Original Article

A comparison of two malnutrition screening tools in acute medical inpatients and validation of a screening tool among adult Indigenous Australian patients

Natasha F Morris MNUR[1,2,3], Simon Stewart PhD[1], Malcom D Riley PhD[4], Graeme P Maguire PhD[1,5]

[1]*Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Australia*
[2]*Baker Heart and Diabetes Institute, Melbourne, Australia*
[3]*Department of Nursing, The University of Melbourne, Melbourne, Australia*
[4]*CSIRO Health and Biosecurity, Adelaide, Australia*
[5]*General Internal Medicine, Western Health, Melbourne, Australia*

Background and Objectives: The objectives of this study were to identify and validate a screening tool to detect malnutrition among Indigenous and non-Indigenous Australian patients. **Methods and Study Design:** This study included medical patients admitted into three regional hospitals in Australia. A literature review was undertaken of current screening tools before the Malnutrition Screening Tool (MST) and the newly developed Adult Nutrition Tool (ANT) were used to validate a screening tool for use among participants against the Subjective Global Assessment (SGA) tool. The sensitivity and specificity of both the MST and ANT were determined for all study participants as well as according to participants' Indigenous status. **Results:** A total of 608 participants were enrolled into the study, of whom 271 (44.6%) were Indigenous. The area under the curve (AUC) when utilising ANT was higher in all participants compared to the MST (0.90, 95% CI 0.88–0.92 versus 0.81, 95% CI 0.77–0.84, $p<0.001$). The AUC was also significantly higher for Indigenous participants when utilising ANT compared to the MST (0.88, 95% CI 0.84–0.92 versus 0.78, 95% CI 0.73–0.83, $p<0.001$). An ANT ≥2 demonstrated superior sensitivity for both Indigenous and non-Indigenous participants (96.0%, 95% CI 92.8–98.7%) than the MST (84.0%, 95% CI 78.9–88.3) but with inferior specificity (59.5%, 95% CI 54.2–64.6) than the MST (70.7%, 95% CI 65.7–75.3). **Conclusions:** The ANT is both a valid and accurate tool for Indigenous and non-Indigenous Australian patients. Further research is required to validate ANT to aide in the detection of malnutrition in other clinical settings.

Key Words: Adult Nutrition Tool, Indigenous Australian patients, Malnutrition Screening Tool, Subjective Global Assessment, validation

INTRODUCTION

Malnutrition is a highly prevalent among hospital patients and is associated with many adverse health outcomes.[1-5] These outcomes include: increased healthcare utilisation; decreased quality of life; and increased risk of patient morbidity and mortality.[1-4] Subsequently, screening patients for malnutrition risk upon admission into a healthcare service is best practice so patients identified at risk of malnutrition are referred to dietetic services for nutritional assessment and management.[6-7] Screening patients for malnutrition risk, should be simple and rapid and is usually based on the detection of key features related to malnutrition such as decreased oral intake and unintentional weight loss.[8-10]

We recently reported the burden of malnutrition among Indigenous Australians in regional hospital settings, demonstrating a higher proportion of malnutrition among Indigenous patients when compared to non-Indigenous patients.[2] In this study, the rate of malnutrition among Indigenous patients was nine per cent higher than non-Indigenous patients (46.1% versus 37.1% respectively) and furthermore, the rate of malnutrition among Indigenous Australian patients residing in Central Australia was much higher when compared to the Top End of the Northern Territory and Far North Queensland (56.7%, 40.7% and 36.7% respectively).[2] The burden of malnutrition in these regional hospital settings highlights the clinical importance of screening patients for malnutrition risk early during their admission for subsequent nutrition management and it is therefore imperative that a valid screening tool is used for patients who are particularly

Corresponding Author: Natasha Morris, The University of Melbourne, 161 Barry Street, Parkville, Melbourne Victoria, 3052, Australia.
Tel: +61 427974756; Fax: +61 427974756
Email: natasha.morris@unimelb.edu.au
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vulnerable to malutrition.

