivity (0.80), specificity (0.89), 0.87 positive predictive value and negative predictive value of 1.0. The relevance of our results increases by taking into consideration the acknowledged fact that nutrition remains a mistreated distressing issue for cancer patients despite its impact in quality of life and survival⁽³⁻⁵⁾.

PG-SGA remains the only validated and specific tool for a thorough nutritional assessment in oncology, and provides guidance for nutritional intervention though requiring a trained nutrition professional^(2,17). In reality, there are not enough trained professionals for every patient; thereby the mandatory integration of PG-SGA in a nutrition protocol can only be effective by an antedated nutritional risk screening, in order to detect patients requiring full assessment and intervention^(2,8,18-20). The lack of a consensual method for

nutritional screening, regardless of their abundance, prompted us to test MUST, a simple though thoroughly validated tool and easy to be applied by any adequately educated health professional^(9,10).

To identify undernutrition, BMI had a very low sensitivity, specificity, positive and negative predictive values: only 4% of patients were underweight *v.* 29% undernourished by PG-SGA; yet this was the only parameter able to identify the 73% well-nourished/overweight/obese patients.

Undernutrition is often overlooked in patients with normal or even excessive BMI who have significantly lost weight⁽²¹⁾. Unintentional reported weight loss is a semi-objective criterion, whose meaning relies on cut-offs that reflect the boundaries between normal and abnormal intra-individual weight changes, and a possible underlying condition which when undetected may well result in further weight loss and undernutrition⁽¹⁰⁾. Nevertheless, unintentional weight loss is unquestionably a major issue in cancer and accordingly, percentage weight loss >5% in the last 3–6 months represents high nutritional risk^(8,19); our results corroborated the consistency of percentage weight loss to detect mild to extreme nutritional changes. By comparison with PG-SGA, percentage weight loss proved to be a valid and reliable nutritional parameter in cancer, revealing high sensitivity, specificity, negative and positive predictive values to detect undernourished patients and those at risk of developing undernutrition. The high performance of percentage weight loss *v.* MUST is probably due to the fact that the three components of the latter reflect the patient 'journey' from the past (weight loss) to the present (current BMI) and into the future (effect of disease). Indeed, by comparison with MUST, the tool under validation in this study, it was confirmed that percentage weight loss *per se* had a strikingly high sensitivity of 0.85, a specificity of 0.91, a positive predictive value of 0.90 and a negative predictive value of 1.0, thus showing a strong capacity to primarily identify patients very likely to be at risk of undernutrition. The use of weight loss has, however, been often questioned, given the many possible affecting non-nutritional factors⁽²²⁾.

MUST does not require time-consuming calculations, incorporates objective and subjective/clinical parameters reflecting changes in nutritional risk and status, and most importantly is easy to use and quick to fill in even by any trained professional without nutritional expertise^(9,10). It is the official tool used by the British Dietetic Association, the Royal College of Nursing, the Registered Nursing Homes Association and the British Association for Parenteral and Enteral Nutrition (BAPEN) and widely used in Europe. In line with recent literature⁽¹⁸⁾, MUST showed that 31% of patients were at moderate/high risk of undernutrition, confirmed by the 29% of patients classified as undernourished by PG-SGA. Up until now, only one study has validated a screening tool in oncology *v.* PG-SGA; the Malnutrition Screening Tool was tested in a population of fifty patients, and the results showed similar sensitivity, specificity and predictive values⁽²³⁾. Another study in 144 cancer patients compared nutritional diagnoses obtained with different methods (SGA, MUST, BMI, serum albumin); only MUST and SGA proved to be good diagnostic tests with convergent results⁽²⁴⁾.

Early screening for undernutrition eventually preceding a comprehensive nutritional assessment is acknowledged as imperative in the development of quality nutrition intervention protocols, to foster quality of care in oncology^(2,5,10). Based on our results, MUST is strongly recommended to be integrated in routine screening in the radiation oncology setting, allowing for an appropriate reassessment schedule and nutrition care plan. Ideally, MUST should be the primary screening tool to refer patients in need of individualised schedules with nutritional professionals, which would then continue individual care with PG-SGA. The subsequent use of PG-SGA exacts every patient nutritional status and requirements. Though MUST is a quick (2–4 min) and easy-to-use tool, health professionals often declare themselves overwhelmed with the multiplicity of procedures. Bearing this in mind, and based on our results, percentage weight loss in the last 3–6 months is a valid and minimum parameter that can be used to predict nutritional risk in routine practice contributing to more effective nutritional care.

As limitations of our study, it is relevant to acknowledge that we included a heterogeneous population of cancer patients in terms of primary site, nutritional goals, radiation fields and prognosis. Furthermore, the study population is restricted to patients receiving radiotherapy and the results should not be generalised to patients who are candidates for systemic anticancer treatments. However, this study should and was designed to be used as an example for future studies in the oncology setting.

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