

Applied nutritional investigation

# Nutritional counseling improves quality of life and nutrient intake in hospitalized undernourished patients

Ursula Rüfenacht, R.D., Maya Rühlin, R.D., Marlene Wegmann, Ph.D.,  
Reinhard Imoberdorf, M.D., and Peter E. Ballmer, M.D.\*

*Department of Internal Medicine and Department of Dietetics, Kantonsspital Winterthur, Winterthur, Switzerland*

Manuscript received August 22, 2008; accepted April 17, 2009.

## Abstract

**Objective:** Up to 60% of hospitalized patients are undernourished. We studied the impact of nutritional therapy on quality of life and food intake.

**Methods:** Undernourished patients were randomized into two groups. The nutritional therapy group (NT group) received individual nutritional counseling and interventions, including oral nutritional supplements if appropriate, by a dietitian. The oral nutritional supplement group (ONS group) received oral nutritional supplements in addition to hospital meals without further instruction or counseling. Study duration was 10 to 15 d. At baseline and before discharge (time point 1) we measured energy and protein intakes and quality of life. Quality of life was measured again 2 mo after discharge (time point 2).

**Results:** Energy and protein intakes increased between baseline and time point 1 in both groups ( $P = 0.001$ ). The NT group ( $n = 18$ ) met the energy requirements at time point 1 by 107% and of protein by 94%, the ONS group ( $n = 18$ ) by 90% and 88%, respectively. Hospital meals alone did not cover the requirements. From baseline to time point 1, quality of life increased in both groups. Quality of life increased further in the NT group from time point 1 to time point 2 ( $P = 0.016$ ), but not in the ONS group.

**Conclusion:** Both interventions caused a significant increase in energy and protein intakes and quality of life. In the NT group every patient received an efficacious individualized intervention. In contrast, the 7 of 18 patients in the ONS group who did not consume ONS had no intervention at all. Therefore, undernourished patients should be counseled individually by a dietitian. © 2010 Elsevier Inc. All rights reserved.

## Keywords:

Nutrition therapy; Quality of life; Malnutrition; Energy intake; Formula diet

## Introduction

Undernutrition (UN) in the hospital setting still is an underestimated problem occurring in 20% to 60% of patients [1–5]. In a recent study, we found UN in nearly 30% of medical patients at our department of medicine [6]. In a Swiss survey, the rate of UN in medical patients on admission was

consistently 18% independent of structural differences of the medical departments [1].

Patients with UN show an increase in length of hospital stay (LOS), comorbidity, and mortality [2,7]. Moreover, UN may decrease quality of life (QoL) substantially as shown previously [8–10]. Also, UN is a significant economic factor of escalating health care costs.

However, the awareness of the problem of UN is still not high enough, and appropriate nutritional treatment for patients with UN may still not take place or only rather delayed [1,11]. To improve the current situation, standardized screening tools such as the Nutrition Risk Score by Rasmussen et al. [11] and Kondrup et al. [12] should be routinely used. In consequence, UN would be detected sufficiently earlier and appropriate nutritional interventions could benefit the patients at risk [12,13].

This work was funded mainly by the Independent Research Fund of the Department of Internal Medicine of Kantonsspital Winterthur. Additional support was provided by the Federation of the Swiss Medical Nutrition Industry.

\*Corresponding author. Tel.: +41-0-52-266-2301; fax: +41-0-52-266-4706.

E-mail address: [peter.ballmer@ksw.ch](mailto:peter.ballmer@ksw.ch) (P. E. Ballmer).

So far, few studies have been published about nutritional therapy in hospitalized patients with UN, as Stratton et al. [7] recently concluded in large review of the literature about the use of oral nutritional supplements (ONSs) and enteral and parenteral nutrition. Most studies have investigated the effects of energy-rich and/or protein-rich ONSs on nutritional status. Studies that have investigated the impact of nutritional therapy by the dietitian show an increase in energy intake, body weight, nutritional status, and QoL [14–17]. Not surprisingly, a positive correlation between nutritional intervention and nutritional status could be proved. However, only ambulatory patients were included, whereas data regarding the usefulness of nutritional counseling by dietitians in hospitalized patients are scarce [15,18]. In the present study, we investigated the effects of a differentiated nutritional intervention in undernourished hospital patients with different disorders. We were also interested in whether individualized nutritional counseling by a dietitian would be superior to merely feeding ONSs without further advice. The primary endpoint was the increase in energy and protein intakes, and improvement of QoL, maintenance of body weight, and better nutritional status were secondary endpoints.

## Materials and methods

The study protocol was approved by the local ethical committee in April 2005. Patients gave written informed consent.

