

Effectiveness and cost-effectiveness of early screening and treatment of malnourished patients¹⁻³

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ABSTRACT

Background: About 25-40% of hospital patients are malnourished. With current clinical practices, only 50% of malnourished patients are identified by the medical and nursing staff.

Objective: The objective of this study was to report the cost and effectiveness of early recognition and treatment of malnourished hospital patients with the use of the Short Nutritional Assessment Questionnaire (SNAQ).

Design: The intervention group consisted of 297 patients who were admitted to 2 mixed medical and surgical wards and who received both malnutrition screening at admission and standardized nutritional care. The control group consisted of a comparable group of 291 patients who received the usual hospital clinical care. Outcome measures were weight change, use of supplemental drinks, use of tube feeding, use of parenteral nutrition and in-between meals, number of consultations by the hospital dietitian, and length of hospital stay.

Results: The recognition of malnutrition improved from 50% to 80% with the use of the SNAQ malnutrition screening tool during admission to the hospital. The standardized nutritional care protocol added \approx 600 kcal and 12 g protein to the daily intake of malnourished patients. Early screening and treatment of malnourished patients reduced the length of hospital stay in malnourished patients with low handgrip strength (ie, frail patients). To shorten the mean length of hospital stay by 1 d for all malnourished patients, a mean investment of €76 (US\$91) in nutritional screening and treatment was needed. The incremental costs were comparably low in the whole group and in the subgroup of malnourished patients with low handgrip strength.

Conclusions: Screening with the SNAQ and early standardized nutritional care improves the recognition of malnourished patients and provides the opportunity to start treatment at an early stage of hospitalization. The additional costs of early nutritional care are low, especially in frail malnourished patients. *Am J Clin Nutr* 2005; 82:1082-9.

KEY WORDS Malnutrition, hospital, Short Nutritional Assessment Questionnaire (SNAQ), screening, undernutrition, effectiveness, cost-effectiveness, length of hospital stay

INTRODUCTION

Disease-related malnutrition is a major health care problem and results in a reduced ability to prevent, fight, and recover from disease. Malnutrition is associated with postoperative complications, increased length of hospital stay, and even death (1-3). The

adverse effect of disease-related malnutrition on patient outcome and recovery results in increased health care use and its associated costs. Prospective studies on the amount of money that could be saved if appropriate screening and nutritional support are provided are lacking.

In 2001, the Dutch Dietetic Association conducted a national screening of disease-related malnutrition in 6150 hospital patients at 56 different locations. Approximately 25% of the hospital patients appeared to be malnourished; however, only 47% of those malnourished patients were identified by the nursing and medical staff (4). To increase early recognition and awareness of malnutrition, we developed a screening tool called the Short Nutritional Assessment Questionnaire (SNAQ; **Table 1**). This screening tool takes $<$ 5 min to complete and can easily be integrated in the nurses' evaluation of patients during admission to the hospital. The SNAQ has been proven to be valid and reliable (5).

The present study reports on the effectiveness and cost-effectiveness of the use of the SNAQ compared with the usual nutritional care for the early recognition and treatment of malnourished hospital patients. Effectiveness and cost-effectiveness were analyzed with respect to length of hospital stay, weight change, use of nutritional supplements, and quality of nutritional care.

SUBJECTS AND METHODS

Study design

A controlled trial with a historical control group was performed. Randomization of the intervention was not feasible because the availability of a screening instrument would influence the nutritional attitude of the nursing staff. Use of the screening

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TABLE 1
The Short Nutritional Assessment Questionnaire¹

Question	Score
Did you lose weight unintentionally?	
>6 kg in the past 6 mo	3
>3 kg in the past month	2
Did you experience a decreased appetite over the past month?	1
Did you use supplemental drinks or tube feeding over the past month?	1

¹ Patients who scored 0 or 1 points were classified as well-nourished and did not receive intervention. Patients who scored 2 points were classified as moderately malnourished and received nutritional intervention. Patients who scored ≥ 3 points were classified as severely malnourished and received nutritional intervention and treatment by a dietitian.

tool would have resulted in more attention to the recognition and early treatment of malnutrition in the control group.

