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ORIGINAL ARTICLE

Development and validation of a hospital screening tool for malnutrition: the short nutritional assessment questionnaire (SNAQ©)

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Summary *Objective*: For the early detection and treatment of malnourished hospital patients no valid screening instrument for the Dutch language exists. Calculation of percentage weight loss and body mass index (BMI) by the nurse at admission to the hospital appeared to be not feasible. Therefore, the short, nutritional assessment questionnaire (SNAQ©), was developed.

Research, design and methods: Two hundred and ninety one patients on the mixed internal and surgery/oncology wards of the VU University medical center were screened on nutritional status and classified as well nourished ($<5\%$ weight loss in the last 6 months and BMI >18.5), moderately malnourished (5–10% weight loss in the last 6 months and BMI >18.5) or severely malnourished ($>10\%$ weight loss in the last 6 months or $>5\%$ in the last month or BMI <18.5). All patients were asked 26 questions related to eating and drinking difficulties, defecation, condition and pain. Odds ratio, binary and multinomial logistic regression were used to determine the set of questions that best predicts the nutritional status. Based on the regression coefficient a score was composed to detect moderately ($\geqslant 2$ points) and severely ($\geqslant 3$ points) malnourished patients. The validity, the nurse–nurse reproducibility and nurse–dietitian reproducibility was tested in another but similar population of 297 patients.

Results: The questions 'Did you lose weight unintentionally?'. 'Did you experience a decreased appetite over the last month?' and 'Did you use supplemental drinks or tube feeding over the last month?' were most predictive of malnutrition. The instrument proved to be valid and reproducible.

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Conclusion: SNAQ© is an easy, short, valid and reproducible questionnaire for early detection of hospital malnutrition.

Introduction

Malnutrition is a state of nutrition in which a deficiency or excess or imbalance of energy, protein and other nutrients, causes measurable adverse effects on tissue or body form (body shape, size and composition), function, and clinical outcome.[1] This broad definition implies that malnutrition may arise from a wide range of conditions that differ in severity and cause. In Western countries, undernutrition is considered to be only a minor problem compared with that of overweight.

In hospital settings however, there is growing awareness that undernutrition may play an important role in the course of the treatment of patients. The body mass index (BMI) (weight/length^2) can be used to provide an approximate guide to the probability of chronic undernutrition. One of the most commonly used cut-off values to define this kind of malnutrition is a BMI <18.5.[1–4] This index does, however, usually not give information about the unintentional recent weight change that is often accompanying underlying disease. Several clinical studies have demonstrated that recent involuntary weight loss $>10\%$ in 6 months is a good indicator of more acute undernutrition.[1,5–8]

In 2001, the Dutch Dietetic Association conducted a national screening on disease related malnutrition in 6150 hospital patients at 56 different locations.[9] Based on the generally acceptable definitions of malnutrition, disease related malnutrition was defined as $>10\%$ involuntary weight loss [1,5–8] or BMI <18.5.[1–3] In this study, about 25% of the hospital patients appeared to be malnourished. Only 50% of the malnourished patients were recognised by the nursing and medical staff.[9]

In an ideal situation the physician or the nurse calculates the BMI and the percentage of involuntary weight loss over the last months at the first day of patients' admission to the hospital. With this information the physician and/or the nurse can decide which patients are malnourished and should be referred to a dietitian. In practice nurses or physicians do not have time to calculate indices of nutritional status. Thus, hospital malnutrition often remains unidentified. Therefore, our team developed a short questionnaire that can be integrated in the nurses' intake of the patient at admission to the hospital and costs less than 5 min time. This questionnaire divides hospital patients into three groups: well nourished, moderately malnourished and severely malnourished. Using this questionnaire, malnourished patients are recognized at admission and referred to dietitian in an early stage. This article describes the process of the development of the so called short nutritional assessment questionnaire (SNAQ©). In addition, it reports the results of the diagnostic value and reproducibility of the SNAQ©.

Research design and methods

The development of the SNAQ© is based on the results of nutritional status data and characteristics of 291 patients (population A). The validity of the SNAQ© is tested in a similar population (population B) (cross validation). The reproducibility of the SNAQ© is also tested in population B.

