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Authors: Grolimund Berset D, Guex E, Valentinuzzi N, Borens O, Wild P, Coti Bertrand P

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Improving nutritional care quality in the orthopedic ward of a Septic Surgery Center by implementing a preventive nutritional policy using the Nutritional Risk Score: a pilot study

Running title: Preventive nutritional policy in Septic Surgery

Author names:

Denise Grolimund Berset, Esther Guex, Nadia Valentinuzzi, Olivier Borens, Pascal Wild, Pauline Coti Bertrand

Author Affiliations:

- Institute for Work and Health, University of Lausanne and Geneva, Lausanne, Switzerland (DGB, PW)
- Clinical Nutrition, Service of Endocrinology, Diabetology and Metabolism, Lausanne University Hospital, Lausanne, Switzerland (EG)
- Septic Surgery Center, Lausanne University Hospital, Lausanne, Switzerland (NV, OB)
- Department of Orthopedic Surgery and Traumatology, Lausanne University Hospital, Lausanne, Switzerland (OB)
- Clinical Nutritionist, Rue d'En-Haut 20, 1143 Apples, Switzerland (PCB)

Address for correspondence:

Denise Grolimund Berset, Institute for Work and Health, University of Lausanne and Geneva, Biopôle, Secteur Croisettes – Bâtiment SC-B, Route de la Corniche 2, 1066 Epalinges-

Lausanne, Switzerland. Tel: +41 21 314 74 19; Fax: +41 21 314 74 30. denise.grolimund-berset@hospvd.ch

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Abstract

Background: Septic Surgery Center (SSC) patients are at a particularly high risk of protein-energy malnutrition (PEM), with a prevalence of 35%–85% found in various studies. Previous collaboration between our hospital's SSC and its Clinical Nutrition Team (CNT) only focussed on patients with severe PEM.

Objective: This study aimed to determine whether it was possible to improve the quality of nutritional care in septic surgery patients with help of a nutritional policy using the Nutritional Risk Score (NRS).

Methods: Nutritional practices in the SSC were observed over three separate periods: in the three months leading up to the implementation baseline, 6 months after implementation of preventive nutritional practices, and at 3 years. The nutritional-care quality indicator was the percentage of patients whose nutritional care, as prescribed by the SSC, was adapted to their specific requirements. We determined the septic surgery team's NRS completion rate and calculated the nutritional policy's impact on SSC length of stay. Data before (T_0) and after (T_1+T_2) implementation of the nutritional policy were compared.

Results: Ninety-eight patients were included. The nutritional-care quality indicator improved from 26% to 81% between T_0 and T_2. During the T_1 and T_2 audits, septic surgery nurses calculated NRS for 100% and 97% of patients, respectively. Excluding patients with severe PEM, SSC length of stay was significantly reduced by 23 days ($p=0.005$).

Conclusion: These findings showed that implementing a nutritional policy in an SSC is possible with the help of an algorithm including an easy-to-use tool like the NRS.

Introduction

The prevalence of protein-energy malnutrition (PEM) was found to be over 30% in surgical patients in several European hospitals [1-7]. Orthopedic septic surgery patients constitute a specific population, suffering from chronically infected lesions of their locomotor systems, such as infected total joint arthroplasties, pressure ulcers, bedsores or diabetic feet, which can even lead to foot amputation. These patients often present with multiple comorbidities, mainly diabetes mellitus, arteriosclerosis and chronic renal insufficiency with or without hemodialysis.

Orthopedic septic surgery patients are particularly at risk nutritionally, as shown by the high, 35%–85% prevalence of PEM found in various studies [8-10]. They frequently suffer loss of appetite, hydro-electrolytic and micronutrient loss, and infection-related inflammatory states leading to an accelerated catabolic process [11, 12]. Prolonged immobilization is often required to improve wound-healing, which itself leads to a decrease of the fat-free mass. PEM can have disastrous consequences for these patients. Particularly in the elderly, poor nutritional status has been associated with impaired wound healing [9, 13, 14] and the development or recurrence of pressure ulcers [15-18]. Secondary infections are often-seen complications [19], leading to more frequent and longer hospital admissions with an increased risk of mortality [20, 21]. Furthermore, PEM leads to decreased quality of life and higher costs and home health care needs [22]. Nutritional assessment has thus now been integrated into infected wound-care protocols [23, 24].

The Nutritional Risk Score (NRS) is a screening tool, recommended by the European Society of Parenteral and Enteral Nutrition (ESPEN) [25], which identifies patients who are nutritionally at risk and likely to benefit from nutritional support [26]. The NRS can identify patients who are undernourished or at nutritional risk because of disease and/or treatment; it considers impaired nutritional state, severity of disease, and age [26] to indicate the need for nutritional counselling and support.

