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The Malnutrition Screening Tool (MST) in geriatric rehabilitation: A comparison of validity when completed by health professionals with and without malnutrition screening training has implications for practice.

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Abstract

Background: The validity of the Malnutrition Screening Tool (MST) in geriatric rehabilitation has been evaluated in a research environment; however, not in professional practice.

Objectives: In older adults admitted to rehabilitation, this study was undertaken to: 1) compare the MST scoring agreement (inter-rater reliability) between health professionals with and without malnutrition risk and screening training, 2) evaluate the concurrent validity of the MST completed by the trained and untrained health professionals compared to the ICD-10-AM using different MST score cut-offs, and 3) determine if patient characteristics were associated with MST scoring accuracy when completed by untrained health professionals.

Design: Observational, cross-sectional.

Participants/setting: n=57 older adults, mean 79.1 years (±7.3 years) were recruited from August 2013 to February 2014 from two rural rehabilitation units in New South Wales, Australia.

Main outcome measurements: MST, ICD-10-AM classification of malnutrition.

Statistical analysis performed: Measures of diagnostic accuracy generated from a contingency table, receiver operating characteristic curve and Spearman's correlation.

Results: The MST scores completed by trained and untrained health professionals showed moderate correlation and fair agreement (r_s: .465, P=0.001; kappa=0.297, P=0.028). When compared to the ICD-10-AM, the untrained MST administration showed moderate diagnostic accuracy (sensitivity 56.5%, specificity 83.3%) but increasing the MST score to ≥3 caused the sensitivity of both the trained and untrained MST administration to decrease (56.5% and 22.9% respectively).

Conclusion: The application of the MST by untrained health professionals in rehabilitation may not provide sufficient accuracy in identifying patients with malnutrition risk. Using an

MST score of ≥2 to indicate malnutrition risk is recommended, as increasing the MST cut-off score to ≥3 is likely to have insufficient accuracy even when completed by trained health professionals. Research evaluating the impact of providing rehabilitation staff with regular and ongoing training in completing malnutrition screening and referral pathways is warranted.

Introduction

In recognition of the high prevalence (45-65%) and poor outcomes of older patients with protein-energy malnutrition (herein referred to as "malnutrition") in sub-acute rehabilitation units[1-3], best-practice guidelines recommend malnutrition screening upon admission[4-7]. In response, screening for nutritional problems upon admission to a health care facility is mandated by Joint Commission on Accreditation of Healthcare Organizations in the United States of America[8]. The Malnutrition Screening Tool (MST) is a nutrition screening tool commonly used at admission to acute and sub-acute health facilities to evaluate risk of malnutrition and initiate a nutrition care pathway including referral to a dietitian[4,9].

The MST consists of two questions: "have you/the patient lost weight recently without trying" (scored 0-4), and "have you/the patient been eating poorly because of a decreased appetite (<3/4 of usual intake and, may also be due to chewing and swallowing problems)" (scored 0-1). Thus the MST provides a continuous score of 0-5, where a score of ≥2 indicates risk of malnutrition and need for full nutrition assessment via dietetic referral[10]. The MST is a low cost and low burden screening tool, where no physical measurements are required, and can be completed by any person, including the patient for self-assessment. The MST was originally developed in acute care patients, and has also shown moderate to strong concurrent validity in oncology outpatients, aged care residents, older hip-fracture acute care inpatients, and most recently in older rehabilitation patients[9,11-18]. In these diagnostic accuracy studies, the MST was completed for research purposes by health professionals (dietitians, nurses, nutrition assistants and public health researchers) who have received education regarding malnutrition and training in malnutrition screening techniques. Therefore, accuracy of tool completion by health professionals in the practice setting, as well as the inter-rater reliability of the tool, is of interest as poor screening accuracy may have significant negative impacts on patient outcomes as well as costs to the health care facility[18]. Of additional interest in the rehabilitation setting, some facilities will now refer to the dietitian upon an MST score of ≥3, where a patient with a score of 2 is placed on a standardized high-protein, high-energy diet code and monitored by nurses[19]. There has been no evaluation of using an MST score of ≥3 to indicate need for a dietetic referral.

Therefore, in older adults admitted to rehabilitation, this study was undertaken to: 1) compare the MST scoring agreement (inter-rater reliability) between health professionals with and without malnutrition risk and screening training, 2) evaluate the concurrent validity of the MST completed by the trained and untrained health professionals compared to the ICD-10-AM using different MST score cut-offs, and 3) determine if patient characteristics were associated with MST scoring accuracy when completed by untrained health professionals.