Questionnaire development study (population A)

Subjects

Two hundred and ninety one patients, admitted to a mixed internal ward (internal medicine, gastroenterology, dermatology, nephrology) and a mixed surgical ward (general surgery and surgical oncology) of the VU University medical center in the period of April until October 2002, were included in the study. Patients who were not able to give informed consent, could not be weighed or were younger than 18 years of age were excluded from the study. The study-design was approved by the medical ethical commission of the VU University medical center.

Nutritional status

On the day of the admission to the hospital, all patients were weighed on the same calibrated scale (SECA 880) and their height was asked for. When patients did not know their height, it was measured (SECA 220). Patients were asked whether they had lost weight unintentionally over the last month and the last 6 months. Patients were considered severely malnourished if one or more of the following conditions were present: a BMI <18.5,[1–4] unintentional weight loss of more than

5% in the last month or more than 10% in the last 6 months. Patients were considered moderately malnourished when they had lost 5–10% of their weight unintentionally in the last 6 months.[1,5–8] Based on the most commonly accepted standards from the literature, this definition of nutritional status was used as the ''objective standard of malnutrition'' against which the questions from the questionnaire were validated.

Questionnaire

On the day of admission to the hospital, all patients completed a detailed questionnaire on symptoms and risk factors of malnutrition. The questionnaire consisted of 26 nutrition-related questions (Table 2) adopted from the quality of life questionnaires EORTC-C30 and EORTC H&N 35,[10] and from complex screening instruments which are too complex and time-consuming for the daily hospital situation (Nutricia Nutritional Screening List, Mini Nutritional Assessment,[11] Subjective Global Assessment).[12] The questionnaire was completed with questions of experts (dietitians, nutritionists) who also unanimously approved the questionnaire.

Analysis

To select symptoms and risk factors that could be used to identify subjects with malnutrition, selection of questions predictive of malnutrition was performed in three phases to finally make up a short and simple questionnaire, the SNAQ©.

First, the odds ratio was calculated for each question of the questionnaire with the presence or absence of malnutrition as dependent variable. All questions with a statistically significant odds ratio ($P<0.05$) were included in the next phase.

Second, logistic regression was carried out with the presence or absence of malnutrition as dependent variable and with questions with a significant odds ratio as independent variables. The questions associated with malnutrition at a significance level of $P<0.05$ in a backward stepwise procedure were selected for the next phase of the analysis.

Third, multinomial logistic regression was carried out with severe malnutrition, moderate malnutrition and no malnutrition as the dependent variable and the questions from phase two as the independent variables using $P<0.05$ as selection criterion. This model contained all the finally selected items together.

The probability of a patient being malnourished can be predicted by the following regression equation, in which the categorization is based on a continuous function of P between 0 and 1: $P(\text{malnourished})=1+e-(a+b_1x_1+b_2x_2+b_3x_3+b_xx_x)^{-1}$ where P(malnourished) represents the probability of being malnourished, a is the constant and b_1, b_2, b_3 and b_x represent the regression coefficients of the questions x_1, x_2, x_3 and x_x.

To make the new questionnaire to a screening tool which is practical, the regression coefficients associated with the questions were transformed into a simple score that can be added up to obtain an aggregate score (in this case: the coefficients of the model are multiplied by 4/7 and rounded to the nearest integer, resulting in a score, ranging from 0 to 7 (Table 3). The cut-off points for the scores belonging to 'moderately malnourished' and 'severely malnourished' were determined by reading the optimal cut-off point in the ROC-curve. All analyses were performed with the SPSS software package, version 9.0.

Questionnaire validation study (population B)

For the validation study a new group of 297 patients, admitted to the same wards of the VU University medical center in the period of February until June 2003, was included. Patients who were not able to give informed consent, could not be weighed or were younger than 18 years of age were excluded from the study.

Upon admission to the hospital the nurse filled out the newly developed screening tool, the SNAQ©, for every patient. Patients who were classified as moderately or severely malnourished following the SNAQ©-score ($\geqslant$2 points) received energy- and protein-enriched meals and twice a day a nutritious snack. Patients who were classified as severely malnourished ($\geqslant$3 points) received, besides the energy- and protein-enriched meals and snacks, treatment by a dietitian (who was not involved in the study). The dietitian scored the referrals based on the SNAQ©-score as 'very necessary', 'moderately necessary' or 'not necessary'.