In many other healthcare services throughout Australia, the Malnutrition Screening Tool (MST)[10] is utilised as the risk screening tool. Despite the number of studies validating the MST in a variety of clinical settings and contexts,[10-17] the MST has not been validated for use among Indigenous patients and there are potentially key features of the MST that may erode its capacity to detect malnutrition in this vulnerable population.

The MST is a two-question tool that screens patients for unintentional weight loss, including the amount of recent weight loss, and patients' loss of appetite.[10] Patients are scored from 0 to 5 and patients with an MST score ≥2 are categorised at risk of malnutrition resulting in a subsequent referral to a dietitian. However, Indigenous Australian people may not able to contextualise the MST questions as many Indigenous people are multilingual where English is not their most common or frequent spoken language.[18] This issue may particularly apply to Indigenous people residing in outer regional, rural or remote regions where English may be their four or fifth spoken language.[18] It is therefore of upmost urgency to identify and validate a malnutrition screening tool to detect malnutrition among a group of patients who are vulnerable to malnutrition.

The objectives of this study were to validate the MST and a new malnutrition screening tool, the Adult Nutrition Tool© (ANT), for use among Indigenous Australian patients. We hypothesise that the MST may not be a valid screening tool for Indigenous Australians and therefore may not accurately detect malnutrition among this group of patients. We also hypothesise that the ANT will be a valid tool in detecting malnutrition among both Indigenous and non-Indigenous patients.

METHODS

Approval for this study was granted by Monash University (CF14/3350 2014001787); Central Australia (HREC-14-256); Menzies School of Health Research (HREC 2014-2282); and Far North Queensland (HREC/141QCH/86-927) Human Research Ethics Committees.

This is a prospective validation study conducted in three large regional hospitals including Alice Springs Hospital and Royal Darwin Hospital in the Northern Territory, and Cairns Hospital in Far North Queensland of Australia. These three hospitals are unique due to their geographical location and the relatively low-density population they service but higher proportion of Indigenous Australian patients compared to non-Indigenous patients.[19] This study included a convenience sample of adult Indigenous and non-Indigenous Australians admitted into medical inpatient settings during February 2015 and September 2015.[2] The eligibility criteria for this validation has been published elsewhere.[20] Briefly however, participant inclusion criteria were patients who were 18 years and over, who were admitted into a medical inpatient setting and were able to provide informed consent. As seen in Figure 1, study recruitment involved identifying eligible patients from respective hospitals' electronic medical databases and patient eligibility was screened against the study's inclusion and exclusion criteria by two study investigators at the beginning of each study day. Where disagreement or uncertainty occurred (for example, reason for medical admission), patients' eligibility criteria were reassessed by the two study investigators by reviewing patients' hard-copy medical records and confirmed by patients' treating doctor or nurse-in-charge.

Following study enrolment, participants were screened for malnutrition risk by a trained registered nurse or accredited dietitian using the MST and the ANT. As described earlier and shown in Figure 2 below, the MST is a two-item tool using a 5-point scoring system.[10] Participants who scored between 0 and 1 were classified as 'no risk' and participants who scored equal or greater than 2 were classified as 'at risk'.[10]

As seen in Figure 3 below, the ANT is a three-item screening tool with a scoring range of 0 to 7. The development and content validation of the ANT include four phases which are provided in more detail in Appendix A. In Phase 1, a search and review of existing malnutrition screening tools was undertaken by the first author (NM). This review included searching for screening tools that had been validated for use among Indigenous patients or patients from culturally diverse populations. Only one screening tool was identified that was a modified MST and included a third criterion requiring the clinician to use their clinical judgement whether the patient appeared undernourished.[21]