Materials and methods

An observational cross-sectional study was undertaken from August 2013 to February 2014 in two publicly-funded rural rehabilitation units in New South Wales, Australia. This study was conducted as part of the MARRC (Malnutrition in the Australian Rural Rehabilitation Community) Study, registered at the Australian New Zealand Clinical Trials Registry (trial version 2.0, 9 May 2013; ACTRN12613000518763), and received ethical and governance approval (North Coast NSW Human Research Ethics Committee: LNR063, G108). Written informed consent was obtained from all participants and/or their guardians.

Study sample

The study sample has been described in detail elsewhere[13]. Briefly, 57 community-dwelling older adults (≥65 years) were consecutively sampled in two public rehabilitation units in rural New South Wales, Australia[20]. The sample size reflects the number of eligible and consenting participants in the recruitment period (consent rate 98%). Participants were recruited if they were admitted with the expectation they would return to the community, and had an informal/family caregiver.

Data collection

All data collection including a full nutrition assessment was completed by the primary researcher (an Accredited Practising Dietitian [Australian certified], referred to as the trained health professional) at bedside (median 2 days following admission), except for the MST completed by nursing staff as part of usual care (referred to as the "untrained-MST"). Assessment was informed by medical notes and participant or family caregiver report. The primary researcher obtained weight and height measurements using calibrated scales and a sliding knee-height caliper, which was used to measure the knee height. Knee height was then entered into a population specific formula to estimate the true height[21]. Participant characteristics which were used to determine association with the accuracy of the untrained-MST were age, gender, marital status, highest level of education attained, living alone, reason for admission (acute/chronic condition), source of admission (acute care/community), dentures, being on a pension, English as first language, ethnicity, religion, body mass index (BMI; kg/m^2) and BMI weight category (normal BMI for older adults was considered $22kg/m^2$ to $27kg/m^2$, $<22kg/m^2$ was considered underweight, and $>27kg/m^2$ overweight/obese)[22].

Nutrition screening and assessment

In both units, nursing staff completed the MST during a full "admission assessment" which also included items related to demographics, care needs, falls risk, and initial care plans. The nurses received no specific training on completion of the MST as part of the study nor as part of usual care, and were blinded to results of how the trained health professional completed the MST (referred to as the "trained-MST"). Upon the new appointment of nurses in the rehabilitation units, the nurses received a brief introduction to the MST and dietetics referral pathway, by the clinical nurse educator (site A) or nursing colleagues (site B), which used no standardized screening training or malnutrition education program. At time of data collection, the sampled rehabilitation units were still recommended to refer to the dietitian upon an MST score of ≥2.

The full nutrition assessment completed by the trained health professional was used to inform the trained-MST and the International Classification for Diseases, 10th revision, Australian Modification (ICD-10-AM) classification of protein-energy malnutrition[23]. As there is no gold standard for diagnosing malnutrition, the ICD-10-AM criteria was selected as the reference measure to diagnose "malnutrition" as it is the recognized standard diagnostic criteria for the identification, documentation and coding of protein-energy malnutrition and is used to provide case-mix funding reimbursements in Australia. The ICD-10-AM considers a patient as malnourished if they a) have a BMI $<18.5 kg/m^2$, or b) have unintentional weight loss of ≥5% with evidence of suboptimal dietary intake as well as evidence of loss of subcutaneous fat and/or muscle[23]. For the MST scoring recommended by the original developers of the tool, a score of 0-1 indicated "no malnutrition risk", and a score of ≥2 indicated "malnutrition risk" (referred to as the trained-MST and untrained-MST)[9]. To test the validity of using a higher cut-off (MST ≥3), patients were re-classified, with a score of 0-2 indicating "no malnutrition risk", and ≥3 indicating "malnutrition risk" (referred to as the "altered-trained-MST" and "altered-untrained-MST").

Statistical approach

All statistical analysis was completed using SPSS Statistics 24[24]. Significance was considered at the $P<0.05$ level two tailed. Normality of the trained-MST and untrained-MST was tested using the Shapiro-Wilk test, and descriptive statistics were used to summarize the results of the MST (patient characteristics reported previously[13]).

To compare the trained-MST and untrained-MST continuous scores, a Spearman's rank-order correlation coefficient was used. A weighted Cohen's kappa coefficient was used to compare the trained-MST and untrained-MST to evaluate how much of the difference between the two tests was due to error variance (true differences between raters) for "no malnutrition risk" or "malnutrition risk".

