

Malnutrition screening tools

Comparison against two validated nutrition assessment methods in older medical inpatients

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1 **TITLE:** Malnutrition screening tools: comparison against two validated nutrition assessment
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3 **RUNNING HEAD:** Malnutrition screening tools in older inpatients

4

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Abstract

Objective: While several validated nutrition screening tools have been developed to “triage” inpatients for malnutrition diagnosis and intervention, there continues to be debate in the literature as to which tool/s clinicians should use in practice. This study compares the accuracy of seven validated screening tools in older medical inpatients against two validated nutrition assessment methods.

Research methods and procedures: Prospective cohort study of medical inpatients aged ≥ 65 years. Malnutrition screening was conducted using seven tools recommended in evidence-based guidelines. Nutritional status was assessed by Accredited Practicing Dietitian using Subjective Global Assessment (SGA) and Mini-Nutritional Assessment (MNA). Energy intake was observed on a single day during first week of hospitalisation.

Results: In this sample of 134 participants (80 ± 8 years, 50% female), there was fair agreement between SGA and MNA ($\kappa=0.53$), with MNA identifying more “at risk” patients and SGA better identifying existing malnutrition. Most tools were accurate in identifying patients with malnutrition determined by SGA, particularly Malnutrition Screening Tool and Nutritional Risk Screening 2002. MNA Short Form was most accurate at identifying nutrition risk according to MNA. No tool accurately predicted patients with inadequate energy intake in hospital.

Conclusion: As all tools generally performed well, clinicians should consider choosing a screening tool which best aligns with their chosen nutrition assessment and is easiest to implement in practice. This study confirms the importance of re-screening and monitoring food intake to allow early identification and prevention of nutritional decline in patients with poor intake during hospitalisation.

Keywords: undernutrition, diagnosis, triage, hospitalization; aged

60 INTRODUCTION

61 Despite the high prevalence and negative health consequences, protein-energy malnutrition in
62 elderly hospital patients continues to be under-recognised and under-treated [1-2].

63 Malnutrition screening is recommended as the first step in nutrition care to allow early
64 identification and treatment malnutrition [2-4]. A screening tool needs to be quick, simple
65 and accurately identify patients with possible malnutrition to allow efficient targeting of
66 resources for nutrition assessment [5,6]. Ideally, such a tool would identify all malnourished
67 patients for assessment (high sensitivity), with a positive screen identifying no well nourished
68 patients (high positive predictive value) [7].

69

70 A range of validated screening tools have been recommended for use in elderly and/or
71 hospital populations (Table 1). Malnutrition Screening Tool (MST [8]) is the most common
72 screening tool used in Australian hospitals [9], while Nutrition Risk Screening (NRS 2002
73 [10]) tool has been successfully implemented throughout Europe [11]. Mini-Nutritional
74 Assessment Short Form (MNA-SF [12]) is recommended for screening elderly people across
75 settings [4]. Simplified Nutritional Appetite Questionnaire (SNAQ [13]) and Rapid Screen
76 [14] were developed in community-dwelling populations, but have not yet been validated in
77 the hospital setting. There are distinct similarities between tools with most including recent
78 change in weight and food intake, with some accounting for body mass index (BMI) and
79 acute disease (Table 1).

80 A major limitation in validating malnutrition screening tools is the absence of a single
81 objective measure or “gold standard” for diagnosing malnutrition [27]. Subjective Global
82 Assessment (SGA [25]) and Mini-Nutritional Assessment (MNA [26]) are both widely-used
83 validated nutrition assessments which use a range of parameters to make a nutritional
84 diagnosis and initiate treatment, have been recommended as outcomes in clinical trials [28]
85 and predict health outcomes in elderly hospital patients [29-30]. There is a key difference
86 between nutrition assessment and nutrition screening [31]: SGA and MNA are
87 comprehensive nutrition *assessments* used by trained professionals (e.g. dietitians,
88 physicians, trained nurses or research assistants) to diagnose malnutrition and initiate
89 nutrition intervention. In contrast, nutrition *screening* tools (such as those in Table 1) are
90 intended as a quick and easy method for identifying possible malnutrition and to “triage”
91 patients for comprehensive nutrition assessment and intervention. While SGA and MNA are
92 both recommended for use in diagnosing malnutrition in the elderly [2], there are substantial
93 differences between the parameters of these assessments, meaning that different “at risk”
94 groups may be identified [21,32]. While previous research has compared existing nutrition
95 screening tools, no study has concurrently investigated the validity of these tools against both
96 SGA and MNA.