The measurements and the definition of the nutritional status were identical to the procedure of the first phase of the study.

The validity of the SNAQ© in population B is expressed in the sensitivity, specificity and the negative and positive predictive value. To measure the cross-validity of the SNAQ© a receiver–operator characteristic (ROC) curve was constructed to present the relationship of the SNAQ©-score with the definition of malnutrition. ROC curves characterise the relationship between the true positive rate (sensitivity) and the false positive rate (1-specificity). The specificity of a test is the probability (0–100%) that the SNAQ© score is $<$2 points

Table 1 Characteristics of the well nourished and the moderately/severely malnourished patients of population A and B.

	Population A			Population B		
	Moderately/ severely malnourished	Well nourished	Whole group	Moderately/ severely malnourished	Well nourished	Whole group
N (%)	93 (32%)	198 (68%)	291	98 (33%)	199 (67%)	297
Internal ward/ surgical and oncological ward (*N*) (% internal)	62/31 (67%)	99/99 (50%)	161/130 (55%)	63/35 (64%)	79/120 (40%)	144/155 (49%)
Sex (men/women) (% men)	38/55 (41%)	80/118 (40%)	118/173 (41%)	36/62 (37%)	81/118 (41%)	117/180 (39%)
Age (years)	62.2±18.3	56.6±18.0	58.4±18.3	62.2±19.0	60.0±16.5	60.6±17.3
BMI (kg/m^2)	22.1±4.7	26.3±5.1	25.0±5.4	22.4±5.0	25.8±4.1	24.7±4.6

for well nourished patients. The sensitivity is the probability (0–100%) that the SNAQ© score is $\geqslant$2 points for moderately malnourished patients and $\geqslant$3 points for severely malnourished patients. The area under the curve (AUC) quantifies the validity of the SNAQ©: the greater the area under the curve, the better the performance of the SNAQ©. It varies between 0.5, when the SNAQ© is no better than the chance in correctly categorising the two groups, and 1.0, when its sensitivity and specificity are perfect.

To measure the inter observer agreement of the SNAQ©, it was filled out for 47 patient by two nurses and for another 47 patients by a nurse and a dietitian. The inter observer agreement was tested with the kappa (κ) and the 95% confidence interval (CI) ($\kappa \pm 1.96$ SE).[13]

Results

Questionnaire development study (population A)

Subjects

Of the 291 patients that participated in this study, 76 patients (26%) were severely malnourished and 17 patients (6%) were moderately malnourished, according to the previously described definition of malnutrition. The characteristics of population A and B, including parameters of nutritional status are presented in Table 1.

Selection of the questions for the SNAQ©

The selection of the SNAQ-questions is described in Table 2. In the first phase of the selection 17 questions showed statistically significant odds ratios. From these, 7 remained in the binary logistic regression analyses of the second phase. The third and last phase of multinomial logistic regression, based on a significant Wald-test, resulted in the final selection of the four questions for the SNAQ© (Table 3). These were "Did you lose weight unintentionally? More than 6 kg in the last 6 months (3 points) or more than 3 kg in the last month" (2 points), "Did you experience a decreased appetite over the last month?" (1 point), "Did you use supplemental drinks or tube feeding over the last month?" (1 point).

Patients with $<$2 points were classified as well nourished. Patients with 2 points were classified as moderately malnourished and patients with $\geqslant$3 points were classified as severely malnourished.

Questionnaire validation study (population B)

Following the objective criteria of malnutrition (reference standard) in population B (*N*=297) 78 patients (26%) were severely malnourished and 19 patients (6%) were moderately malnourished Demographic data were similar in population A and B (Table 1).

Validity and cross-validity of the SNAQ©

The validity and the cross-validity of the SNAQ© is shown in Table 4 for the two cut-off points. In population B, both sensitivity and specificity proved to be more than 75% for both cut-off points. The ROC-curve (Fig. 1a) of the moderately and severely malnourished patients (cut-off point $\geqslant$2) shows an area under the curve of 0.85 (95% CI 0.79–0.90;

Table 2 Selection of the SNAQ-questions.