The concurrent validity (comparison of the score of a new measure to that of an established measure) of the trained-MST has been reported previously[13]. To evaluate the concurrent validity of the untrained-MST, altered-untrained-MST and altered-trained-MST, contingency tables were produced and the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and weighted Cohen's kappa statistic, with 95% confidence intervals (CIs) were reported. The ICD-10-AM classification for protein energy malnutrition in adults was used as the reference standard against which the MST was compared in the contingency table. In line with previous research, we set a minimum value of 80% for sensitivity and 60% for specificity to indicate a good nutrition screening tool[9,13]. The trained-MST and untrained-MST continuous scores were further assessed against the ICD-10-AM classification of malnutrition using a Receiver Operating Characteristic (ROC) curve. An ROC curve provides an assessment on the discriminative power of a test score, with an ROC area under the curve (AUC) on a scale of 0.0 (no clinical use) to 1.0 (excellent test)[25].

To determine if participant characteristics were associated with the correct/accurate completion of the MST by untrained health professionals, the untrained-MST was dichotomized as "correct" or "incorrect" if the score indicated "agreement" or "no agreement" with the ICD-10-AM classification of malnutrition respectively. Participant characteristics were also tested for association with missing cases, (no untrained-MST documented). Associations were tested using the chi-square test and independent t-test.

Results

The participants were µ79.1±7.3 years of age and 49% female. The majority were admitted by transfer from an acute care hospital (86.0%) for an acute condition (73.7%). At admission, the mean BMI was 25.0±5.7kg/m^2, and according to the ICD-10-AM, 45.6% of the participants were malnourished. The untrained health professionals documented the MST for 47 (82.5%) participants. The median untrained-MST was 0 (IQR: 0.0-2.0), indicating that more than half of the participants were documented as having an MST score of 0 by the untrained health professionals, and 17 (36.2%) were documented as at risk of malnutrition (MST score ≥2). However, the altered-untrained-MST (MST score ≥3) only considered five participants as at risk of malnutrition (8.8%). The trained-MST was completed for all participants with a median score of 2 (interquartile range (IQR: 0.5-3.0), where 54.4% were at risk of malnutrition. This was reduced to 35.1% being considered at risk of malnutrition using the altered-trained-MST. Both the trained-MST and untrained-MST were not normally distributed; however, only the untrained-MST had a statistically significant positive skew (skewness: 0.920, standard error (SE): 0.347, P<0.01). The trained-MST and untrained-MST showed moderate correlation (r_S: 0.465, P=0.001) and fair agreement (kappa=0.297, P=0.028, 95%CI: 0.046-0.548). The altered-trained-MST and altered-untrained-MST also showed fair agreement (kappa=0.322, P=0.003, 95%CI: 0.091-0.553).

The results of the diagnostic accuracy (concurrent validity) of the untrained-MST, altered-untrained-MST and altered-trained-MST are reported in table 1. The concurrent validity of the trained-MST, although reported previously, is also included in table 1 for the purposes of comparison. Of the ten participants in which untrained health professionals failed to complete and document the MST score, three (30%) were malnourished according to the ICD-10-AM. The trained-MST showed moderate agreement with the ICD-10-AM, where the untrained-MST only showed fair agreement (kappa=0.478, P<0.001 versus kappa=0.401, P=0.004

respectively). The agreement with the ICD-10-AM was reduced in both altered MST versions (MST score ≥3), but particularly for the altered-untrained-MST (kappa=0.221, *P*<0.016, 95%CI: 0.045-0.397). Except for the trained-MST, no tool met the a-priori value of ≥80% for sensitivity to identify malnutrition risk (true positive). The altered-trained-MST and altered-untrained-MST both revealed an increase in specificity from the original scoring; however, the sensitivity was lowered, indicating a significant risk of under-recognizing the risk of malnutrition (increased risk of false negatives).

When considered as a continuous score, the trained-MST was considered a "very good test"[25] when compared to the ICD-10-AM (ROC area under the curve (AUC): 0.805± S.E:0.058, *P*<0.001; 95% CI: 0.692 – 0.919). The ROC AUC of the untrained-MST was poor (ROC AUC: 0.681± S.E:0.080, *P*<0.033; 95% CI: 0.524 – 0.838), falling into the ROC AUC category "sufficient test without much value in the clinical setting"[25]. The coordinates of the curve produced by the ROC test (table 2) suggests that the best MST score to identify risk of malnutrition, when used by a trained health professional, is an MST score of 2 as per the original development of the tool[9]. However, no untrained-MST score had enough sensitivity to meet the a-priori minimum sensitivity of 80%.