In the intervention group, the nurse completed the SNAQ for every patient at admission to the hospital. The patients who were classified as moderately malnourished on the basis of a SNAQ score of ≥ 2 points received energy- and protein-enriched meals and 2 in-between meals/d, which accounted for an additional 600 kcal and 12 g protein/d. The patients who were classified as severely malnourished (≥ 3 points) received treatment by a dietitian in addition to receiving the energy- and protein-enriched meals. The patients in the control group received the usual hospital nutritional care and were not routinely screened for nutritional status during their admission to the hospital; referral to a dietitian occurred only by indication.

Subjects

The intervention group consisted of 297 patients who were admitted to a mixed internal ward (general internal medicine, gastroenterology, dermatology, rheumatology, and nephrology) and a mixed surgical ward (general surgery and surgical oncology) of the VU University Medical Center from February to June

2003. The control group consisted of a group of 291 comparable patients who were admitted to the same wards from April to October 2002. Patients who were unable to give informed consent, could not be weighed, or were < 18 y of age were excluded from the study. The study was designed in accordance with the Declaration of Helsinki and was approved by the institutional review board of the VU University Medical Center.

Outcome measures

Outcome measures were weight change during hospital stay, use of supplemental drinks, use of tube feeding, use of parenteral nutrition and in-between meals, number of consultations by a dietitian, and length of hospital stay. Patients who died during their hospital stay were not included in the analyses (Table 2). Use of tube feeding, parenteral feeding, and supplemental drinks was obtained from each patient's medical chart by a researcher for both the intervention and the control groups. In the intervention group, the number of consumed in-between meals was recorded by the nutritional assistant who handed out the in-between meals (in-between meals were not routinely provided in the control group). In both the control and the intervention groups, the number of consultations per patient and the total number of dietetic consultations was obtained from the patient's dietetic chart and from the consult registration files by a researcher. Also, the number of days of hospitalization before consultation with a dietitian was recorded.

Nutritional status

Patients were characterized as severely malnourished if they had ≥ 1 of the following: a body mass index (in kg/m^2) < 18.5 , unintentional weight loss of $> 5\%$ of body weight in the past month, or unintentional weight loss of $> 10\%$ in the past 6 mo. Patients were characterized as moderately malnourished if they had experienced an unintentional weight loss of 5-10% in the past 6 mo (6-11). All analyses were performed by comparisons between the well-nourished patients and the severely and moderately malnourished patients.

TABLE 2
Characteristics of patients in the intervention and control groups¹

	Intervention group		Control group	
	Well-nourished (n = 199)	Malnourished (n = 98)	Well-nourished (n = 198)	Malnourished (n = 93)
Age (y)	60.0 \pm 1.16 ²	62.0 \pm 1.91	56.6 \pm 1.28	62.2 \pm 1.90
Sex (% M)	41	37	40	41
BMI (kg/m^2)	25.8 \pm 0.29	22.4 \pm 0.49	26.3 \pm 0.36	22.1 \pm 0.49
Handgrip strength (kg)	29.8 \pm 1.03	23.7 \pm 1.23	32.5 \pm 1.09	28.5 \pm 1.83
INTERMED score (range: 0-60)	11.0 \pm 0.46	15.7 \pm 0.87	13.0 \pm 0.48	17.9 \pm 0.91
Mortality [n (%)]	6 (3)	7 (7)	4 (2)	4 (4)
Specialty (%)				
Oncologic surgery	45	22	34	22
Gastrointestinal surgery	17	15	14	14
General internal medicine	19	35	24	32
Gastroenterology	6	17	12	17
Rheumatology	7	5	9	8
Dermatology	3	4	4	7
Nephrology	3	2	3	0

¹ Characteristics of the malnourished and well-nourished patients were not significantly different between the intervention and control groups.

² $\bar{x} \pm \text{SE}$ (all such values).

On the day of admission to the hospital, a trained researcher weighed all patients (with clothes, without shoes) on the same calibrated scale (SECA 880; SECA, Hamburg, Germany) and asked the patients for their height. Height was measured (SECA 220; SECA) if the patient did not know his or her height. Patients were asked whether they had lost weight unintentionally over the past month and over the past 6 mo. The patient's handgrip strength was measured on the nondominant hand with a mechanical dynamometer (Baseline; Smith & Nephew, Dublin, Ireland), and the better of 2 readings was recorded. The measurement was performed as recommended by the American Society of Hand Therapists (12) and with the standards of Mathiowetz et al (13). The complexity of care (care complexity) was evaluated with INTERMED scores. INTERMED is an observer-rated instrument that assesses care complexity and has been validated in several medical inpatient populations (14, 15). Information from 4 domains (biological, psychological, social, and health care) is integrated and assessed in the context of time (history, current state, and prognosis). For each of the 4 domains, 5 variables are scored from 0 to 3 according to a manual with clinical anchor points, which results in a potential range of 0 to 60 points (high scores reflect high complexity). Scoring is based on a patient interview and on a review of the patient's medical chart. A cutoff of >20 points was found to be optimal for the detection of care complexity (16).