Our institution's Septic Surgery Center (SSC) is a 35-bed unit; orthopedic patients represent more than 40% of all cases. They suffer from post-operative wounds or chronically infected wounds of the locomotor system, like pressure ulcers and bedsores, diabetic feet, amputation, or other specialized care needs. About 40% of them are ≥ 65 years old and often present significant comorbidities. The average SSC length of stay is therefore about three times longer than the overall average length of stay (8.8 days) in our institution. Despite this, prior to the present study, collaboration between the SSC and our institution's Clinical Nutrition Team (CNT) focused solely on patients with severe PEM. The SSC admits about 700 patients annually, but less than 5% were spontaneously referred to the CNT for specific adapted nutritional care. Most recommendations concerned specific diets (e.g., for diabetics) or specific micro-nutrients (e.g., calcium, vitamin D) [27]; PEM was rarely considered. Indeed, nutritional care was not considered a priority. Any nutritional intervention, but particularly tube feeding, was considered a supplementary weight on patients already suffering from chronic pathologies. In this population, being overweight frequently hides PEM and is often associated with comorbidities like diabetes mellitus and terminal renal insufficiency that leads to hemodialysis [28, 29]. To improve nutritional care, the SSC began screening all patients with the NRS [26].

This study aimed to determine whether it was possible to improve the quality of nutritional care in septic surgery patients nutritionally at risk of or suffering from moderate or severe PEM by implementing a preventive nutritional policy using the NRS [26].

Materials and Methods

Three prospective audits were carried out in the SSC. Nutritional practices were observed by one of the two study nutritionists (a physician and a dietitian) up to the baseline (T_0, the three months before the implementation of preventive nutritional practices), at 1 month (T_1, until 5 months after implementation), and at 2 years 7 months (T_2, until 2 years 10 months after implementation).

Patients

Patients aged 18–90 years old were eligible for inclusion if they suffered from chronically infected wounds of the locomotor system such as pressure ulcers, bedsores, diabetic feet, amputation, or other. All patients were well-informed about the study and able to understand its aims; patients with overt dementia or other psychiatric and addictive disorders were excluded. The study protocol was approved by the Lausanne University Hospital Institutional Ethics Committee, and all participants gave their informed written consent.

Additional recorded data included age, sex, type of wound, and comorbidities. The Charlson Comorbidity Index was determined for every patient [30].

Nutritional status assessment

During each audit, a study nutritionist performed a post-admission nutritional assessment of all septic surgery patients, independently of any request by the SSC. Collected and measured data included food intake, usual weight, actual weight, weight loss in the last three months, height, body mass index (BMI), arm muscle circumference (AMC), and fat-free mass (FFM) measured using bioelectrical impedance analysis.

Body weight was measured using an electronic chair-scale or hoist. In hemodialysis patients, body weight was recorded after dialysis (dry-weight). In cases of amputation, amputated limb

weight was measured after surgery, subtracted from usual weight, and then BMI was adapted according to the percentage of body weight represented by the limb [31].

Anthropometric values of AMC and FFM were measured on the non-dominant side if this was appropriate according to the pathology (e.g., amputation, dialysis-fistula) and within 2 h of dialysis [32]. Reference data for AMC and FFM were sex- and age-matched and the level defined as an abnormally low value was $\leq 5^{th}$ percentile [33, 34]. PEM was defined as either absent, moderate, or severe (Table 1). The prevalence of moderate and severe PEM in septic surgery patients was calculated. The sensitivity and specificity of NRS were determined using the criteria for present PEM (moderate + severe) as the gold standard.

Implementation and assessment of preventive nutritional practices

The implementation of preventive nutritional interventions included the following steps:

1) At baseline, a 3-month audit observed the usual nutritional practices in the SSC prior to the intervention. No nutritional interventions were proposed unless patients with severe PEM were referred to the CNT by the study nutritionist.
2) The septic surgery team and the CNT then defined a nutrition management pathway (Figure 1), including preventive measures, screening, treatment, and criteria for referral to the CNT. Preventive measures were defined: mealtimes were protected to provide patients with an environment that would encourage them to eat (in particular, there was no wound care at mealtimes); food consistency was adapted for impaired chewing and swallowing; patients were prepared for meals, i.e., comfortably installed for eating, assisted by a septic surgery nurse if necessary. The pathway screened patients nutritionally at risk (NRS ≥ 3) weekly, referring them to the CNT for nutritional assessment and a personalized intervention if appropriate. According to the patient's clinical status and plan for surgical treatment, the CNT proposed a treatment in the form of dietetic care (food fortification and between-meal snacks) or nutritional

support (oral nutritional supplementation or tube feeding if oral nutritional supplementation failed).