### Patients

All patients admitted to the department of medicine with a Nutrition Risk Score  $\geq 3$  [12] were screened for inclusion into the study. Inclusion criteria were estimated LOS  $\geq 10$  d, unintended loss of body weight  $\geq 5\%$  of usual weight over the previous 2 mo, and loss of appetite. Exclusion criteria were terminal illness, existing enteral or parenteral nutrition, ongoing nutritional counseling or interventions, e.g., intake of ONSs, impaired cognition, and incapability to give consent.

From April 2005 to March 2006, 517 patients had a Nutrition Risk Score  $\geq 3$ . Of these, 435 were excluded because of exclusion criteria. The most frequent exclusion criterion was short LOS or cognitive impairment. Of the remaining patients, 53 gave informed consent and were included. The most frequent reason for refusal was recently diagnosed severe illness or exhaustion.

### Nutritional interventions

Patients participating were randomized into two groups selected by sealed envelopes. We used block sizes of eight. The randomization ratio was 1:1. A patient was randomized just after providing informed consent. The allocated treatment started 1 d after randomization.

### Nutritional therapy (NT group)

The patients were individually counseled by the dietitian according to standardized procedures that are equal to our standard care. Nutritional therapy consisted of an appropriate treatment with respect to the patient's requirements and the course of disease. The first step was an extensive assessment with a history of usual and actual food intakes, course of body weight, and problems with food intake. Thereafter, an individual nutritional plan was made with a variety of interventions such as enrichment of foods with energy and/or protein, e.g., maltodextrin, oil, powdered protein and energy- and/or protein-rich snacks, beverages and energy-dense ONS, additional to usual hospital meals. Nutritional interventions were continuously adapted to the requirements of patients.

### Oral nutritional supplements (ONS group)

The patients received energy-dense ONSs and were informed about the risks of UN. They received 2 U of ONSs (Nutridrink, Nutricia, Bulle, Switzerland; 1 U equals 200 mL, 300 kcal, 12 g of protein) in addition to usual hospital meals, without further nutritional instructions. The intake of ONSs was controlled and registered to 0.5 U by the nursing staff.

The aims were:

- Increase of energy and protein intakes by  $\geq 50\%$  but optimally  $\geq 75\%$  of energy and protein requirements that were calculated according to the formula of Ireton-Jones and Jones [19], with 1 g of protein per kilogram of body weight.
- Improvement in QoL.
- Stable body weight, i.e.,  $\pm 1$  kg.

### Measurements

The study time period equaled the LOS but was not longer than 15 d.

At baseline (time point 0), i.e., just after randomization and before the start of the allocated treatment, and on the last day, i.e., mostly at release from the hospital (time point 1), measurements were done as shown in Figure 1.

The most important parameters were nutrient intake and QoL. All meals were weighed before and after consumption. From the difference between given and consumed foods, energy and main nutrients were calculated with PRODI 5.0 Expert (Nutri-Science GmbH, Freiburg, Switzerland).

Quality of life was assessed by a validated questionnaire mainly used in patients with cancer (Functional Assessment Anorexia-Cancer Therapy [FAACT]) [20] and with a visual analog scale (VAS) elaborated for the study (Table 1). We used the FAACT because this questionnaire contains a sub-scale with 12 questions concerning nutrition.

The FAACT and VAS were completed twice during the hospital stay. Two months after a patient's release,

**Overview – measurements**

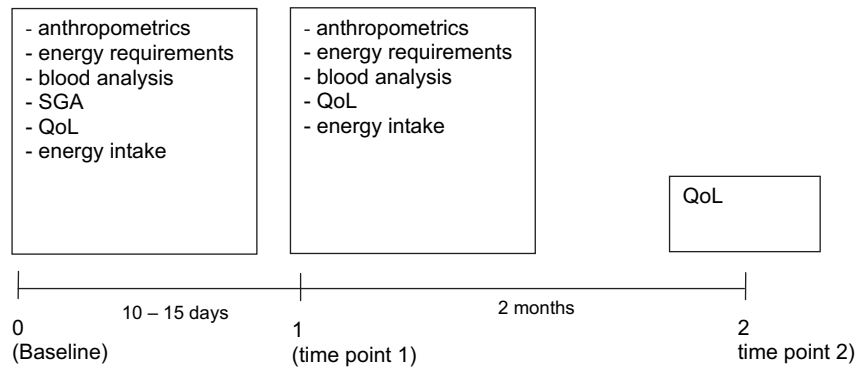


Fig. 1. Study design and overview of the measurements. QoL, quality of life; SGA, Subjective Global Assessment.

the FAACT was sent to the patient’s home by regular mail. The patient sent the questionnaire back to the hospital after having answered the questions for the third time.

Energy requirements were calculated according to the formula of Ireton-Jones and Jones [19]. Resting energy expenditure was measured by a hand-held indirect calorimeter (MedGem, Healthetech, Golden, CO, USA). Protein requirement was set at 1 g/kg of body weight per day.

Nutritional status was assessed by the Subjective Global Assessment (according to Detsky et al. [21]).