Phase 2 included the development of the ANT, modified from the MST. In collaboration with dietitians (including the first author of the MST and dietitian managers from each participating hospital), health language experts, and Aboriginal Liaison Officers from Alice Springs Hospital, questions one and two from the MST were modified to form two items of the ANT that relate to decreased food intake (item one) and weight loss (item two). A key difference between the MST and the ANT relates to item two regarding the amount of recent weight loss is quantified. Instead of asking patients to quantify their weight loss in kilograms, the ANT asks patients to quantify their using three categories: a lot; a little bit; or not sure. This categorisation was based on a pain scale rating that nurses may use to measure Indigenous patients level of pain when the numerical pain scale (pain score 0 to 10) is not understood by the patient.[22] The third and final item in the ANT, asks the clinical to make an assessment whether the patient looks 'undernourished' using the prompts: loss of muscle mass; subcutaneous fat loss; or hollow or sunken eyes. This third item was based on the modified MST by Frew et al[21] and the findings of Green et al[8] who found that nurses' professional judgement overrides screening tools.

Phase three included content validation by pilot testing the ANT in acute medical inpatients during November and December 2014. Testing of the ANT was undertaken using the SGA tool[23] and modifications to the scoring of ANT and final content validation was undertaken by the first author (NM) and the hospital dietitian managers included in this study.

Phase four included index testing of the ANT and was undertaken between February 2015 to September 2015. Participants were screened separately either by a trained registered nurse or an accredited dietitian. Participants