3) To raise awareness of malnutrition and motivate the septic surgery team, the first audit's results and a particularly complicated case study involving a patient with severe PEM were presented and discussed [35]. Septic surgery nurses and physicians were taught about the consequences of PEM, and nurses were trained to use the nutrition management pathway and specifically the NRS [26].
4) Six months after implementation of this strategy, a second audit (T_1) was performed and its new results were presented to the team. Again, the only intervention by the study nutritionist was to notify the CNT, during weekly meetings, of non-referred patients with an NRS ≥ 3.
5) Three years after implementation, a third audit (T_2) was performed and feedback was given to the septic surgery team. Again, the study nutritionist notified the CNT, during weekly meetings, of non-referred patients with an NRS ≥ 3.

Outcome measures

Major outcome

Measurement of the quality of nutritional care was the major outcome. The nutritional care quality indicator used for each audit was defined as the percentage of patients who had received adequate nutritional care by septic surgery staff. Adequate nutritional care by septic surgery staff was defined as the number of patients whose nutritional care was adapted to their specific nutritional requirements and the number of patients with an NRS < 3 who received no nutritional treatment. Inadequate prescriptions by septic surgery staff were defined as nutritional care prescriptions which were modified, stopped, or had to be prescribed by the CNT. Septic surgery staff defined the need for nutritional care according to

an NRS ≥ 3 or to a nutritional assessment by the CNT (moderate/severe PEM). Nutritional care was given in the form of dietetic care or nutritional support, including oral nutritional supplements or tube feeding.

Secondary outcomes

Concerning nutritional screening, the NRS completion rate by the septic surgery team was determined at T_1 and T_2. The CNT referral rate for patients at nutritional risk was determined using the number of patients with an NRS ≥ 3 who were referred to the CNT by septic surgery staff. The subjective CNT referral rate was determined using the number of patients with an NRS < 3 who were referred to the CNT following a decision by septic surgery staff, according to the subjective criteria of PEM.

SSC length of stay, overall hospital length of stay, and discharge destination (home, rehabilitation center, another hospital, nursing home, palliative care, or death) were obtained from the computerized patient hospital record after patients had been discharged by an orthopedic surgeon.

Statistical analysis

Statistical analyses were performed using Stata 14.1 software (College Station, TX). Anova tests were used to compare continuous data, and Fisher's exact test was used for categorical data. Continuous data were presented as mean ± standard deviations. Categorical data concerning SSC length of stay were compared before (T_0) and after (T_1+T_2) implementation of the nutritional policy, based on linear regression after adjusting for type of wound. The same analysis was performed after exclusion of patients with severe PEM, as their treatment was managed in a similar way before and after the new policy. The difference in SSC length of stay attributable to the use of the NRS, before and after implementation of the nutritional

policy, was calculated based on linear regression, adjusted for the type of wound and after exclusion of patients with severe PEM. A *p*-value of < 0.05 was considered statistically significant.

Results

Patient characteristics

Across the three 3-month audit periods, 116 patients were eligible for the study. Eighteen (16%) refused to participate. The general characteristics of the 98 patients included are shown in Table 2 and were not significantly different between the 3 audits: 57 (58%) were diabetic, all suffering from type-2 diabetes mellitus; 12 (12%) were undergoing hemodialysis. The Charlson Comorbidity Index ≥ 3, representing a one-year risk of death from a comorbid disease, was 59% [30].

Nutritional status

Table 3 shows nutritional parameters at inclusion in the study. There was no significant difference between the 3 audits. The prevalence rates of moderate and severe PEM across all participants were 25% and 19%, respectively. The mean BMI was 26.1 ± 4.9 kg/m^2; more than half of patients had a BMI ≥ 25; 33% had a BMI of 25–30; 22% had a BMI > 30. With regards to the NRS, most patients scored 1 point for disease severity, so the final score was actually determined by age and impaired nutritional status.

Outcome

Quality of nutritional care

Of 98 study participants, 60 (62%) needed nutritional care according to their NRS and the CNT. Twenty-six patients (43.3%) were provided with dietetic care, 29 (48.3%) with oral nutritional supplements, and 5 (8.3%) with tube feeding (details in Table 4). Septic surgery staff started 30 nutritional regimens before referring patients to the CNT; the CNT stopped six. Among the other 24 prescriptions (8 for dietetic care, 12 for oral nutritional supplements,

4 for tube feedings), the CNT adapted nine. In all, the CNT began 18 nutritional support and 18 dietetic care regimens. All patients with severe PEM received nutritional care.