The severity of disease was assessed by the Case Mix Index, a measurement that is routinely used in Switzerland to weigh the costs of a patient’s case [22]. The Case Mix Index reflects the severity of disease and comorbidities: the higher the Case Mix Index, the more severely ill is the group of patients.

*Statistics*

The results are presented as mean ± standard deviation. Statistical analyses were performed with Sigmaplot 8.0 (SPSS Inc., Chicago, IL, USA). Differences within groups were statistically analyzed by the Wilcoxon signed rank test, whereas differences between the groups were analyzed using the Wilcoxon rank sum test. Analyses of categorical data were made by the chi-square and Fisher’s exact test. Statistical significance was defined as  $P \leq 0.05$ .

**Results**

Fifty-three patients were included, and 36 could be analyzed. The main reasons for patients dropping out were withdrawal of informed consent by three patients, two patients

Table 1  
Questions about QoL (visual analog scale, translated from German to English for publication)

1. How was your appetite in recent days? 0 = no appetite 10 = normal appetite (as usual)	2. Have you eaten as much as usual over the past 3 d? 0 = absolutely not 10 = yes, as usual
3. How much effort have you needed for eating in the past 3 d? 0 = no effort 10 = great effort	4. Has your taste been as usual? 0 = not at all 10 = exactly (normal)
5. How much pleasure do you have when eating? 0 = no pleasure at all 10 = as usual	6. How much do you feel distressed by eating? 0 = no stress at all 10 = great stress
7. Did you have diarrhea in the past 3 d? If yes, how much was QoL affected by diarrhea? 0 = not at all 10 = very strongly	8. Have you been nauseated in the past 3 d? If yes, how much was QoL affected by nausea? 0 = not at all 10 = very strongly
9. Did you have to vomit in the past 3 d? If yes, how much was your QoL affected by vomiting? 0 = not at all 10 = very strongly	10. How do you judge your energy of life in the past 3 d? 0 = no energy 10 = full of energy (like normal)
11. How strong (energetic) did you feel in the past 3 d? 0 = no energy 10 = normal energy	12. Give an estimate of your QoL in the past 3 d. 0 = very bad 10 = very good

QoL, quality of life.

discharged too early, and four deaths in the NT group and withdrawal of informed consent by four patients, one patient discharged too early, one death, and cognitive impairment in two patients in the ONS group.

The two groups were comparable at the start of the study (Table 2). Also, we found no substantial differences in severity and character of disease. Most patients had malignancies. The Case Mix Index, as a reflection of the severity of disease, was not different between the groups. Laboratory results are listed in Table 2.

The NT group showed a significant increase in body weight between baseline and time point 1 of 1.3 kg ( $P = 0.021$ ), whereas the ONS group demonstrated no significant increase ( $+0.4$  kg,  $P = 0.212$ ).

### Energy and protein intakes

At baseline the NT group showed a daily energy intake of  $1178 \pm 389$  versus  $880 \pm 428$  kcal in the ONS group, which was not significantly different ( $P = 0.079$ ).

The increases in energy intake were  $+667 \pm 439$  kcal ( $+57\%$ ,  $P < 0.001$ ) in the NT group and  $+545 \pm 446$  kcal ( $+61\%$ ,  $P < 0.001$ ) in the ONS group.

The NT group showed an 89% increased energy intake versus 78% in the ONS group (not significant).

At time point 1 no significant difference in energy intake occurred between the groups ( $1841 \pm 570$  kcal in NT group versus  $1425 \pm 662$  kcal in ONS group,  $P = 0.174$ ). Energy intake increased in the NT group by 40.7% (480 kcal) exclusively by dietary means. In the ONS group, energy intake increased by 30.3% (267 kcal) exclusively by liquid ONSs.

At baseline protein intake was  $39.5 \pm 17$  g in the NT group versus  $28.2 \pm 15.3$  g in the ONS group ( $P = 0.058$ ).

Table 2  
Characterization of the two study groups

	NT group (n = 18)	ONS group (n = 18)	P
Age (y)	69.2 ± 12.6	70.8 ± 13.3	0.669
Male/female	11/7	9/9	
Body weight (kg)	64.6 ± 16.3	57.8 ± 11.4	0.304
BMI (kg/m <sup>2</sup> )	22 ± 4	22 ± 3.6	0.950
SGA			
A	2	1	
B	16	17	
C	0	0	
NRS 2002 (0–7)	3.8 ± 0.7	3.9 ± 0.9	0.657
Diseases			
Malignant tumors	7	7	
Pneumonia	3	4	
COPD	2	2	
Other	6	5	
CMI	1.453 ± 0.953	1.451 ± 0.950	0.591
Albumin (g/L)	33 ± 5.8	32 ± 6.3	0.752
CRP (mg/L)	67 ± 48.7	56 ± 53.9	0.223
Creatinine (mmol/L)	100 ± 73.8	106 ± 107.8	0.255

BMI, body mass index; CMI, Case Mix Index; COPD, chronic obstructive pulmonary disease; CRP, C-reactive protein; NRS 2002, Nutrition Risk Score 2002 [12]; NT, nutritional therapy; ONS, oral nutritional supplement; SGA, Subjective Global Assessment.