97
98 Studies have shown that nutritional status declines during hospitalisation [33] and that
99 nutritional intake is suboptimal [1,34-35]. In elderly hospital patients, it has become clear that
100 malnutrition on admission does not necessarily predict poor nutritional intake during
101 hospitalisation [1]. In fact, many well-nourished inpatients eat poorly, presenting a second
102 group of patients who should be identified early in their hospital admission to prevent
103 malnutrition. This highlights the importance of screening and re-screening elderly patients to
104 not only pick up existing malnutrition, but also those at risk of poor intake during

105 hospitalisation. While malnutrition screening tools are now commonly used to identify
106 existing malnutrition [9,11], there are no screening tools to proactively identify patients at
107 risk of poor nutritional intake during hospitalisation.

108

109 This study aims to a) compare the assessment of malnutrition using SGA and MNA in elderly
110 medical inpatients, b) compare the accuracy of seven nutrition screening tools in identifying
111 patients with malnutrition as assessed by SGA and MNA and c) compare the predictive
112 accuracy of screening tools to identify patients with poor energy intake during the first week
113 of hospitalisation.

114 MATERIALS AND METHODS

115 This was a prospective cohort study conducted in medical wards of the Royal Brisbane and
116 Women's Hospital, a large metropolitan public teaching hospital in Brisbane, Australia, and
117 was part of a larger observational study of nutritional intake in older medical patients [1]. The
118 study was approved by the hospital human research ethics committee.

119
120 Consecutive patients aged 65 years or older with a hospital stay of more than two days were
121 recruited between November 2007 and March 2008. Between day 3 and day 7 of admission, a
122 single trained dietitian (AY) screened each patient with MST, MNA-SF, Malnutrition
123 Universal Screening Tool (MUST), NRS 2002, Short Nutritional Assessment Questionnaire
124 (SNAQ[©]), Simplified Nutritional Appetite Questionnaire (SNAQ) and Rapid Screen
125 (presented in Table 1). We draw the reader's attention to the differences between the two
126 "SNAQ" tools in Table 1. These screening tools were selected as they are recommended for
127 use in evidence-based practice guidelines [2,3]. Each tool was performed separately and as
128 per authors' instructions. The same dietitian assessed each participant using SGA [25] and
129 MNA [26]. Nutrition screening and assessment data was available for all participants, with
130 the exception of SNAQ (missing data for 2 participants).

131
132 Dietary intake was measured at breakfast, lunch and dinner on the same day of nutrition
133 screening and assessment. Plate waste of each meal component (e.g. soup, meat, vegetables)
134 was visually estimated, which correlates closely to weighed methods [36]. Mid-meal intake,
135 including snacks and/or nutrition supplements (ordered for 20% of participants as per existing
136 nutrition support protocol) was estimated by observation and/or patient recall. It has
137 previously been shown that food intake on a single day during hospitalisation closely
138 correlates with intake over two or three days [1,37]. Energy intake was determined using

139 known food composition data of each meal component and analysis of standardised recipes in
140 FoodWorks Professional software (version 3.02, Xyris, Brisbane Australia 2004). Resting
141 energy expenditure (REE) was calculated as 18.4 kcal/kg bodyweight/day for patients with
142 BMI $>21\text{kg/m}^2$ and 21.4 kcal/kg/day for those with BMI $\leq 21\text{ kg/m}^2$ [38].

143

144 Nutrition assessments were categorised as “well nourished” (SGA A; MNA score ≥ 24) or
145 “malnourished or at risk of malnutrition” (SGA B or C; MNA score <24). Scores for each
146 screening tool were also categorised into “no/ low risk” or “at risk” of malnutrition, using
147 recommended cut-points (Table 1). Inadequate energy intake was defined as measured energy
148 intake less than REE.

149

150 Participant characteristics were summarised using mean and standard deviation (SD) for continuous
151 variables, or categorised according to validated cut-offs and clinical meaning. To compare the
152 performance of the two nutrition assessments (SGA and MNA), kappa statistics were calculated and
153 interpreted using criteria by Shrout [39]. To compare the accuracy of each screening tool to detect
154 malnutrition as diagnosed using each nutrition assessment, sensitivity, specificity, positive
155 predictive value (PPV) and negative predictive value (NPV) were calculated. Sensitivity is defined
156 as the proportion of malnourished correctly identified as such, whereas specificity is the proportion
157 of well-nourished who are correctly identified as well-nourished. PPV is the proportion of patients
158 with a positive screen who are malnourished. Conversely, NPV is the proportion of patients with a
159 negative screen who are well-nourished. These were calculated for the three outcomes of interest:
160 (1) malnutrition assessed using SGA; (2) malnutrition assessed using MNA; and (3) inadequate
161 energy intake. In further analysis, raw scores for each tool (except Rapid Screen which produces
162 dichotomous data) were used to construct receiver operating characteristic (ROC) curves where the
163 sensitivity was plotted against the false positive rate (1 – specificity) for each outcome of interest.