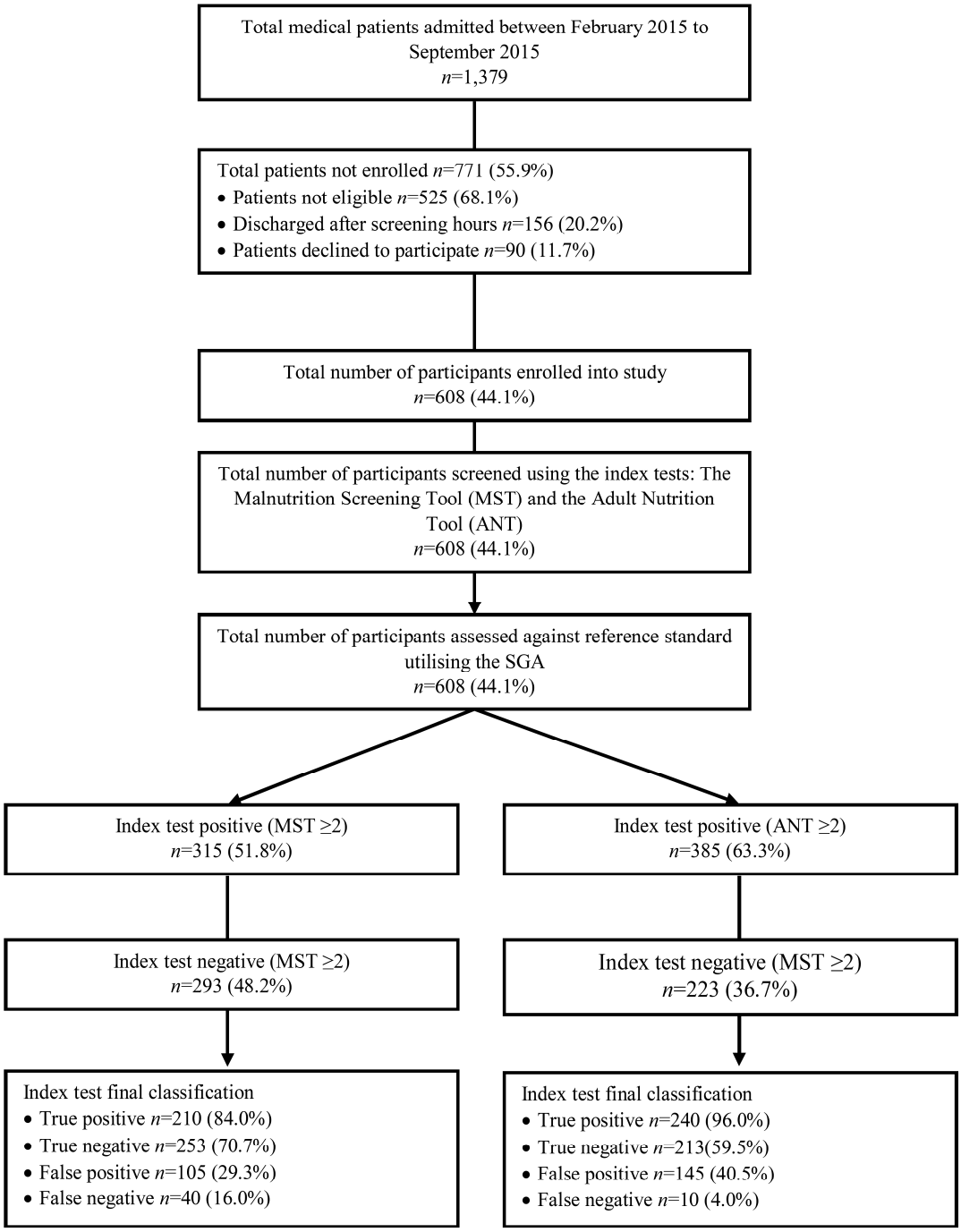

Figure 1. Study recruitment and index and reference standard testing.

The Malnutrition Screening Tool (MST).[10]

1. Have you/the patient lost weight recently without trying?	**Score**
No	0
Unsure	2
Yes, how much (kg)	
1–5 kg	1
6–10	2
5–11	3
>15	4
Unsure	2
2. Have you/the patient been eating poorly because of a decreased appetite?	
No	0
Yes	1

Figure 2. The Malnutrition Screening Tool (MST).

The Adult Nutrition Tool (ANT)©

1. Do you think you have been eating enough food lately?	**Score**
Yes	0
A little bit less *or* not sure	1
No	3
2. Do you think you have lost weight without trying? (prompt: ask the patient if they have been feeling weak or if their clothes have become loose recently)	
No	0
Not sure	1
Yes	2
If yes, how much weight do you think you have lost?	
A little bit	1
A lot	2
3. Does the patient look frail *or* undernourished? (assess the patient for signs of muscle wasting, poor skin integrity and/or loss of subcutaneous fat (i.e. hollow sunken eyes)).	
No	0
Somewhat (a little bit)	2
Yes	3

Figure 3. The Adult Nutrition Tool (ANT)©.

were screened either firstly using the MST followed by the ANT or vice versa (ANT followed by the MST). Immediately after screening, participants were assessed for malnutrition using the SGA tool.[23] At the end of each study day, participants' MST, ANT and SGA results were discussed and agreed upon between the two study investigators. Where disagreement or uncertainty occurred in respect to screening or SGA results, confirmation and agreement were sought from participants' respective medical ward dietitian.

Although there are no current studies that have validated the SGA specifically among Indigenous patients, we used the SGA as the reference standard in this study. The SGA is a validated nutrition assessment among medical patients that incorporates both subjective and objective data.[23] These data include: history of recent weight loss; oral intake; gastrointestinal symptoms; functional capacity; subcutaneous fat loss; muscle wasting; and signs of oedema or ascites.[23] As per the SGA criteria, participants with an SGA of 'A' were classified as 'nourished' and participants with an SGA of 'B' or 'C' were classified as 'malnourished'.[23]

A cut-off point of an MST equal or greater than two (≥2) was used to classify participants' 'at risk' of malnutrition according to the MST's original validation study.[10] A cut-off point using the ANT was determined where the sensitivity was equal or greater than 81% (very good)[24] and specificity equal or greater than 41% (moderate)[25] when referenced against the standard of an SGA of B or C (malnourished).