Statistics

Because the patients were not randomly assigned, the results may be subject to bias. Propensity scores, which reflect the predicted probability of receiving treatment (ie, being part of the treatment group), were used to reduce this bias (17). Predictors were age, sex, INTERMED score, and medical specialty. Because the data for length of hospital stay was skewed to the right, the data were log transformed (natural log) for a more symmetrical distribution.

All analyses were carried out for the total group with nutritional status (malnourished and well nourished) and treatment (intervention and control) as factors. When effect modification occurred, the analyses were stratified by subgroups of the effect modifier. The effectiveness of the screening and of the use of the treatment plan were assessed through linear regression analyses with log transformed length of hospital stay as the dependent variable and age, care complexity (INTERMED score), and group as the independent variables. Change in weight during hospital stay was analyzed by analysis of covariance with weight and body mass index (measured on the first and last days of the hospital stay) as the dependent variables and intervention or control group as a factor. The covariables were sex, length of hospital stay, and handgrip strength.

Differences in the use of supplemental drinks, tube feeding, parenteral nutrition and in-between meals and the number of consultations by a dietitian between the intervention and the control group were tested with the chi-square test and Student's *t* test. Numbers are reported as means \pm SDs or means \pm SEMs.

Economic evaluation

The economic evaluation was performed from a societal perspective. All relevant direct costs, such as costs of SNAQ screening, dietetic treatment, and hospitalization, were prospectively

recorded by a researcher. For the effectiveness part of the cost-effectiveness analyses, the length of hospital stay was the outcome measure.

Because the costs were skewed to the right, bootstrapping was used to calculate the cost-effectiveness ratio and for a pairwise comparison of the mean differences in costs between the intervention group and the control group. CIs were obtained with bias correction and accelerated bootstrapping, with 2000 as the number of replications. An incremental cost-effectiveness ratio was calculated by dividing the difference between the mean costs in the intervention and control groups by the difference in the mean length of hospital stay (ln transformed) of both groups. This ratio expresses the incremental costs of nutritional screening and treatment per day of hospitalization reduced. The cost-effectiveness ratio was also calculated for the subgroup of malnourished patients. Bootstrapped cost-effectiveness ratios were plotted on a cost-effectiveness plane (18). Because of the skewed length of hospital stay data, a sensitivity analysis, which excluded the patients with a length of hospital stay >40 d, was performed on the total malnourished group. Costs are defined in Euros and the cost-effectiveness ratios in Euros and US dollars (rate €1 = US\$1.21).

RESULTS

In both the intervention group and the control group, 26% of the patients were severely malnourished and 6% were moderately malnourished. The baseline characteristics of the intervention and control groups are presented in Table 2. Groups were not significantly different with regard to age, sex, body mass index, handgrip strength, and INTERMED score or when classified by nutritional status.

Dietitian consultation and nutritional care

In the malnourished patients in the intervention group, referrals to a dietitian were significantly higher and the use of supplemental drinks was significantly lower than in the malnourished patients in the control group. In the intervention group, 76% of the malnourished patients were referred to a dietitian on the basis of their SNAQ scores. In the control group, the nurse or physician referred 46% of the malnourished patients to a dietitian. Twenty-eight percent of the malnourished patients in the intervention group used supplemental drinks compared with 37% of the malnourished patients in the control group. The use of tube feeding and parenteral feeding was not significantly different between the intervention and the control groups. In the intervention group, 79% of the malnourished patients received extra nutritional care (2 in-between meals and an enriched breakfast, lunch, and dinner). In malnourished patients, no significant differences were observed in the mean number of consultations from a dietitian between the intervention group ($\bar{x} \pm$ SD: 2.1 \pm 2.6) and the control group ($\bar{x} \pm$ SD: 2.0 \pm 3.6). The mean number of days in the hospital before the first consultation with a dietitian was lower in the intervention group ($\bar{x} \pm$ SD: 2.6 \pm 2.1 d) than in the control group ($\bar{x} \pm$ SD: 5.8 \pm 6.7 d; $P < 0.001$).