164 Area under the curve (AUC) values for each ROC curve were interpreted as follows: acceptable
165 (0.70–0.80), excellent (0.80–0.90), outstanding (>0.90) [40]. ROC analysis was also used to explore
166 instrument cut-points.
167

168 **RESULTS**

169 **Participants and nutrition assessments**

170 Over the 16 week study period, 134 patients (mean age 80 years (SD 8), 50% female, mean
171 weight 70 kg (SD 17), mean BMI 26 kg/m² (SD 6).and median length of stay 8 days (IQR 8))
172 consented to participate in the study (38% consent rate). One participant was excluded due to
173 incomplete data. Participant characteristics are shown in Table 2. Non-participants had
174 similar demographic characteristics and length of stay, but were more likely to be discharged
175 to residential aged care (24% vs 13%).

176

177 There was fair agreement between SGA and MNA ($\kappa=0.53$, 95% CI 0.40-0.66; Table 3).

178 More participants were assessed as “at risk” or “malnourished” using MNA (68%) than with
179 SGA (47% malnutrition).

180

181 **Malnutrition as determined by Subjective Global Assessment**

182 The performance of each screening tool to identify malnutrition determined by SGA (rating
183 of B or C) is summarised in Table 4. MST, NRS 2002, MUST and SNAQ© all had high
184 sensitivity and PPV, with MST and NRS-2002 achieving slightly better NPV. While MNA-
185 SF and SNAQ were highly sensitive, they had a lower specificity and PPV, meaning more
186 well-nourished patients would be identified for assessment. Conversely, Rapid Screen was
187 highly specific but had a very low sensitivity (29%), indicating that many malnourished
188 patients may be missed using this tool.

189

190 All tools (excluding Rapid Screen) showed excellent to outstanding discrimination between
191 those who were and those who were not malnourished using AUC analysis. The cut-off point

192 for MNA-SF with the highest accuracy in this sample was ≤ 8 (compared with the published
193 cut-off of ≤ 11), with sensitivity and specificity of 89%.

194

195 **Malnutrition risk as determined by Mini-Nutritional Assessment**

196 When malnutrition was determined using MNA (score of < 24), MNA-SF was most sensitive,
197 with a good PPV (Table 5). All other tools tested were highly specific but were less sensitive.

198 In particular, Rapid Screen had very low sensitivity in this sample (20%).

199

200 Using AUC analysis, MNA-SF was outstanding at discriminating between those who were
201 and those who were not at risk of malnutrition with MNA. All other tools showed excellent
202 discrimination, with ROC curves demonstrating that using lower cut-points for MST, NRS-
203 2002 and SNAQ[©] and higher cut-point for SNAQ may increase the sensitivity of these tools
204 to identify malnutrition risk determined by MNA.

205

206 **Inadequate energy intake**

207 The majority of participants (59%) had inadequate energy intake to meet estimated REE. All
208 screening tools had low sensitivity and specificity for predicting patients with inadequate energy
209 intake on a single day during their first week of hospitalisation (see Table 6). AUC analysis shows
210 that no screening tool adequately discriminated between those who had adequate versus inadequate
211 energy intake. SNAQ obtained the highest level of discrimination (0.66), but did not reach an
212 acceptable level.

213 **DISCUSSION**

214 This study compares the accuracy of validated malnutrition screening tools against two
215 commonly used nutrition assessments (SGA and MNA) in a sample of elderly medical
216 inpatients. Only fair agreement was found between SGA and MNA ($\kappa=0.53$), indicating that
217 these nutrition assessments identify different “at risk” groups. Velasco [19] reported similar
218 agreement between SGA and MNA ($\kappa=0.49$) in their study of 400 hospital patients, as did
219 Persson [32] and Martins [21] who proposed that, due to its “holistic” approach, the MNA,
220 identifies those “at risk”, as well as those with existing malnutrition. In contrast, SGA
221 identifies existing malnutrition only. Choice of nutritional assessment tool should be guided
222 by the goal of therapy; that is, whether the goal is prevention or treatment-focused [21,32,41].
223 This suggests that MNA may be better suited where a service aims to prevent malnutrition or
224 where there is a well-resourced dietetic workforce, while SGA may be more useful in the
225 acute setting for identifying existing malnutrition to be prioritised for treatment during the
226 short time-frame of hospitalisation.

227

228 The primary objective of this study was to compare the performance of seven screening tools
229 to identify patients with malnutrition. When nutritional status was assessed using SGA, most
230 tools performed with high sensitivity and specificity with MST and NRS 2002 having the
231 highest accuracy. In the current study, the increased complexity of NRS 2002 (which
232 includes medical condition and BMI) did not improve accuracy compared to the simpler
233 MST. Similar accuracy between simple screening tools (MST and SNAQ©) and more
234 comprehensive tools (MUST and NRS-2002) has been reported previously [42]. As it is
235 important that nutritional screening is quick, easy and can be completed by anyone (e.g.
236 nursing, medical staff, allied health assistants or patients themselves) [3], MST is
237 recommended as a highly accurate and user-friendly malnutrition screening tool [6,42]. Other

238 review papers have found NRS-2002 and MUST to also have high accuracy [19-20]. As
239 outlined in Table 1, the screening tools compared in this study include similar parameters, so
240 it is not unexpected that they have similar performance.