Data were entered and coded in Microsoft Excel for Windows, 2016 (Microsoft Office 2016®) and data analyses performed in Stata Release 15.1 (StataCorp LP, Texas, USA). Data for all 608 study participants were included in the data analyses and receiver operator characteristic (ROC) curves were developed and the area under the curve (AUC) were determined for the MST and the ANT using the SGA as the reference standard. In addition, the AUC for the MST and the ANT was determined after categorisation by participants' Indigenous status (Indigenous Australian or non-Indigenous Australian). Utilising the predetermined (MST ≥2) or yet to be determined ANT cut-off points; sensitivity, specificity, positive predictive value and negative predictive value were determined for all study participants and for subgroups categorised according to participants Indigenous status. A $p<0.05$ was taken to indicate statistical significance and all tests were two-sided. The sample size for this study was determined by the sample size required for the cross-sectional survey published elsewhere.[20]

RESULTS

Baseline demographic and clinical characteristics of study participants are described elsewhere.[2] As seen in Figure 1, a total of 608 participants were included in this validation study of which 271 (44.6%) were Indigenous Australian. According to the SGA, 250/608 (41.1%, 95% CI 37.2–45.1%) of participants were malnourished and of the 250 malnourished participants, 125/271 (46.1%, 95% CI 40.1–52.3%) Indigenous Australians were malnourished versus 125/337 (37.1%, 31.9–42.5%) non-Indigenous participants classified as malnourished.[2]

As seen in Figure 4, the unadjusted AUC utilising the ANT was significantly greater than the MST to predict malnutrition using the reference standard SGA for both Indigenous and non-Indigenous participants ($p<0.001$). As seen in Figures 5 and 6, the unadjusted AUC utilising the ANT was also significantly higher compared to the MST when comparing screening tools stratified by participants Indigenous and non-Indigenous status ($p<0.001$ and $p<0.001$ respectively). No significant difference was observed however when predicting malnutrition using the MST between Indigenous and non-Indigenous participants ($p<0.05$) and likewise; no significant difference was observed when predicting malnutrition using the ANT between Indigenous and non-Indigenous participants

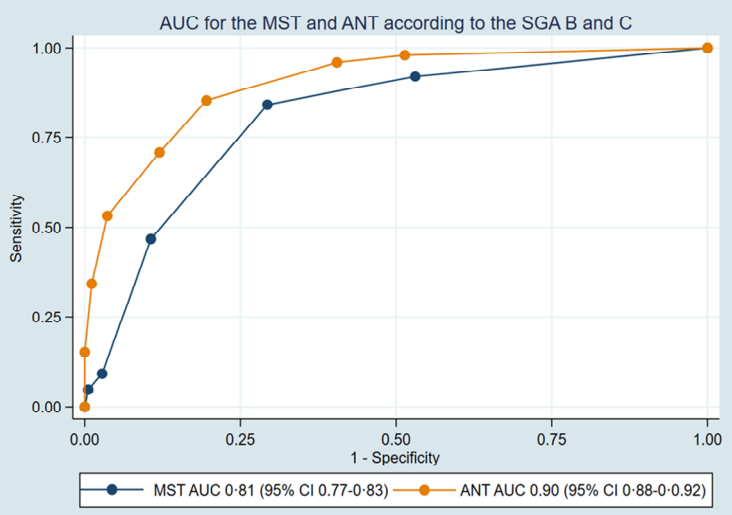

Figure 4. Area Under the Curve (AUC) for the Malnutrition Screening Tool (MST score range = 0 to 5) and the Adult Nutrition Tool (ANT score range = 0 to 7) according the reference standard, Subjective Global Assessment (SGA B or C = malnourished) among both Indigenous and non-Indigenous participants.

(p<0.05).