Over the last month:	OR phase 1 (95% CI)	Phase 2 (*P*-value)	Phase 3 (*P*-value)
1. Did you experience difficulty while eating?	4.50 (2.50–8.07)	0.05	
2. Did you eat less than normal?	7.36 (3.85–14.07)	0.33	
3. Did you experience a decreased appetite?	5.12 (2.86–9.17)	0.02	0.005
4. Did the food taste differently?	1.17 (0.61–2.22)		
5. Did you experience nausea?	2.48 (1.44–4.28)	0.38	
6. Did you vomit?	1.96 (1.07–3.56)	0.85	
7. Did you experience pain while eating?	2.42 (1.27–4.62)	0.92	
8. Did you need help with eating and drinking?	4.60 (1.96–10.77)	0.81	
9. Did you skip a meal occasionally?	2.45 (1.41–4.27)	0.99	
10. Did you often eat alone?	1.48 (0.86–2.54)		
11. Do you have false teeth?	2.13 (1.23–3.68)	0.56	
12. Did you experience difficulty chewing?	3.47 (1.67–7.18)	0.14	
13. Did you experience difficulty swallowing?	2.36 (1.25–4.43)	0.15	
14. Did you have diarrhea?	1.93 (1.12–3.33)	0.34	
15. Did you have constipation?	1.74 (1.00–3.05)		
16. Did you have loss of blood?	1.36 (0.67–2.75)		
17. Did you experience burping?	1.18 (0.67–2.09)		
18. Do you suffer from a food allergy or are you food intolerant?	0.44 (0.12–1.54)		
19. Did you have to eat an adjusted diet?	1.18 (0.56–2.47)		
20. Did you use supplemental drinks or tube feeding?	5.38 (2.62–11.07)	0.03	0.01
21. Did you experience feelings of fatigue or weakness?	4.60 (2.00–10.6)	0.04	
22. How often have you been admitted to a hospital during the last year?	0.98 (0.57–1.68)		
23. Did you lose weight unintentionally?	24.73 (10.67–57.33)	<0.001	
24. More than 3 kg in the last month?	379 (50–2859)	<0.001	<0.001
25. More than 6 kg in the last 6 months?	43 (19–97)	<0.001	<0.001
26. Do you have an oncological disease	0.13 (0.88–2.79)		

Table 3 Final selection of the questions for the SNAQ©.

	Regression coefficient	Regression coefficient x 4/7	Score[a]	OR (95% CI)
Constant	−4.07			
Did you lose weight unintentionally?				
More than 6 kg in the last 6 months	5.59	3.19	3	267.0 (30.0–2376.2)
More than 3 kg in the last month	3.63	2.07	2	37.7 (12.5–113.6)
Did you experience a decreased appetite over the last month?	1.42	0.81	1	4.2 (1.5–11.4)
Did you use supplemental drinks or tube feeding over the last month?	1.47	0.84	1	4.3 (1.4–13.9)

[a]To get round numbers for the SNAQ-scores, the B-coeficients of the logistic regression analyses are multiplied with 4/7 and rounded of to the nearest integer.

$P<0.0001$). The area under the curve for the severely malnourished patients (cut-off point $\geqslant 3$) (Fig. 1b) was similar (AUC=0.85; 95% CI 0.79–0.90; $P<0.0001$).

Dietary intervention based on the SNAQ©-score

One hundred and eleven patients had a SNAQ©-score $\geqslant 2$ points. They received enriched meals and two nutritious snacks per day, by which their daily

Table 4 Validity of the SNAQ© in population A and the cross-validity of the SNAQ© in population B.

	⩾2 points (moderately and severely malnourished patients)		⩾3 points (severely malnourished patients)	
	Population A (%)	Population B (%)	Population A (%)	Population B (%)
Sensitivity	86	79	88	76
Specificity	89	83	91	83
Positive predictive value	79	70	78	62
Negative predictive value	93	89	96	91

intake during the hospital stay was increased with approximately 600 kcal and 10–12 g of protein. Ninety five patients had a SNAQ©-score ⩾3 points and were sent to an independent dietitian for further consultation. Six of these patients did not receive additional dietary advise because they were too ill or had gone home before the dietitian was able to see the patient. Eighty nine patients were treated by a dietitian based on the SNAQ-score. In 89% of the cases (79 patients) the dietitian scored the consultation as very necessary, in 7% (6 patients) as moderately necessary and in 4% (4 patients) as not necessary. All patients scored by the dietitian as 'not necessary' were indeed well nourished following the objective criteria.