Length of hospital stay

In the well-nourished group, the mean (\pm SD) length of hospital stay was 9.6 \pm 7.6 d for the intervention group and 10.0 \pm 10.0 d for the control group. In the malnourished group, the uncorrected mean (\pm SD) length of hospital stay was 11.5 \pm 8.0 d

TABLE 3

Linear regression analyses of ln length of hospital stay (LOS) in malnourished patients with low handgrip strength¹

	Coefficient	P
Constant	2.025	< 0.001
Age (y)	0.00417	0.2
INTERMED score (range: 0–60)	0.01633	0.08
Control group/intervention group (0/1)	−0.311	0.03

¹ $n = 94$. $\ln \text{LOS} = 2.025 + 0.00417 \times \text{age} + 0.01633 \times \text{INTERMED score} - 0.311 \times \text{intervention group}$. Taking the outcome of the whole regression equation as the exponent (x) in the formula $y = e^x$ (back transformation), the difference in LOS in the intervention group and the control group becomes interpretable.

in the intervention group and 14.1 ± 13.3 d in the control group. In the total group, nutritional intervention had no significant effect on the length of hospital stay ($P = 0.13$)

Handgrip strength appeared to be an effect modifier for length of hospital stay in the malnourished group [interaction of intervention group \times handgrip strength (lower than standard), $P = 0.012$]. Analyses of the effect of screening and nutritional intervention on the length of hospital stay were, therefore, stratified by handgrip strength (lower or higher than the standard). No other interactions were present.

Malnourished patients in the intervention group with low handgrip strength ($n = 59$) had a shorter length of hospital stay than did the malnourished patients in the control group with low handgrip strength ($n = 35$). None of the variables from Table 2 were confounders for this effect. Because age and INTERMED score had a significant effect on the length of hospital stay in the malnourished group as a whole, these variables were added to the regression model. With addition of the INTERMED score, the model was corrected for care complexity. The results of the linear regression analyses of the log transformed length of hospital stay are shown in Table 3.

Application of this regression equation with back-transformation showed that a malnourished 62-y-old (mean age in the malnourished group) patient in the control group with low handgrip strength and with an INTERMED score of 17 (mean INTERMED score in the malnourished group) would have a length of stay in the hospital of 13 d. A patient with the same characteristics in the intervention group would stay 9.5 d in the hospital ($P = 0.02$). Analyses that excluded the outlying high values (83 and 73 d) in the control group showed similar results.

Weight change during hospital stay

Weight change during hospital stay was not significantly different between the intervention and control groups ($P = 0.6$). The mean (\pm SD) weight change in the intervention group was $-0.1 \pm 7.9\%$ compared with $-0.3 \pm 5.9\%$ in the control group. Forty-three percent of the malnourished patients in the intervention group gained weight during their hospital stay compared with 45% of the malnourished patients in the control group.

Cost-effectiveness analysis

The costs of the SNAQ screening and treatment are described in Table 4. The costs of SNAQ screening by a nurse at admission to the hospital were €2 per patient. The costs of the SNAQ treatment consisted of the in-between meals, the distribution of the in-between meals in a cooled cart (the SNAQ cart), personnel

TABLE 4

Mean costs in all patients and in the malnourished patients

	Intervention group	Control group
All patients ($n = 588$)		
No. of in-between meals at 51 euro cents	887 ± 9.9^1	0
SNAQ cart (€) ²	2083	0
Extra costs of nutritional assistant (€)	4800	0
Dietitian		
Consultations (no.)	1.1 ± 2.0	1.0 ± 2.4
Cost (€)	60.3 ± 103.4	56 ± 123
Length of hospital stay (d)	10.4 ± 8.4	12.0 ± 13.5
Malnourished patients ($n = 191$)		
Dietitian		
Consultations (no.)	2.1 ± 2.6	2.0 ± 3.6
Cost (€)	120 ± 134	109 ± 184
Length of hospital stay (d)	11.5 ± 8.0	14.0 ± 13.3

¹ $\bar{x} \pm \text{SD}$ (all such values).