As summarised in Table 1, an ANT ≥2 demonstrated superior sensitivity to a MST ≥2 but with inferior specificity in Indigenous and non-Indigenous participants. Only 10 (10/250, 4.0%, 95% CI 1.9–7.2%) malnourished participants tested false negative for malnutrition with an ANT ≥2 compared to 40 (40/250, 16.0%, 95% CI 11.7–21.1%) malnourished patients testing false negative with a MST score ≥2. Similarly, an ANT ≥2 demonstrated superior sensitivity for Indigenous malnourished patients but with overall inferior specificity. Five (5/125, 4.0%, 95% CI 0.13–0.91%) malnourished Indigenous participants tested false negative utilising an ANT ≥2 compared to 15 malnourished Indigenous participants (15/125, 12.0%, 95% CI 6.9–19.0%) testing false negative with a MST ≥2. For non-Indigenous Australian participants, an ANT ≥2 also demonstrated superior sensitivity compared to a MST ≥2 or ANT ≥3 but with inferior specificity. For non-Indigenous participants who were malnourished, five (5/125, 4.0%, 95% CI 0.10–0.90%) tested false negative with an ANT ≥2 compared to 25 (25/125, 20%, 95% CI 13.4–28.1%) who tested false negative with a MST ≥2.

DISCUSSION

This study represents a cohort of Indigenous and non-Indigenous medical inpatients admitted into three regional Australian hospitals. We found that although the MST is a validated tool in a variety of different clinical contexts, the newly developed ANT is a valid screening tool for Indigenous and non-Indigenous Australian patients. In our study, we found that the MST had limited sensitivity and specificity for predicting malnutrition risk in Indigenous and non-Indigenous patients when referenced against the SGA. In practical terms, in this study's context, for every 100 patients screened, the MST will miss 16 patients who should be referred for further nutritional assessment and management compared to an ANT score ≥2 which will miss a total of four patients who are malnourished. The greater sensitivity of an ANT ≥2 was offset by a lower specificity than the MST. For every 100 patients screened with an ANT ≥2, nearly 41 patients will test false-positive for malnutrition, compared to nearly 30 nourished patients using the MST.

To facilitate malnutrition screening by clinicians and engage nurses in screening, it is important that screening tools permit clinicians to exercise their clinical expertise and judgements when screening patients for malnutrition. In Green et al's study,[8] screening tools that do not facilitate nurses to apply their clinical knowledge when screening patients for malnutrition resulted in the reduced uptake of screening. Overriding or not affording clinicians to use their clinical expertise, may result in misclassification of patients and potentially contributing to adverse health outcomes due to untreated malnutrition.[8] Therefore, screening tools (like ANT) that incorporate nurses (or other clinicians) to make an assessment and clinical decision that a patient is undernourished may enable and increase the uptake of patient screening.

While some screening tools like the Malnutrition Universal Screening Tool (MUST)[26] include objective data into their screening tool (for example, BMI), many screening tools rely on subjective data and their validity threatened by patient recall. In our study setting, acute or recent changes in weight may not easily be noticed by Indigenous Australian people due to the number and severity of chronic disease they experience.[27] This is compounded in rural and remote settings, where potentially access to weighing scales may be restricted when compared to Indigenous people residing in outer-regional or metropolitan settings. However, our study is not the first validation study to modify the MST that incorporated clinicians' clinical expertise. As described earlier, Frew et al[21] validated a modified MST against the SGA for patients with advanced age and for patients from culturally diverse backgrounds with limited English language skills with the addition of a third criterion "Does the patient look obviously frail/underweight" (p. 72) with a binary 'yes' or 'no' response.[21] The modified MST included a cut-off point ≥2 and the sensitivity and specificity of the modified MST was 77% and 83% respectively.[21] In our study, ANT demonstrated superior sensitivity (96.0%) but with inferior specificity (59.5%) than the modified MST.

Table 1. Predicting malnutrition risk as defined by SGA and the (MST) and the ANT©