In total, 52% of the prescriptions (51/98) written by septic surgery staff were inadequate. Nevertheless, the nutritional care-quality indicator improved from 26% to 81% between T_0 and T_2, respectively (Figure 2).

NRS completion rate

Forty-six (47%) of the 98 patients were classified as nutritionally at risk (Table 3). The sensitivity and specificity of the NRS to screen patients with moderate and severe PEM in our study population were 67% and 69%, respectively. During the T_1 and T_2 audit periods, septic surgery nurses calculated the NRS in 100% and 97% of patients, respectively.

CNT referral rates

The rate at which patients at nutritional risk were referred to the CNT rose from 16% to 63% and 82%, at T_0, T_1, and T_2, respectively. Patients not referred to CNT with BMI ≥ 25 increased from 42% to 68%, respectively before and after implementation of the nutritional policy. The subjective CNT referral rate for patients not at nutritional risk changed from 25% to 40% and 5% at T_0, T_1 and T_2, respectively. Despite an NRS < 3, half of these 12 patients suffered from moderate or severe PEM.

Hospital length of stay and discharge destination

Although not statistically significant ($p = 0.06$), a 19-day reduction of overall hospital length of stay was observed in our study population, when comparing before and after implementation of the nutritional policy. SSC length of stay was significantly reduced by 17 days ($p = 0.039$) when comparing before and after implementation of the nutritional policy.

After exclusion of patients with severe PEM, SSC length of stay was even more significantly reduced, by 23 days ($p = 0.005$).

The SSC length of stay was not influenced by sex, age, or BMI, but was influenced by the type of wound: patients with pressure ulcers/bedsores and major amputation had longer mean SSC length of stay. A significant positive relationship was found between NRS and SSC length of stay at T_0 ($p = 0.002$). This relationship was even more significant after the exclusion of patients with severe PEM, all of whom had received nutritional care ($p = 0.0001$). No relationship was found between NRS and SSC length of stay after implementation of the nutritional policy ($p = 0.9$). The difference in the effect of NRS on SSC length of stay before and after implementation of the nutritional policy, adjusted to the type of wound and after exclusion of patients with severe PEM was found to be significant ($p = 0.001$). Figure 3 displays the model-predicted SSC length of stay after adjustment for the type of wound.

Discharge destination did not change significantly, although more patients were released home after implementation of the nutritional policy than before (66% and 55%, respectively).

The hospitalization costs of an orthopedic patient in our SSC are about EUR 1,000 per day. After implementation of the nutritional policy, patients remained in the SSC 17 days less than before, representing a saving of about EUR 17,000 per patient.

Discussion

The present study showed that the NRS is an effective tool for guiding nutritional interventions on septic surgery patients at nutritional risk or with moderate and severe PEM. The SSC's nutritional care quality indicator improved from 26% to 81%. Our results showed that after the implementation of its new nutritional policy, the Lausanne University Hospital's Septic Surgery Center more adequately identified and treated its patients at nutritional risk or suffering from PEM.

Our orthopedic patients had a high, 44% prevalence of moderate or severe PEM, which is consistent with literature [8-10]. This is one of the first studies showing that the NRS is a useful, routine, nutritional screening tool for such patients. It allowed the identification of patients at nutritional risk, despite high BMI values (mean 26.1 kg/m^2). It is important to point out that being overweight is no protection from undernutrition. Excess fat mass reduces the sensitivity of using BMI to detect nutritional depletion [36] and this can lead to unrecognized PEM. The present study showed this with an increase from 42% to 68% of patients with a BMI $\geq$ 25 who were not referred. Thus, subjective nutritional assessment alone is of limited value in overweight and obese patients, and the implementation of a simple, objective nutritional screening tool is necessary to get around these difficulties. In contrast, the NRS has a limitation in undernourished patients: it does not identify chronic PEM effectively enough (67% sensitivity) when weight and/or appetite decrease slowly and significantly over several years. This appeared to be a particular problem among our study patients, who were suffering from chronic diseases leading to repeated hospitalizations. In the present study, this limitation was balanced by the increased awareness of or sensitivity to severe PEM among septic surgery staff after the first feedback session. Feedback reports are a recognized method [35] of improving adherence to nutritional guidelines. Our study allowed the septic surgery team to consider patients' nutritional states in previous hospitalizations in their screening.

This study also showed that it was possible to use the NRS in the post-operative period of orthopedic septic surgery, although septic surgery staff did encounter some difficulties in completing the NRS. Strict bedrest was always prescribed to improve wound-healing, and this made it necessary, and time consuming, to weigh patients using a hoist. After discussion with SSC physicians, patients were allowed to be carefully lifted once weekly to be weighed. Interestingly, this new practice did not induce wound complications.