² SNAQ, Short Nutritional Assessment Questionnaire.

costs of the nutritional assistants (2 h per round, 4 h/d), and the dietitian costs (first consultation = €73.53, and any other consultations = €49). The cost-effectiveness of the SNAQ screening was analyzed for all patients who were screened at admission to the hospital. In addition, a subgroup analysis was conducted for the malnourished patients only, because malnourished patients in the intervention group received the nutritional treatment.

An overview of the costs and effects included in the cost-effectiveness analysis is shown in Table 5. For each patient, the total amount of in-between meals consumed was recorded and multiplied by the costs, which were calculated by dividing the costs of the SNAQ cart by the amount of in-between meals and adding this number to the costs of one in-between meal.

The results of the analyses of the cost-effectiveness of SNAQ screening in all hospital patients at admission to the hospital and the application of the SNAQ treatment plan in malnourished patients are shown in Table 6 and Figure 1. The mean costs of the screening and of the treatment plan were €36.77 higher in the intervention group than in the control group. The cost-effectiveness ratio indicated that the additional costs of SNAQ screening and treatment to reduce the mean length of hospital stay by 1 d were €35.4 (US\$42.48). As shown in Figure 1, 73% of the bootstrapped ratios lie in the northwest quadrant, which

TABLE 5

Endpoints in the cost-effectiveness analyses in malnourished patients in both the control group and the intervention group

	Intervention group ($n = 297$)	Control group ($n = 291$)
Costs		
In-between meals (€)	18.4 ± 12.9^1	0
Nutritional assistant (€)	54 ± 51	0
Dietitian (€)	118.2 ± 136.3	104.7 ± 174.7
Effects		
Length of stay (d)	11.5 ± 8.0	14.0 ± 13.3
Weight change (%)	-0.1 ± 7.9	-0.3 ± 5.9
>3% increase in weight during hospitalization (%)	18	16

¹ $\bar{x} \pm \text{SD}$ (all such values).

TABLE 6Incremental costs, effects, and cost-effectiveness ratio (ICER) of the entire population and the subgroup of malnourished patients¹

	Δ Costs ²	Δ Effects ³	ICER
Entire population ($n = 588$)	36.8 (15.1, 58.4)	-1.04 (-1.16, 1.07)	-35.4 (-1239.2, 109.4)
Malnourished patients ($n = 191$)	86.0 (33.7, 138.3)	-1.13 (-1.36, 1.07)	-76.1 (-478.2, 218.0)
Malnourished patients with low handgrip strength ($n = 94$)	68.6 (-11.6, 40.9)	-1.36 (-1.82, 1.02)	-50.4 (-195.7, 2.8)

¹ All values are \bar{x} with 95% CIs in parentheses. SNAQ, Short Nutritional Assessment Questionnaire.² Difference between the mean costs of SNAQ screening and nutritional interventions (screening, in-between meals, nutritional assistant, and dietitian) in the intervention group and the mean costs of the nutritional intervention (dietitian) in the control group.³ Difference in length of hospital stay (measured in days) between the intervention and control groups.

indicates higher costs and a shorter length of hospital stay. Twenty-seven percent of the bootstrapped ratios lie in the northeast quadrant, which indicates higher costs and longer length of hospital stays.

The results of the analyses of the cost-effectiveness of SNAQ screening and treatment in the malnourished group are presented in Table 6, **Figure 2**, and **Figure 3**. The mean (95% CI) costs of SNAQ treatment and of consultation with a dietitian were €86 (€33.7, €138.3) higher in the intervention group than in the control group. The mean (95% CI) length of hospital stay (log transformed) was 1.13 d (-1.36, 1.07 d) less in the intervention group than in the control group. As shown in Figure 2, 88% of the bootstrapped cost-effectiveness ratios are in the northwest quadrant, which indicates higher costs and reduced length of hospital stay. The incremental costs of SNAQ treatment to reduce the length of hospital stay by 1 d were €76.10 (US\$91.32). In the subgroup of patients with low handgrip strength, the incremental costs to reduce the length of hospital stay by 1 d were only €50.40 (US\$60.48). In this subgroup, the costs of the SNAQ treatment and dietitian consultation were €69 higher in the intervention group than in the control group. The mean length of hospital stay (log transformed) was 1.36 d less in the intervention group than in the control group. Ninety-three percent of the bootstrapped cost-effectiveness ratios are in the

northwest quadrant, which indicates higher costs and reduced length of hospital stay (Figure 3).