Protein intake significantly increased by  $+22.7 \pm 16.5$  g ( $+57\%$  from baseline,  $P < 0.001$ ) in the NT group and  $22.5 \pm 18.2$  g ( $+80\%$  from baseline,  $P < 0.001$ ) in the ONS group. At time point 1 patients in the NT group consumed daily  $62.2 \pm 22.5$  g of protein and those in the ONS group consumed  $50.7 \pm 25.1$  g. Protein intake increased in the NT group by 41.5% (16.4 g) exclusively by dietary means. In the ONS group, protein intake increased by 38.3% (10.8 g) exclusively by liquid ONSs.

### Energy and protein requirements

Energy requirements were achieved by 70% in the NT group and by 56% in the ONS group at baseline. At time point 1 the values were 107% (NT group) and 90% (ONS group), respectively.

In the NT group protein requirements were covered in 61% at baseline and in 94% at time point 1. In the ONS group the values corresponded to 49% and 88%.

#### 75% coverage of energy requirements at baseline

In the NT group, 10 of 18 patients covered their energy needs by 75%. Of the eight patients whose coverage was below 75%, four patients' coverage was below 50%. In the ONS group, 6 of 18 patients covered their energy needs by 75%. Of the 12 patients whose coverage was below 75%, 7 patients' coverage was below 50%.

#### 75% coverage of energy requirements at time point 1

In the NT group, 17 of 18 patients covered their energy needs by 75%. The one who did not cover 75% still ingested more than 50%. In the ONS group, 11 of 18 patients covered their energy needs by 75%. Of the seven patients whose coverage was below 75%, three patients' coverage was below 50%.

At time point 1, the difference in covering 75% of the energy requirement between the NT group and the ONS group was significant ( $P = 0.041$ ).

#### 75% coverage of protein requirements at baseline

In the NT group, 5 of 18 patients covered their protein needs by 75%. Of the 13 patients whose coverage was below 75%, five patients' coverage was below 50%. In the ONS group, 2 of 18 patients covered their protein needs by 75%. Of the 16 patients whose coverage was below 75%, eight patients' coverage was below 50%.

#### 75% coverage of protein requirements at time point 1

In the NT group, 14 of 18 patients covered their protein needs by 75%. Every patient covered  $\geq 50\%$  of their protein needs. In the ONS group, 12 of 18 patients covered their protein needs by 75%. Of the six patients whose coverage was below 75%, four patients' coverage was below 50%.

At time point 1 the difference in covering 75% of the protein requirement between the NT group and the ONS group was not significant ( $P = 0.710$ ).