The present study also shows that using the NRS may influence outcome. SSC length of stay decreased significantly by 17 days compared to before implementation of the nutritional policy. This dramatic improvement cannot be explained by a change of wound care protocols, nor by any institutional policy for length of stay reduction. Indeed, overall, length of stay in Lausanne University Hospital did not decrease during the study period. However, because of the present study's small number of patients and its particular design, its results need to be confirmed by further investigations. The shorter length of stay in the SSC almost certainly allowed savings on hospitalization costs for our study population.

However, the NRS alone does not seem to be sufficient for determining all the modalities of nutritional treatments. The implementation of a preventive nutritional policy will require an algorithm defining the screening protocol, the modalities of nutritional care, and coordination between the SSC and the CNT. This coordination was particularly important to avoid overnutrition: five nutritional support regimen had to be stopped by the CNT at T_1 and one at T_2. This problem mainly occurred because septic surgery staff started nutritional care before receiving a proposal from the CNT. Feedback sessions appeared to be useful for improving this issue. The algorithm will not be able to ignore basic nutritional care, 43% of which was by dietetic care and 48% by oral nutritional supplements. There was no significant increase in the number of tube feedings started (8% of our study population). Finally, the CNT experts were on hand to guarantee the quality of nutritional care in daily practice, to manage certain

complicated nutritional situations, like refeeding-syndrome, and to continue training septic surgery staff.

Conclusion

The present study showed that it was possible to implement a nutritional policy in an SSC, with the help of a tool like the NRS, and to reduce the mistakes made in subjective evaluations. Using an algorithm improved the identification of patients nutritionally at risk or malnourished, and it provided the opportunity to start nutritional care while controlling metabolic risks with the help of the CNT. The algorithm also enabled the CNT to use its expertise in improving treatments in complex situations rather than consuming valuable time on basic screening. The NRS showed itself to be useful in our study population, but other methods can be used in nutritional policies [37, 38]; the most important thing is to have a strategy that can be used in daily clinical practice [39]. The present study set a milestone for the implementation of an institutional nutritional policy which is currently underway.

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The authors declare no conflict of interest.

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464

Figure legends

Figure 1

Nutritional management pathway

NRS, Nutritional Risk Score; SSC, Septic Surgery Center; CNT, Clinical Nutrition Team

* *Eats as usual* is defined as usual food intake before onset of illness

Figure 2

Nutritional care prescription

Figure 3

Predictive margins of an NRS at inclusion, before and after implementation of a preventive nutritional policy, with 95% CIs.

Tables

Table 1

Criteria of protein-energy malnutrition (PEM)

	Weight loss	BMI	AMC	FFM
Absent	< 10 %	≥17 kg/m^2	> 5th percentile	> 5th percentile
Moderate	< 10% AND [A]	< 17 kg/m^2	≤ 5th percentile	≤ 5th percentile
	10%–20 %	-	-	-
Severe	10%–20 % AND [A]	< 17 kg/m^2	≤ 5th percentile	≤ 5th percentile
	> 20%	-	-	-

BMI, body mass index; AMC, arm muscle circumference; FFM, fat-free mass

[A] and at least one of the three criteria (BMI, AMC, FFM)

Table 2

General patient characteristics

	T_0 n = 31	T_1 n = 36	T_2 n = 31
Age (years) [A]	70.5 ± 14.7	66.9 ± 11.4	69.6 ± 12.6
Male/Female (n)	20/11	23/13	25/6
Type of wound			
Pressure ulcers or bedsores	3 (10%)	5 (14%)	3 (10%)
Diabetic feet	6 (19%)	6 (17%)	10 (32%)
Minor amputation [B]	5 (16%)	14 (39%)	9 (29%)
Major amputation [B]	2 (6%)	0 (0%)	1 (3%)
Other	15 (49%)	11 (30%)	8 (26%)
Comorbidity			
Diabetes mellitus	15 (48%)	21 (58%)	21 (68%)
Hemodialysis	4 (13%)	5 (14%)	3 (10%)
Charlson Comorbidity Index [B]	3 ± 2	3 ± 2	4 ± 3

[A] Data are expressed as mean ± standard deviation

[B] Minor amputation means below the ankle; major amputation means above the ankle