A sensitivity analysis, which excluded the patients with a length of hospital stay of >40 d, was performed on the total malnourished group. The mean costs of the SNAQ treatment and the consultation of the dietitian were higher (\bar{x} : 100 d; 95% CI: 57.3, 143.8 d) in the intervention group than in the control group. The mean (95% CI) length of hospital stay was 1.08 d (-1.3, 1.1 d) less in the intervention group than in the control group.

DISCUSSION

Malnutrition screening at admission to the hospital and early treatment of malnourished patients seemed to improve clinical outcome. Almost 80% of the malnourished patients were recognized through screening compared with 50% through the usual clinical practice (4, 5). The dietetic treatment of malnourished patients who were recognized with screening started at an earlier stage of hospitalization than did the treatment of malnourished patients recognized through the usual clinical practice. Through standardization of nutritional care, the daily intake of the malnourished patients increased by \approx 600 kcal and 12 g protein. The number of meals was increased, and the types of meals changed from medical nutrition (ie, supplemental drinks) to normal food.

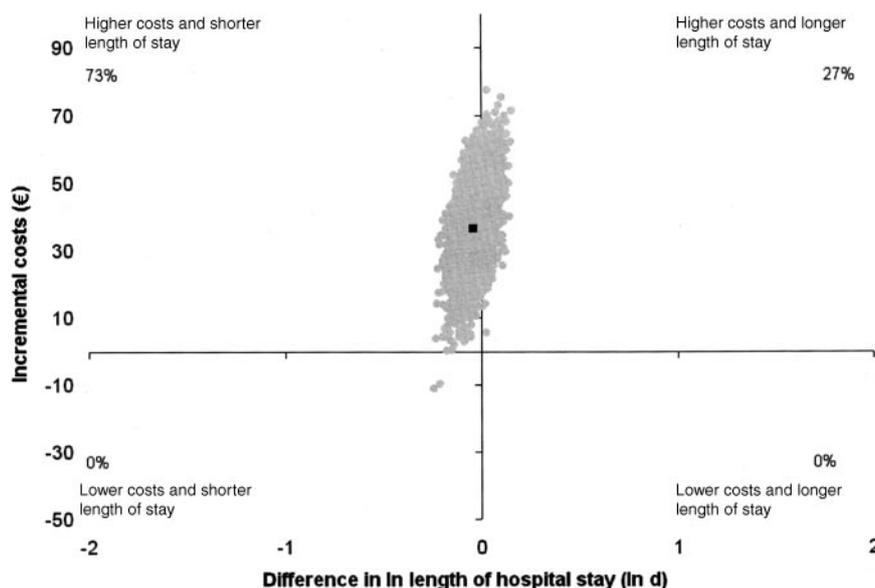


FIGURE 1. Cost-effectiveness plane of costs of the Short Nutritional Assessment Questionnaire (SNAQ) screening and treatment against length of hospital stay in all patients. The effect is expressed as length of stay in the hospital; therefore, a negative effect (left of the y axis) indicates a shorter hospital stay for the patients in the intervention group than for the patients in the control group. The black square (■) indicates the mean.