No participant characteristics were associated with the untrained-MST correctly identifying "malnutrition risk" according to the ICD-10-AM (data not shown, all tests *P*>0.05). In addition, no participant characteristics were associated with the untrained-MST not being documented by untrained health professionals (missing cases) (data not shown, all tests *P*>0.05).

Discussion

The results of this diagnostic accuracy study have important implications for clinical practice. Although the untrained-MST completion rate of 82% may be considered acceptable by some health services, it is worth noting that this resulted in three malnourished patients not being identified as at risk of malnutrition. For benchmarking purposes, this study suggests that an MST completion rate of 100% is needed upon patient admission. This finding compliments other research which emphasizes the need for regular re-screening of older rehabilitation patients[30].

While the untrained-MST showed some clinical value categorizing participants as having malnutrition risk or no malnutrition risk, the continuous score had poor discriminative value, where the ROC AUC was categorized as a 'sufficient test without much value in the clinical setting'[25]. When applied by health professionals without malnutrition screening training in the practice setting, it appears the MST was better able to identify well-nourished patients than malnourished (higher specificity of 83.3%, lower sensitivity of 57.7%). As reported previously[30], 16 of the 30 malnourished patients were referred to the dietitian, which closely aligns with the 17 patients identified as at risk of malnutrition by the untrained-MST in practice (referral rate of 94%). However, this low sensitivity of the untrained-MST carries negative clinical implications as it is important to identify and manage all patients with malnutrition to prevent further downstream health outcomes such as rehospitalization and mortality[3]. Also considering these serious health outcomes when malnutrition fails to be identified and treated, this study does not support the referral to a dietitian only after a MST score of ≥3 as this resulted in a severe decrease in the sensitivity of the MST to identify malnourished patients (sensitivity of 23%, specificity of 98% when conducted by practice nurses).

It should also be acknowledged that other malnutrition screening tools have shown inadequate diagnostic accuracy in older patients. The Mini-Nutritional Assessment-Short Form failed to have sufficient specificity in geriatric rehabilitation even when applied by a highly trained dietitian (sensitivity 100%, specificity 22.6%)[13]. In an older hip-fracture population, Bell et al.[18] evaluated eight nutrition screening tools and anthropometric measures; however, none had sufficient validity to identify the risk of malnutrition when completed by nutrition assistants with basic training in malnutrition screening. However, it must be acknowledged that this was in a sample where 65% had dementia, delirium or cognitive impairment[18].

This study showed a clear difference in screening accuracy when completed by a trained health professional compared with health professionals without malnutrition education or screening training. Although the level of malnutrition education and nutrition screening training is a clear difference between the health professionals in this study, it should be acknowledged, while important, that the level of training may not be the primary or sole reason for the difference in MST screening accuracy. Factors related to the screening tool itself (ease and acceptability of the tool), staff (value of clinical judgment, prioritization of other clinical activities, knowledge and skills) and context (organizational culture, adequate time and resources, communication processes) have been identified as important barriers and facilitators to nutrition screening in the practice setting[26,27]. These factors are unlikely to present a barrier to screening when completed by a trained health professional as part of a research study (as was the case in this study with the "trained-MST"), which may explain the observed difference between screening results. Although no participant characteristics were associated with the accuracy and documentation of the untrained-MST in this study, patient factors may be an important contributor in other settings, particularly those with increased prevalence of cognitive impairment. With the cost of treating malnutrition with nutrition support estimated to be less than 2.5% of the total expenditure of malnutrition[31-33], ensuring rehabilitation staff are properly educated, trained and supported to implement malnutrition screening and referral pathways is an important strategy in providing more cost-effective treatment for this patient group. Reflecting this, identifying and treating malnutrition is ranked fifth in the top clinical (including medical and pharmaceutical) guidelines shown to produce savings to healthcare by the National Institute for Health and Care Excellence[34].

Limitations and implications for further research

The limitation of this study lies primarily in the small representation of health care facilities and practitioners, which may limit generalizability to other facilities and rehabilitation teams. However, results align with studies conducted in acute settings, and highlight the importance of appropriate training and support of rehabilitation staff in malnutrition screening and referral pathways[18]. Although this study found no association between participant characteristics and the accuracy of MST completion by health professionals without malnutrition screening training, this may be because the rehabilitation units did not admit patients with significant cognitive impairment or dementia, and the rural sample was mostly culturally homogenous[13]. Therefore, it may be worth exploring patient characteristics associated with nutrition screening accuracy in larger and more diverse samples internationally.