Table 3

Nutritional parameters at inclusion

	T_0 n = 31	T_1 n = 36	T_2 n = 31
Weight (kg) [A]	71.9 ± 19.2	75.8 ± 16.6	78.5 ± 17.1
Weight loss (%)[A, B]	8.2 ± 8.1	4.7 ± 7.8	3.2 ± 8.5
BMI (kg/m^2) [A]	25.4 ± 5.5	26.7 ± 5.2	25.9 ± 4.0
NRS ≥ 3	19 (61%)	16 (44%)	11 (35%)
Protein-energy malnutrition			
Absent	14 (45%)	22 (61%)	19 (61%)
Moderate	9 (29%)	7 (19%)	8 (26%)
Severe	8 (26%)	7 (19%)	4 (13%)

BMI, body mass index; NRS, Nutritional Risk Score

[A] Data are expressed as mean ± standard deviation

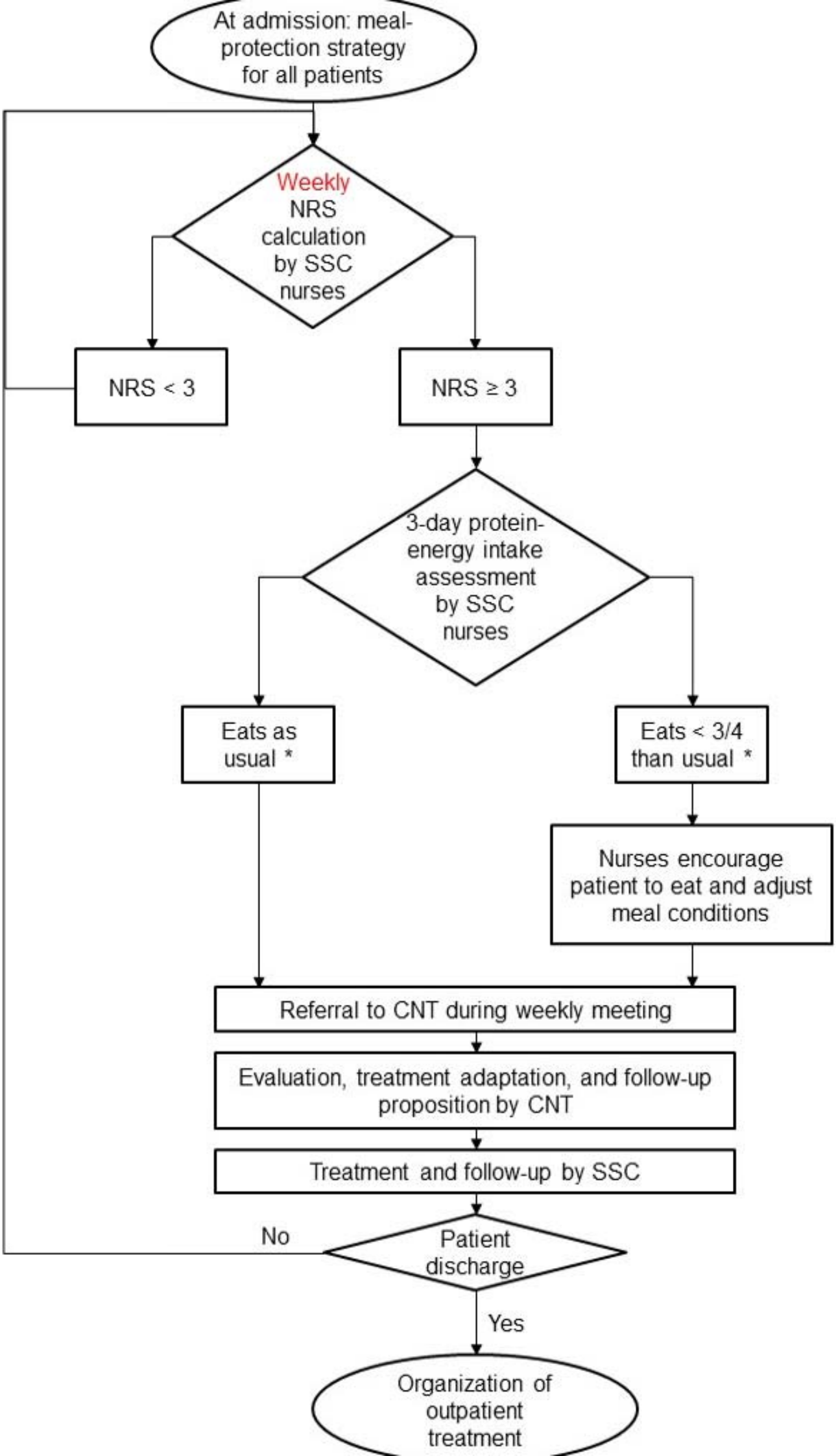
[B] Weight loss does not include weight of amputated extremity