Reproducibility of the SNAQ©

The kappa (κ) of the SNAQ©-score, an indicator for the nurse–nurse reproducibility in 47 patients, was 0.69 (95% CI: 0.45–0.94). The κ of the SNAQ©-score in 47 patients by a nurse and a dietitian was 0.91 (95% CI:0.80–1.03). From the 47 patients in whom the nurse-nurse reproducibility was tested, 7 patients (15%) were classified in different categories. In the group of patients in whom the nurse-dietitian reproducibility was tested, 3 patients (6%) were classified differently.

Discussion

In August 2003, Kondrup et al. published the ESPEN guidelines for nutritional screening.[18] One of their conclusions was that existing screening tools are published with insufficient details regarding their intended use and method of derivation, validation, and with an inadequate assessment of their effectiveness. The development of SNAQ© does correspond to these requirements. The derivation and validation have been described in this article, its effectiveness (clinical outcome) will be reported on in a separate article.

The questions with regard to involuntary weight loss, loss of appetite and recent use of supplemental drinks or tube feeding appeared to be the best indicators for malnutrition. These items can be easily scored by the nurse at admission of the patient to the hospital. Based on the impact of the three items on the nutritional status, reflected by the value of the regression coefficient, a score was assigned to each item. Based on this score the treatment plan was developed.

By using two populations, population A for the development of the SNAQ© and population B for the cross-validation of the SNAQ© we have provided insight into the performance of the questionnaire in clinical practice. Both population A and B contained approximately the same number of severely and moderately malnourished patients. The patients were recruited on the same medical wards, but recruited in different seasons. Nevertheless, both populations were very comparable.

The validity and cross-validity of the SNAQ© were good. Of course, the validity of the SNAQ© in population A was more impressive than the cross-validity in population B because the logistic regression model was build on population A. However the results of the cross validation in population B are more meaningful, as they reflect the value of the SNAQ© in clinical practice. The area under the curve in population B for both cut-off points is 0.85. The positive predictive value of the severely malnourished patients (⩾3 points) was 62%. This indicates that 38% patients who were referred to the dietitian based on the SNAQ©-score, were not severely malnourished, which adds to the workload of the dietitian. On the other hand, the dietitians scored 89% of the referrals based on the SNAQ©-score as very necessary. Besides on BMI and weight loss, the dietitian