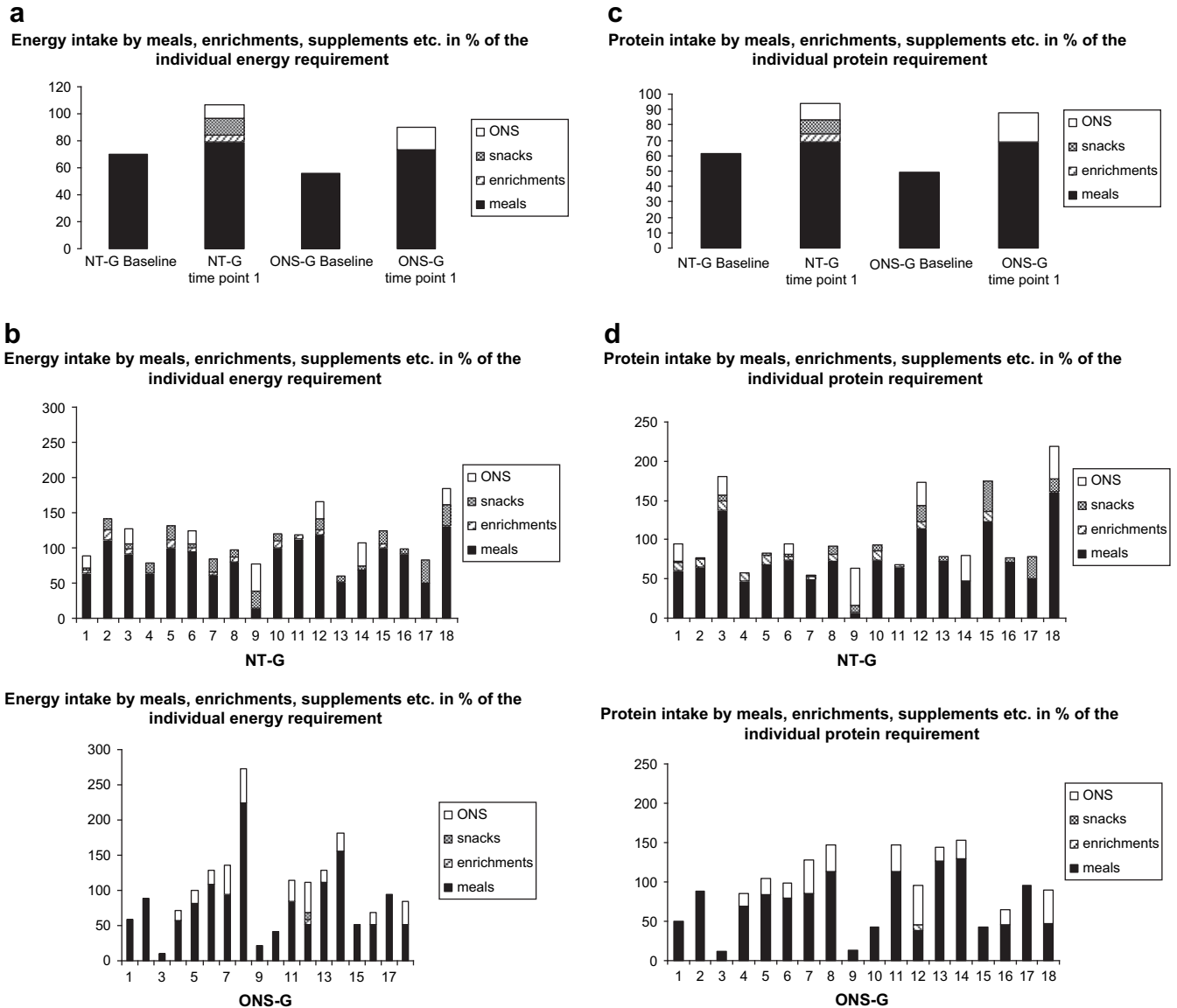


Fig. 2. (a) Means of energy intake by meals, ONSs, snacks, and food enrichment in percentages of the average requirements. (b) Individual energy intake in both treatment groups by meals, ONSs, snacks, and food enrichment in percentages of the energy requirements. (c) Means of protein intake by meals, ONSs, snacks, and food enrichment in percentages of the average protein requirements. (d) Individual protein intake in both treatment groups by meals, ONSs, snacks, and food enrichment in percentages of the protein requirements. NT-G, group receiving nutritional therapy; ONS, oral nutritional supplements; ONS-G, group receiving oral nutritional supplements.

*Energy and protein intake by different components*

Figures 2a and 2b summarize energy intakes in percentages of individual requirements. Figure 2a shows the lack of covering energy needs completely (100%) at baseline and time point 1 by usual meals alone. In Figures 2c and 2d, protein intakes are summarized.

*Measurement of QoL*

**FAACT questionnaire.** A significant improvement in QoL occurred in both groups from time points 0 to 1 without a difference between the groups. Between time points 1 and 2, only the NT group showed a further significant

increase in QoL (Fig. 3). For details in subscales of FAACT, see Table 3.

**VAS questionnaire.** A significant improvement of QoL occurred in both groups between baseline and time point 1 (NT group:  $+28.5 \pm 20.6$  points,  $P < 0.001$ ; ONS group:  $+17.1 \pm 20.4$  points,  $P < 0.003$ ). A significant correlation between energy intake and the VAS sum score is presented in Figure 4.

**Discussion**

In the present study, nutritional interventions resulted in increased energy and protein intakes in the NT group with

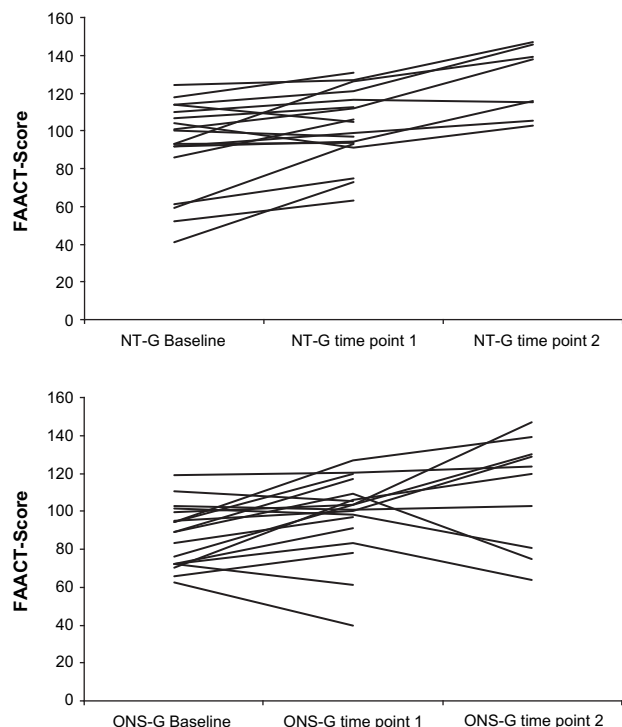


Fig. 3. Results of the FAAC-T questionnaire at time points 0 and 1 in the hospital and 2 mo after discharge (time point 2). FAAC-T, Functional Assessment Anorexia-Cancer Therapy; NT-G, group receiving nutritional therapy; ONS-G, group receiving oral nutritional supplements.