Although further research could be directed towards observing the inter-rater reliability and accuracy of nutrition screening by health professionals in different settings, research directed towards evaluating the cost-benefit and efficacy of interventions which overcome barriers in malnutrition screening accuracy and completion would be of high clinical value.

Conclusion

Although the MST has sufficient accuracy when completed by health professionals with training in nutrition screening, application of the tool by health professionals without malnutrition screening training may not provide sufficient accuracy in identifying patients with malnutrition risk. Additionally, this study demonstrates that increasing the MST cut-off score to ≥3 as a strategy to manage high demand may result in a severe under-diagnosis and under-treatment of malnutrition. Future research should be directed towards providing high quality interventional research to train and support rehabilitation staff in accurately implementing malnutrition screening and referral pathways.

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Table 1: Measures of diagnostic accuracy (concurrent validity) of the Malnutrition Screening Tool (MST) completed a highly-trained health professional (trained-MST) and health professionals with no malnutrition screening training (untrained-MST) against the ICD-10-AM classification of protein-energy malnutrition using different cut-off points in a cohort of 57 older adults admitted to two rural rehabilitation facilities in rural New South Wales, Australia

	Kappa statistic	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Trained-MST[a]					
- value	0.478[c]	80.8	67.7	67.7	80.8
- 95%CI[b]	0.193-0.677	62.1-91.5	50.1-81.4	48.6-83.3	60.6-93.4
Altered-trained-MST[d]					
- value	0.424[e]	57.7	83.9	75.0	70.3
- 95%CI	0.191 – 0.657	57.1 – 58.3	83.5 – 84.3	74.4 – 75.6	69.8 – 70.8
Untrained-MST[a,f]					
- value	0.401[g]	56.5	83.3	76.5	66.7
- 95%CI	0.146 – 0.656	34.5 – 76.8	62.6 – 95.3	50.1 – 93.2	47.2 – 82.7
Altered-untrained-MST[d]					
- value	0.221[g]	22.9[h]	98.0[h]	91.7[h]	57.0[h]
- 95%CI	0.045 – 0.397	22.4 – 23.5	97.8 – 98.2	90.9 – 92.4	56.5 – 57.5

[a] Trained-MST and untrained-MST apply the usual MST scoring where 0 – 1 indicates "no malnutrition risk", and a score of 2 – 5 indicates "malnutrition risk".
[b] CI, confidence interval.
[c] *P*<0.0001, "moderate agreement" as per Landis and Koch kappa statistic classification[26].
[d] Altered-trained MST and altered-untrained-MST apply a different scoring where 0 – 2 indicates "no malnutrition risk", and a score of 3 – 5 indicates "malnutrition risk".
[e] *P*=0.001, "moderate agreement" as per Landis and Koch kappa statistic classification[26].
[f] Data analysed for n=47 as there were 10 missing cases. No participant characteristics were associated with the untrained-MST not being completed (missing cases).
[g] *P*<0.05, "fair agreement" as per Landis and Koch kappa statistic classification[26].
[h] The false positive value for the altered-untrained-MST compared with the ICD-10-AM criteria was zero. However, due the problems with computation of diagnostic accuracy measures with a zero value, each cell in the contingency table had 0.5 added[27-29].

Table 2: The Receiver Operating Characteristics (ROC) Coordinates of the Curve for the Malnutrition Screening Tool (MST) scores completed by a highly-trained health professional (trained-MST) and health professionals with no malnutrition screening training (untrained-MST) compared to the ICD-10-AM classification of protein-energy malnutrition in adults.

MST scores (cut-off value to indicate risk of malnutrition)[a]	Trained-MST		Untrained-MST	
	Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)
-1	100.0	0.0	100.0	0.0
1	96.2	41.9	56.5	66.7
2[b]	80.8	67.7	56.5	83.3
3[c]	57.7	83.9	21.7	100.0
4	23.1	96.8	8.7	100.0
5	11.5	96.8	-[d]	-[d]
6	0.0	100.0	0.0	100.0

[a] The smallest cutoff value is the minimum observed MST score minus one, and the largest cutoff value is the maximum observed MST score plus one.

[b] A cut-off value of 2 indicates the reported sensitivity and specificity of the trained-MST and untrained-MST reported in table 1.

[c] A cut-off value of 3 indicates the reported sensitivity and specificity of the altered-trained-MST and altered-untrained-MST reported in table 1.

[d] No values provided as the nursing staff did not score any participant as having an MST score of 5.