	Sensitivity % (95% CI)	Specificity % (95% CI)	Positive predictive value % (95% CI)	Negative predictive value % (95% CI)	Area under the curve % (95% CI)	Correct classification rate %
MST ≥2						
All participants	84.0 (78.9–88.3)	70.7 (65.7–75.3)	66.7 (61.2–71.9)	86.3 (81.9–90.1)	0.81 (0.77–0.84)	76.2
Indigenous	88.0 (81.0–93.1)	63.7 (55.3–71.5)	67.5 (59.7–74.6)	86.1 (78.1–92.0)	0.78 (0.73–0.83)	74.9
Australian non-Indigenous Australian	80.0 (71.9–86.6)	75.5 (69.1–81.1)	65.8 (57.7–73.3)	86.5 (80.7–91.1)	0.82 (77.3–0.86)	77.2
ANT ≥2						
All participants	96.0 (92.8–98.7)	59.5 (54.2–64.6)	62.3 (57.3–67.2)	95.5 (91.9–97.8)	0.78 (0.75–0.81)	74.5
Indigenous Australians	96.0 (90.9–98.7)	58.9 (50.5–67.0)	66.7 (59.3–73.5)	94.5 (87.6–98.2)	0.77 (0.73–0.82)	76.0
non-Indigenous Australian	96.0 (90.9–98.7)	59.9 (53.0–66.6)	58.5 (51.5–65.4)	96.2 (91.4–98.8)	0.78 (0.74–0.82)	73.3

MST: Malnutrition Screening Tool; ANT: Adult Nutrition Tool; CI: confidence interval.

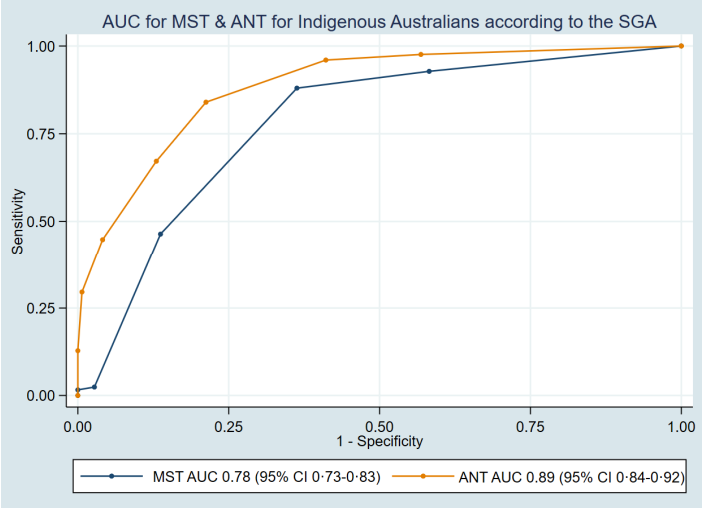

Figure 5. Area Under the Curve (AUC) for the Malnutrition Screening Tool (MST score range = 0 to 5) and the Adult Nutrition Tool (ANT score range = 0 to 7) for Indigenous Australian participants according to the reference standard, the Subjective Global Assessment (SGA B or C = malnourished).

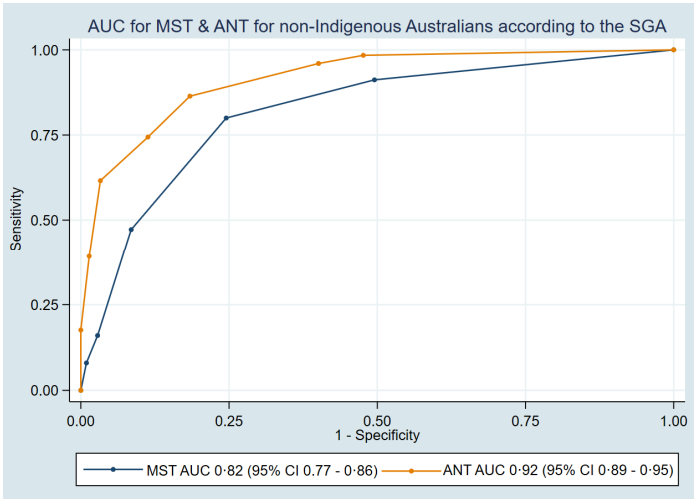

Figure 6. Area Under the Curve (AUC) for the Malnutrition Screening Tool (MST score range = 0 to 5) and the Adult Nutrition Tool (ANT score range = 0 to 7) for non-Indigenous Australian participants according to the reference standard, Subjective Global Assessment (SGA B or C = malnourished).