dietary counseling and the ONS group with supplements. Moreover, QoL improved in both groups during the hospital stay. Maintenance of the improvement in QoL was achieved only in patients in the NT group, whereas those in the ONS group showed no further improvement.

Undernutrition is frequent in hospitalized patients and causes increased comorbidity and mortality, longer LOS, may reduce QoL, and cause a substantial economic burden. With the present study, we investigated the efficacy of

Table 3

Changes in quality of life across TPs 0, 1, and 2 in different subscales of the FAAC-T

	NT group			ONS group		
	Baseline	TP 1	TP 2	Baseline	TP 1	TP 2
PWB	14.4	18.5 <sup>‡</sup>	23.1	16.5	18.6	22
SWB	22.8	23	25.2	20.5	22.1	22
EWB	15.4	17	19.6	15.9	17.2	18.1
FWB	13.3	12.3	19.6*	11.1	10.9	14.8
ACS	26.5	31.2 <sup>†</sup>	38.6	23.1	29.1*	34.2
FAAC-T total	92.3	102 <sup>†</sup>	126.2*	87.1	97.8*	111.1

ACS, additional factors such as nutrition; EWB, mental well-being; FAAC-T, Functional Assessment Anorexia-Cancer Therapy; FWB, functional impairment; NT, nutritional therapy; ONS, oral nutritional supplement; PWB, physical well-being; SWB, relationship to friends and relatives; TP, time point.

\*  $P < 0.05$ .

<sup>†</sup>  $P < 0.01$ .

<sup>‡</sup>  $P < 0.001$  versus previous TP.

individual nutritional counseling by professional dietitians in comparison with feeding ONSs in addition to the hospital meals.

A potential confounding factor for the increased energy and protein intakes may be the spontaneously favorable course of the disease. Although the ONS group started with substantial lower energy and protein intakes than the NT group, we did not find any difference in type and severity of disease or other patient characteristics (Table 2). However, usual meals alone could not cover nutritional requirements. Covering energy and protein requirements at time point 1, i.e., 10 to 15 d after admission, was achieved only by additional nutritional interventions. This observation is in line with data by Raffoul et al. [23] who investigated nutrient intake and the significance of feeding ONSs in elderly patients with chronic low-limb and pressure ulcers. In line with our investigation, other researchers have demonstrated that energy intake could be augmented with nutritional intervention [15,17,24]. In those studies, dietitians also were responsible for nutritional interventions. In contrast to our study, the controls were not given any supplements or dietary counseling. Ethical reasons, however, did not allow a control group without any measures in the severely ill and undernourished patients.

We also intended to show differences between individual nutritional counseling by dietitians and feeding ONSs. Patients in the ONS group received general information about UN and potential consequences. When the patients refused ONSs, no alternative instructions were given. However, the general information by the responsible physicians and the study coordinator and offering ONSs by the nurses may have sensitized the patients with regard to sufficient energy intake and may have been responsible, at least in part, for the increased intake.

As for the coverage of 75% of the energy requirements, there was a significant difference between the groups at time point 1 ( $P = 0.041$ ). The aim to cover 75% of the energy needs

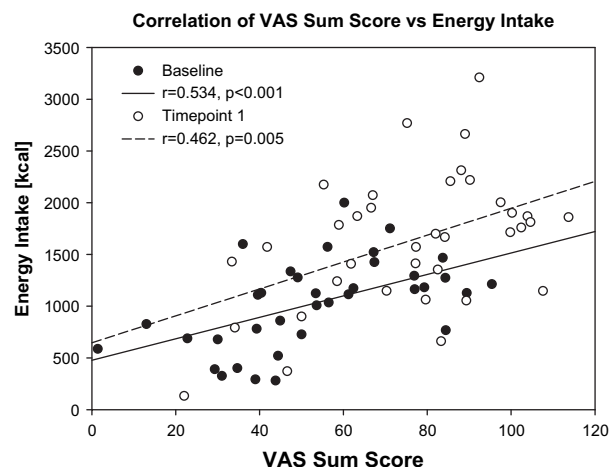


Fig. 4. Linear regression (Spearman's correlation,  $P < 0.001$ ) of quality of life measured by VAS and energy intake at time points 0 (closed circles) and 1 (open circles). VAS, visual analog scale.

was achieved by all but one patient in the NT group. However, this patient still covered more than 50% of the requirements. In contrast, in the ONS group, only 61% of the patients achieved the goal of covering 75% of energy needs. This impressive difference suggests that energy intake can be optimized by active nutritional counseling with dietary measures individually tailored to the patients' needs. In comparison, the ONS group without additional dietary counseling did clearly worse and did not achieve the goal in 40%. The data suggest that the effect of a professional dietitian is of paramount importance and that the undernourished hospital patients should, whenever possible, be individually counseled.