241
242 As reported previously, MNA-SF had high sensitivity and specificity when used with MNA
243 [16-17]; however poor specificity and PPV was observed when compared with SGA. MNA-
244 SF was designed to identify patients requiring further assessment with MNA, and the poor
245 performance against SGA is likely to be due to the different focus of MNA and SGA as
246 discussed above. A recent study of 275 hospital patients also reported low specificity of
247 MNA-SF in identifying existing malnutrition [42]. To improve specificity of MNA-SF,
248 clinicians could consider reducing the cut-off of the MNA-SF score, as suggested by the
249 original authors [12]. While the revised MNA-SF (where BMI is substituted for calf
250 circumference) was not tested in this study, this tool could be expected to perform similarly
251 to the original MNA-SF as shown previously [17]. Rapid Screen had very poor sensitivity
252 against both SGA and MNA, suggesting it may only identify the most severely malnourished.
253 Further validation studies are recommended before this tool is used with elderly hospital
254 patients.

255
256 In summary, with the exception of Rapid Screen, all tools (including simple tools such as
257 MST) were accurate in identifying malnutrition using SGA and can therefore be
258 recommended for use in elderly hospital patients. While the MNA-SF was accurate, it
259 identifies a larger number of “at risk” patients, **also reported Raslan et al. [43]**, and,
260 therefore, should be chosen only where health services have sufficient resources to provide
261 nutritional assessment and intervention to all “at risk” patients. When choosing which

262 screening tools to use in practice, clinicians should consider which tool is simple to
263 implement, as well as resources available to provide nutritional care to all “at risk” patients.
264

265 In this study, the majority of participants had inadequate energy intakes. However, no
266 screening tool accurately discriminated between those with adequate and inadequate intake.
267 While all screening tools, with the exception of Rapid Screen, include a brief assessment of
268 recent dietary intake, this study has found that they do not adequately identify those with poor
269 intake during hospitalisation. This finding may reflect the other important predictors of poor
270 nutritional intake, such as delirium and feeding dependency [2], which are not all adequately
271 covered in these screening tools. Barriers to nutritional intake may also be related to the
272 hospital environment and culture, for example quality of hospital food, interruptions during
273 mealtimes and lack of mealtime assistance [44]. This study demonstrates an absence of
274 existing screening tools to proactively identify patients at risk of poor nutritional intake, and
275 supports the concept of two discrete nutritionally “at risk” groups for which different
276 nutrition care processes are required: malnutrition screening to identify existing malnutrition
277 and close monitoring of food intake to identify inadequate nutritional intake.
278

279 This is the first study to compare a range of screening tools against two recommended
280 nutrition assessments in elderly hospital patients. It is also the first study to consider the
281 accuracy of these tools to identify poor nutritional intake in hospital, which is common in this
282 patient group. We do recognise some study weaknesses. While the assessment tools (SGA
283 and MNA) are widely used by health professionals and the research community to diagnose
284 malnutrition, there is no single objective measure of malnutrition to validate screening tools
285 against. An important part of assessing the performance of a screening tool is to consider the
286 reliability of the tool. As one dietitian performed all screening and assessments in this study,

287 the reliability of measurements is enhanced. However, we are unable to comment more
288 generally on the reliability of the tools or the performance of the tools when used by non-
289 dietetic staff. However, the high inter-rater reliability of the tools has been reported
290 previously [8,22,24]. Dietary intake was measured only on a single day, but we have shown
291 close correlation between intake on day 3 and 7 of hospitalisation [1]. A further limitation of
292 assessment of dietary intake was the estimation of energy requirements of individual
293 participants, rather than measurement using indirect calorimetry. The low consent rate may
294 have resulted in underrepresentation of the frailest group of patients, as fewer participants
295 were discharged to residential aged care compared with the general elderly medical
296 population. However, this is not likely to have affected the comparison of the screening tools.
297

298 **CONCLUSION**

299 With the exception of Rapid Screen, all screening tools were accurate in identifying
300 malnutrition (as assessed by common clinical assessment tools) and therefore can be
301 recommended for use in elderly hospital patients. No tool predicted poor nutritional intake
302 during hospitalisation, highlighting importance of re-screening and monitoring intake to
303 allow early identification and prevention of nutritional decline.

304 **CONFLICT OF INTEREST STATEMENT**

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308

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