Furthermore, in consultation with Aboriginal Liaison Officers language such as 'underweight' or reference to being 'skinny' was not culturally appropriate terms and in ANT, the word 'under-nourished' was used to avoid reference to body size and to also consider patients who may have a high BMI (≥25.0 kg/m^2) who may have protein-energy malnutrition.

While utilising an ANT ≥2 is likely to generate greater referral of adequately nourished patients to dietetic services, in our study cohort, utilising an ANT ≥2 resulted in identifying 30 patients who were malnourished that may have otherwise not been identified. While an ANT ≥2 has overall lower specificity than the MST, we argue that the costs associated with unnecessary dietetic referrals reduces potential harm to patients. A small increase in referral of patients eventually assessed to be adequately nourished is likely to be outweighed by the additional costs associated with not detecting and treating patients with malnutrition.[28]

In our study context, the ANT is a superior screening tool to the MST for both Indigenous and non-Indigenous patients as the ultimate intention for screening is to detect malnourished patients. While the ANT with a cut-off point ≥2 may result in a small increase in unnecessary referrals when compared to the MST, it is more likely to detect malnutrition among Indigenous and non-Indigenous patients and facilitate early nutritional assessment and intervention. Moving forward however, further research is required to explore new approaches to malnutrition screening in addition to subjective patient history such as weight loss and food intake. For example, in our earlier study, we found that acute and chronic disease severity indices were independent predictors for malnutrition among Indigenous and non-Indigenous patients and therefore future studies exploring the use of disease severity indices should be explored to determine their use in detecting malnutrition.[2] Furthermore, clinicians responsible for screening should receive education and training on how to assess for protein-energy malnutrition in the context of acute care settings in patients who are often admitted with several chronic and complex diseases and further research is required to identify enablers

of malnutrition screening by clinicians.

In addition to our study's research aim to validate a malnutrition screening tool for use among Indigenous Australian participants, this is the first known study to use the SGA specifically among Indigenous patients. In Australia, only one published study has measured the burden of malnutrition among Indigenous patients with end stage kidney disease using the Patient Generated Subjective Global Assessment (PG-SGA).[29] In this study, only 25 patients were identified as Aboriginal Australian and/or Torres Strait Islander and nine (35%) were found to be malnourished.[28] The SGA has been validated among patients admitted into acute healthcare services and we recommend the SGA as a validated tool for use among Indigenous patients.

One of the major limitations of this study is that the ANT has only been validated among medical inpatients and thus its generalisability to other inpatient groups is therefore limited. Although this tool has been validated as a screening tool for Indigenous and non-Indigenous patients, further validations studies are required in other patient populations such as surgical, renal and oncology patients. Another main limitation of this study, that although the study investigators reviewed and confirmed each study participants' screening and SGA results at the end of each study day, the investigators were not blinded to participants nutrition status therefore potentially introducing research bias. This study did not test the inter-rater reliability of the ANT and future studies should be undertaken to establish the performance of this tool by healthcare providers responsible for screening patients for malnutrition.

Conclusion

This is the first study to validate a new malnutrition screening tool designed specifically for Indigenous Australian patients and the first study to utilise the SGA specifically among Indigenous Australian patients. We found that the Adult Nutrition Tool – ANT is a validated tool for screening Indigenous and non-Indigenous Australian medical inpatients for malnutrition. Overall, utilising an ANT ≥2 is highly sensitive for predicting malnutrition in both Indigenous and non-Indigenous patients but may result in an increase in unnecessary dietetic referrals. We argue, given the impact of malnutrition on both patients and healthcare services, including dietetic resources, the benefits of utilising an ANT ≥2 are likely to outweigh any potential additional costs associated with a small increase in ultimately unnecessary dietetic referrals for nourished patients. Further research will be required to ensure the utility of the ANT remains robust when used in routine clinical care as a screening tool to detect malnutrition in adult Indigenous and non-Indigenous Australian hospital patients.

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AUTHOR DISCLOSURES

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