The question remains as to which dietary measures caused the improvement in the NT group. Enrichment of food, energy-rich snacks, drinks, and ONSs contributed to the increase in energy intake. Also, the dietitian improved feeding with ONSs by giving instructions with regard to timing, rate, and choice of ONSs. Our results are in line with previous studies showing increases in total energy intake by snacks and energy-rich drinks. This contradicts uncertainties about such interventions that may hamper energy intake from usual hospital meals as was shown by others [7,25–27]. We found no reduction in food intake by meals caused by nutritional interventions. In contrast, there was a slight increase in energy intake by meals between baseline and time point 1 in both groups.

We measured QoL with a validated tool (FAACT) [20] and found a significant improvement of QoL between baseline and time point 1. Two months after hospital discharge, a significant increase of QoL occurred exclusively in the NT group. We believe this effect on QoL can be ascribed to the intensive, individual, and qualified counseling by the dietitian. Patients in the NT group were individually counseled; therefore, every patient received a specific intervention (Fig. 2b,d). The patients were intensively taught how to manage nutrition at home and received qualified nutritional instructions. Thus, the improvement in QoL at time point 2 in the NT group must be an expression of a learning effect in the patients. The patients were reassured in the self-management of continuous nutritional care.

The influence of dietary counseling on QoL has seldom been investigated. However, the study of Johansen et al. [15] investigated the effect of a nutritional intervention on QoL in hospitalized undernourished patients. QoL was assessed on admission and after 28 d. The design of the study was different from ours, i.e., the time schedule was different. Moreover, the main focus of that study was the LOS. However, although they could not find an increase of overall QoL, individual health items, such as bodily pain and social functioning, improved significantly in both groups. Ravasco et al. [28] investigated the impact of nutritional counseling (group 1), regular food plus ONSs (group 2), or no intervention (group 3) on nutritional intake and QoL in oncologic outpatients undergoing radiotherapy. The intervention lasted as long as patients were treated with radiotherapy, i.e., about 6 wk. After radiotherapy, nutritional intake and QoL function scores improved in groups 1 and 2 but worsened in group 3. At

3 mo, patients in the counseled group maintained or improved overall QoL, whereas patients in groups 2 and 3 maintained or worsened overall QoL. That study showed, comparable to our data, the beneficial ongoing effect of nutritional counseling in comparison with ONSs as the only intervention. However, they investigated outpatients with cancer, and their results are therefore not entirely comparable to our data.

## Conclusion

The interventions caused increases in energy and protein intakes and QoL. Hospital food alone was insufficient to cover energy and protein intakes. However, we found a sustained effect on QoL only in the NT group. Therefore, undernourished hospitalized patients should be counseled individually by a dietitian.

## Acknowledgments

The authors thank the dietitians for counseling of the patients and Sara Kühl for the measurements of BIA. They especially thank the kitchen crew who helped in weighing the meals.

## References

- [1] Imoberdorf R, Meier R, Krebs P, Hangartner PJ, Hess B, Stäubli M, et al. Prevalence of malnutrition on admission in Swiss Hospitals. *Clin Nutr* 2004;23:1467–8.
- [2] Kyle UG, Morabia A, Slosman DO, Mensi N, Unger P, Pichard C. Contribution of body composition to nutritional assessment at hospital admission in 995 patients: a controlled population study. *Clin Nutr* 2001;20:725–31.
- [3] Kyle UG, Pirlich M, Schütz T, Lübke HJ, Lochs H, Pichard C. Prevalence of malnutrition in 1760 patients at hospital admission: a controlled population study of body composition. *Clin Nutr* 2003;22:473–81.
- [4] Pirlich M, Luhmann N, Schütz T, Plauth M, Lochs H. Mangelernährung bei Klinikpatienten: Diagnostik und klinische Bedeutung. *Aktuell Ernähr Med* 1999;24:260–6.
- [5] Pirlich M, Schütz T, Norman K, Gastell S, Lübke HJ, Bischoff SC, et al. The German hospital malnutrition study. *Clin Nutr* 2006;25:563–72.
- [6] Gehring N, Imoberdorf R, Wegmann M, Rühlin M, Ballmer PE. Serum albumin—a qualified parameter to determine the nutritional status? *Swiss Med Wkly* 2006;136:664–9.
- [7] Stratton RJ, Green CJ, Elia M. Disease-related malnutrition: an evidence-based approach to treatment. Wallingford: CABI Publishing; 2003.
- [8] Larsson J, Akerlind I, Permerth J, Hörmqvist JO. Impact of nutritional state on quality of life in surgical patients. *Nutrition* 1995;11:217–20.
- [9] Öhrn KE, Sjöden PO, Wahlin YB, Elf M. Oral health and quality of life among patients with head and neck cancer or haematological malignancies. *Support Care Cancer* 2001;9:528–38.
- [10] Ravasco P, Monteiro-Grillo I, Marques Vidal P, Camilo ME. Cancer: disease and nutrition are key determinants of patient's quality of life. *Support Care Cancer* 2004;12:246–52.
- [11] Rasmussen HH, Kondrup J, Staun M, Ladefoged K, Kristensen H, Wengler A. Prevalence of patients at nutritional risk in Danish hospitals. *Clin Nutr* 2004;23:1009–15.
- [12] Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. *Clin Nutr* 2003;22:415–21.