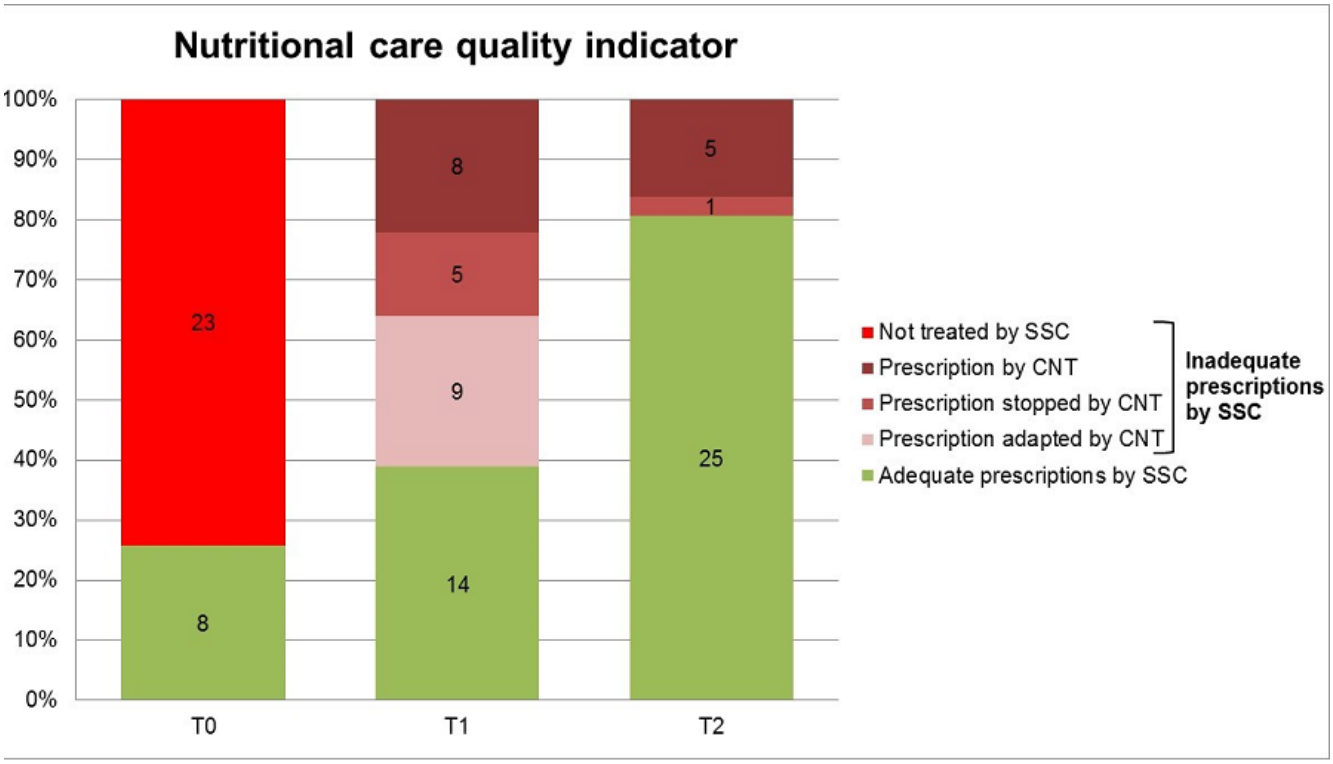
Table 4

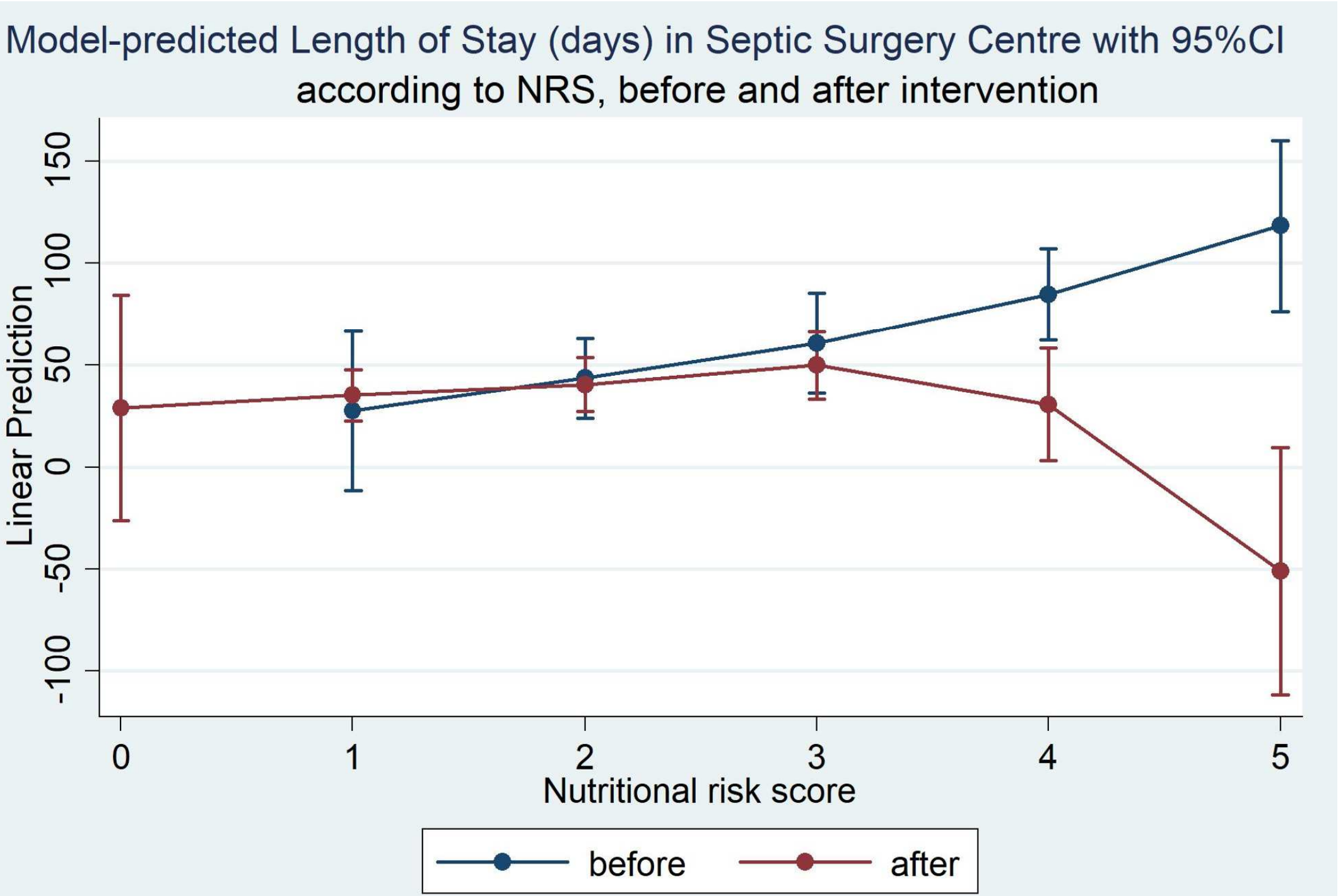
Provided nutritional care

	T_0 n = 31	T_1 n = 36	T_2 n = 31
Patients in need of nutritional care according to NRS and CNT	23	21	16
Adequate prescriptions by SSC	-	4/21 (19%)	11/16 (69%)
Dietetic care	-	4	4
Oral Nutritional Supplement	-	-	5
Tube feeding	-	-	2
SSC prescription adapted by CNT	-	9/21 (43%)	0/11 (0%)
Dietetic care	-	-	-
Oral Nutritional Supplement	-	7	-
Tube feeding	-	2	-
Prescription by CNT	23/23 (100%)	8/21 (38%)	5/16 (31%)
Dietetic care	5	8	5
Oral Nutritional Supplement	17	-	-
Tube feeding	1	-	-
SSC prescription stopped by CNT	-	5	1

NRS, Nutritional Risk Score; CNT, Clinical Nutrition Team; SSC, Septic Surgery Center


At admission: meal-protection strategy for all patients
Weekly NRS calculation by SSC nurses
NRS < 3
NRS ≥ 3
3-day protein-energy intake assessment by SSC nurses
Eats as usual *
Eats < 3/4 than usual *
Nurses encourage patient to eat and adjust meal conditions
Referral to CNT during weekly meeting
Evaluation, treatment adaptation, and follow-up proposition by CNT
Treatment and follow-up by SSC
No
Patient discharge
Yes
Organization of outpatient treatment


Nutritional care quality indicator
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
23
8
8
5
9
14
5
1
25
T0
T1
T2
Not treated by SSC
Prescription by CNT
Prescription stopped by CNT
Prescription adapted by CNT
Adequate prescriptions by SSC
Inadequate prescriptions by SSC


Model-predicted Length of Stay (days) in Septic Surgery Centre with 95%CI
according to NRS, before and after intervention
Linear Prediction
150
100
50
0
-50
-100
0
1
2
3
4
5
Nutritional risk score
before
after
Severe PEM excluded (n = 78)