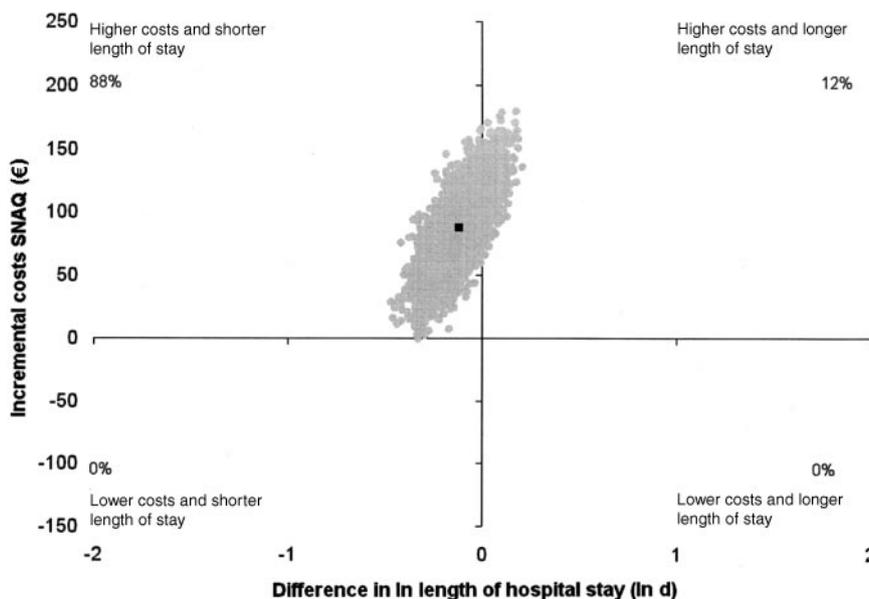


FIGURE 2. Cost-effectiveness plane of costs of the Short Nutritional Assessment Questionnaire (SNAQ) screening and treatment against length of hospital stay in malnourished patients. The effect is expressed as length of stay in the hospital; therefore, a negative effect (left of the y axis) indicates a shorter hospital stay for the patients in the intervention group than for the patients in the control group. The black square (■) indicates the mean.

No significant difference was observed between the intervention and control groups in the total number of consultations with a dietitian; however, the number of patients who were referred to a dietitian was significantly higher in the intervention group than in the control group (76% compared with 47%). This indicates that a dietitian visited some patients in the control group more often than patients in the intervention group. However, this can be explained by the increased efficiency of the standardized nutritional care in the intervention group. A dietitian’s work is limited to the following original tasks: evaluating the nutritional needs and status of the patients, informing and motivating the patient, and coordinating the individual clinical nutritional

care. The nutritional assistant is responsible for providing in-between meals and stimulating the patient to eat during his or her hospital stay.

In a post hoc analysis, early screening and treatment of malnourished patients effectively reduced the length of hospital stay in malnourished patients with low handgrip strength (ie, frail patients). Previous findings in the elderly showed that only subjects who are very thin benefit from nutritional supplementation (19).

The incremental cost of a 1-d reduction in the length of hospital stay in the malnourished group through extra nutritional care and dietetic treatment was €76 (US\$91.2). The incremental costs

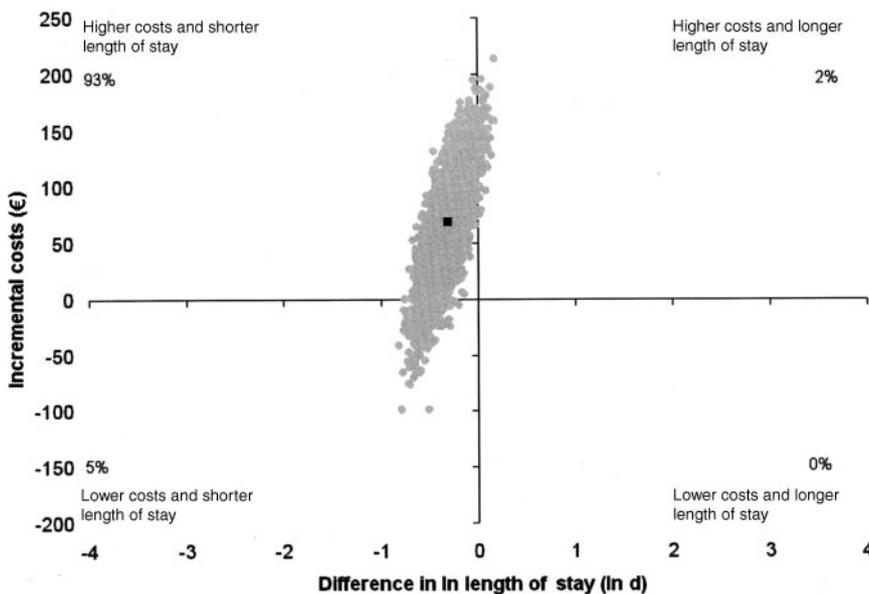


FIGURE 3. Cost-effectiveness plane of costs of Short Nutritional Assessment Questionnaire (SNAQ) screening and treatment against length of hospital stay in malnourished patients with low handgrip strength. The effect is expressed as length of stay in the hospital; therefore, a negative effect (left of the y axis) indicates a shorter hospital stay for the patients in the intervention group than for the patients in the control group. The black square (■) indicates the mean.

were even lower in the total malnourished group and in the subgroup of malnourished patients with low handgrip strength. If the mean costs of a 1-d stay in the hospital are €476 (US\$571.2) for university hospitals and €337 (US\$404.4) for peripheral hospitals (20), then implementation of SNAQ screening and treatment would result in substantial savings.