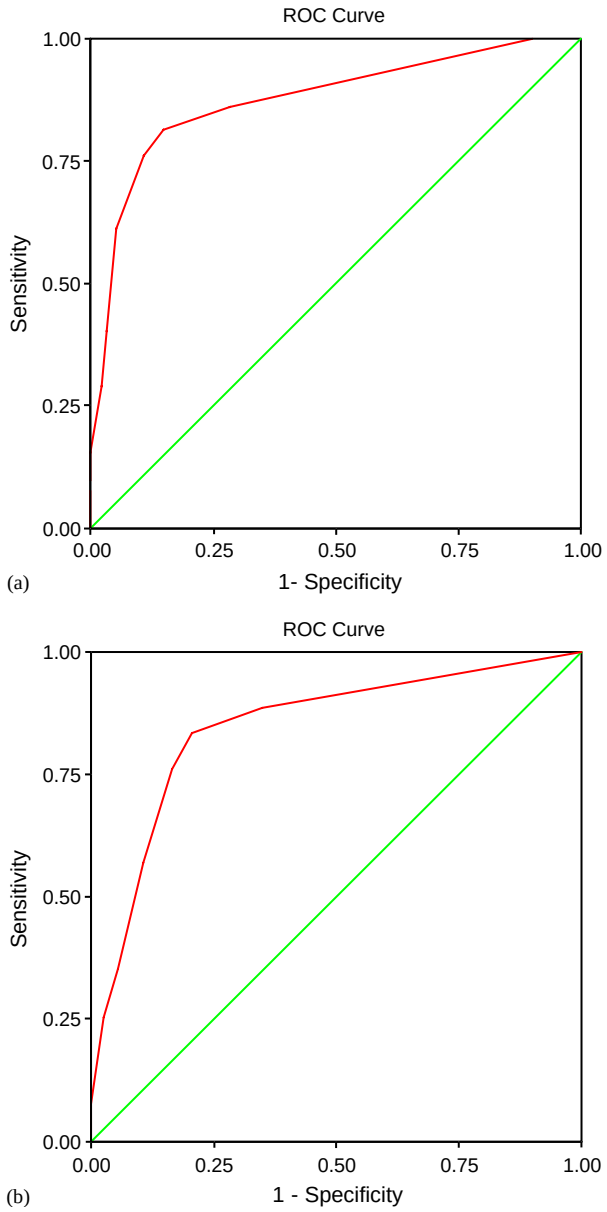

Figure 1 (a)ROC curve of the SNAQ© score in the moderately and severely malnourished patients against the objective standard of malnutrition for population B. (b) ROC curve of the SNAQ© score in the severely malnourished patients against the objective standard of malnutrition for population B.

valuates (subjectively) whether the patient is at risk of becoming malnourished.

The sensitivity was 76% in the severely malnourished patients. Six of the 19 patients who were "missed" still scored 2 points and did receive the enriched meals and the snacks and the extra attention of the nutritional assistant on the ward. They lacked the consultation by the dietitian. Although the sensitivity and the positive predictive value were not as high in population B as in population A, these results are an enormous improvement to the current clinical situation in which only half of the malnourished patients is being recognized, mostly not at admission to the hospital but in a later stage of hospitalization.

The reproducibility of the SNAQ© was also good. Training of the nursing staff on the impact of malnutrition in hospital patients and the need of nutritional screening could result in an even better nurse-nurse reproducibility.

The SNAQ© was validated in a population of mixed internal, surgical and oncological patients. This group of patients is a good reflection of the nutritionally relevant population of a general hospital. The results of this study are applicable to most wards in Dutch hospitals. The SNAQ© has not been validated for an outpatient population. This will be subject of further study.

For a more complete insight in the nutritional status of the study population, body composition was measured at admission to the hospital with bio electrical impedance analyses and upper arm muscle circumference. The hand grip strength was measured with handgripdynamometry. Because these measurements do not contribute to the definition of malnutrition which was used to validate the SNAQ©, the results of these measurements are not reported in this article.

The true validity of a screening tool can only be discussed when its impact on clinical outcome has been proven. To do so, length of hospital stay, care complexity, weight change during hospital stay and costs during hospital stay were recorded to determine whether the use of the SNAQ© and its treatment plan were cost-effective. Preliminary results are promising; we do expect improvement in clinical outcome parameters. However, we have chosen to publish these results in a later stage.

The SNAQ© and other short screening instruments

Other short screening instruments for hospital setting are the NRS-2002,[14] the MUST,[15] the MST[16] and the NNSF.[17] All instruments are valid and suitable for the screening of hospital patients on malnutrition. Our goals in developing the SNAQ© (costs less than 5 min of the nurses time, needs no calculating, includes a treatment plan based on the screeningscore) are only met by the MST. The NNSF is too time-consuming and complicated, the MUST needs calculating of the BMI and the percentage of recent weight loss and the NRS-2002 needs calculating of the BMI. Both the MST and the SNAQ© are suitable for screening of hospital patients at

admission to the hospital. In both cases patients at risk are being referred to a dietitian for further assessment. Besides, the SNAQ© also provides with a treatment plan (standard enrichment of meals and extra in-between meals, both for moderately and severely malnourished patients).

The impact of the SNAQ© and its linked treatment plan with respect to clinical outcome is currently under study. The value of the SNAQ© in comparison with other screening and treatment instruments can only be determined after publication of these results.

Conclusion

The SNAQ© proves to be a valid and reproducible instrument to detect and treat malnourished hospital patients in an early stage of hospitalization without the need to calculate percentage weight loss or BMI. The SNAQ© and its linked treatment plan is, therefore, a very practical instrument that can easily be used in all Dutch hospitals and on all medical wards with adult patients, even if nurses are not focussed on inquiring specific details of nutritional status.

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