- [13] Angelini A, Ballmer PE, Keller U, Stanga Z, Sterchi B, Berger MM, et al. Prävention der Mangelernährung und Ernährungstherapien im Spital. Bericht und Empfehlungen aus dem Europarat. *Aktuel Ernähr Med* 2003;28:133–6.
- [14] Isenring EA, Capra S, Bauer JP. Nutrition intervention is beneficial in oncology outpatients receiving radiotherapy to the gastrointestinal or head and neck area. *Br J Cancer* 2004;91:447–52.
- [15] Johansen N, Kondrup J, Munk Plum L, Bak L, Nørregaard P, Bunch E, et al. Effect of nutritional support on clinical outcome in patients at nutritional risk. *Clin Nutr* 2004;23:539–50.
- [16] Rabeneck L, Palmer A, Knowles JB, Seidehamel RJ, Harris CL, Merkel KL, et al. A randomized controlled trial evaluating nutrition counselling with or without oral supplementation in malnourished HIV-infected patients. *J Am Diet Assoc* 1998;98:434–8.
- [17] Ravasco P, Monteiro-Grillo I, Marques Vidal P, Camilo ME. Dietary counselling improves patient outcomes: a prospective, randomized, controlled trial in colorectal cancer patients undergoing radiotherapy. *J Clin Oncol* 2005;23:1431–8.
- [18] Gariballa S, Forster S, Walters S, Powers H. A randomized, double-blind, placebo-controlled trial of nutritional supplementation during acute illness. *Am J Med* 2006;119:693–9.
- [19] Ireton-Jones C, Jones JD. Improved equations for predicting energy expenditure in patients: the Ireton-Jones equations. *Nutr Clin Pract* 2002;17:29–31.
- [20] Ribaudo J, Cella D, Hahn EA, Lloyd S, Tchekmedyan NS, VonRoenn J, et al. Re-validation and shortening of the Functional Assessment of Anorexia/Cachexia Therapy (FAACT) questionnaire. *Qual Life Res* 2000;9:1137–46.
- [21] Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, et al. What is subjective global assessment of nutritional status? *JPEN* 1987;11:8–13.
- [22] Schwab P, Meister A. Der Case Mix Index—ein Mass für den durchschnittlichen Schweregrad der Krankenhausfälle. *Methode und Auswertungen. Stat Sante* 2004;3:33.
- [23] Raffoul W, Far MS, Cayeux MC, Berger MM. Nutritional status and food intake in nine patients with chronic low-limb ulcers and pressure ulcers: importance of oral supplements. *Nutrition* 2006;22:82–8.
- [24] Ovesen L, Allingstrup L, Hannibal J, Mortensen EL, Hansen OP. Effect of dietary counselling on food intake, body weight, response rate, survival, and quality of life in cancer patients undergoing chemotherapy: a prospective, randomized study. *J Clin Oncol* 1993;10:2043–9.
- [25] Bauer JD, Capra S. Nutrition intervention improves outcomes in patients with cancer cachexia receiving chemotherapy—a pilot study. *Support Care Cancer* 2005;13:270–4.
- [26] Delmi M, Rapin CH, Bengoa JM, Delmas PD, Vasey H, Bonjour JP. Dietary supplementation in elderly patients with fractured neck of the femur. *Lancet* 1990;335:1013–6.
- [27] Turic A, Lowry Gordon K, Craig LD, Gonyon Ataya D, Coble Voss A. Nutrition supplementation enables elderly residents of long-term-care facilities to meet or exceeded RDAs without displacing energy or nutrient intakes from meals. *J Am Diet Assoc* 1998;98:1457–9.
- [28] Ravasco P, Monteiro-Grillo I, Marques Vidal P, Ermelinda Camilo M. Impact of nutrition on outcome: a prospective randomized controlled trial in patients with head and neck cancer undergoing radiotherapy. *Head Neck* 2005;27:659–68.