The SNAQ screening and treatment did not result in significant weight changes during the hospital stay. Weight change is a difficult variable to measure in clinical practice because the fluid balance of patients who are admitted to a hospital is often disturbed. The weight of some patients at admission is too high and in other patients it is too low. Weight gain is very difficult to achieve in the short period of hospitalization, even with enriched meals and extra in-between meals. For a weight gain of 1 kg, a patient needs to consume ≈ 7000 kcal more than the metabolic requirements. Consequently, weight change is not a reliable outcome measure for this frail clinical population. Future studies should focus on length of hospitalization or reduction of complications as relevant outcome measures.

The development and validation of the SNAQ and the effectiveness and cost-effectiveness analyses were carried out in one study. A historical control group was used for both the effectiveness and cost-effectiveness analyses. Consequently, treatment allocation was not concealed, and patients, care providers, and outcome assessors were not blinded to the intervention. Randomization was not feasible because if the nurse had given high SNAQ scores to patients in the control group, then the nurse would have inevitably given more attention to those patients' nutritional status. Thus, more attention would have been given to the recognition and early treatment of malnutrition in the control group, which would have introduced bias.

The most important disadvantage of this design, in contrast with a randomized controlled trial design, is that other factors, beside the SNAQ screening and treatment, may have influenced the endpoints. For example, we checked for any important policy changes in the wards, and in January 2002, before the study period of the control group began, the internal ward started a protocol to shorten the length of stay and to improve the management of the postclinical home care facilities. Because this protocol was implemented before the start of the present study, we do not expect the effects of the protocol to bias the results. Possible effects cannot be ruled out, but no trends were detected.

Furthermore, we studied the comparability of the historical control group and the intervention group in detail. Both groups were comparable with regard to patient characteristics (Table 2) and to the length of hospital stay of the well-nourished patients. No confounders and no seasonal effects were identified. We therefore assumed that the time effect that could have influenced the results was negligible. Although the study population was recruited in one hospital, the findings of the present study seem relevant to other hospitals. The study population is a good reflection of the population of a general hospital. Also, the prevalence of malnutrition found in the present study agreed with the prevalence found in other studies (4, 21–23).

The role of a nutritional assistant in a ward is of great importance in the SNAQ treatment. The assistant stimulates patients to eat both their regular meals and their in-between meals and reports to the dietitian when oral nutrition is insufficient. In the

present study, a nutritional assistant spent 4 h/d on the distribution of the in-between meals and on the registration of the consumption of the in-between meals. Nevertheless, this new approach appeared to be cost-effective; that is, low incremental costs (€76) are needed to reduce hospitalization by 1 d. We expect that if the SNAQ treatment is implemented in a hospital, then the SNAQ-related tasks will be integrated with the nutritional assistant's other tasks, and that incremental costs will be even lower.

This analysis of cost-effectiveness has provided more information on the costs of nutritional intervention and dietetic treatment in proportion to the total costs of hospitalization. These numbers can be used for management decisions on hospital nutritional care. Optimal nutritional care in malnourished patients who are waiting for treatment or who are recovering from illness is an essential part of total medical care. Future economic evaluations are needed to evaluate whether nutritional interventions in periclinical settings are also cost-effective.

In conclusion, application of the SNAQ screening and treatment plan improved the recognition of malnourished patients and provided the opportunity to start treatment at an early stage of hospitalization. With a small investment for in-between meals and dietetic care, the nutritional care during the hospital stay was improved and the duration of hospital stay was reduced in a subgroup of frail malnourished patients. 

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HMK was responsible for the study design, the data collection and the analysis, and the writing of the manuscript. MWVT participated in the development of the study design, data analysis, and writing of the manuscript on the area of cost-effectiveness. JCS and MAEVB-S participated in the development of the study design, analysis of the data, and writing of the manuscript. HJA participated in the methodology. AT was responsible for most of the included patients and participated in the writing of the manuscript. None of the authors had any conflicts of interest.

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