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Original article

Protein and energy intake improved by in-between meals: An intervention study in hospitalized patients

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SUMMARY

Background/aim: Disease related malnutrition is a major problem in hospitals. Malnutrition in hospitalized patients is caused by many factors. Among these factors are decreased appetite and early satiety, and reaching nutritional requirements in nutritional risk patients is a challenge when using ordinary energy and protein dense food. The aim of this study was to examine if total protein and energy intake in medical and surgical patients at nutritional risk could be improved by protein fortified and energy rich in-between meals.

Methods: An assortment of fortified in-between meals including 10 g of protein was developed based on patient preferences and served in the Departments of Lung Medicine and Abdominal Surgery for a period of three months. Nutrition intake was recorded before and after intervention.

Results: Food intake records were collected from a total of 92 patients, (46 before and 46 after intervention). The total amount of protein intake per in-between meal was increased from 2,6 g to 10,3 g. Total daily protein intake increased from 49% to 88% ($p < 0.00$) and total energy intake from 74% to 109% ($p < 0.00$) of requirements.

Conclusion: Protein and energy intake for surgical and medical patients at in-between meals as well as total daily intake increased significantly. Recommended average level for individually measured requirements was reached.

Introduction

Malnutrition in hospitalized patients has been reported since the 1970s. However, 40 years later, malnutrition remains a challenge that requires attention [1,2].

Despite the use of evidence based screening tools for identifying patient at nutritional risk, disease related malnutrition is a problem in hospitals today [3–5]. Malnutrition is related to poor clinical outcomes such as increased risk of morbidity, mortality, longer hospitalization and re-admittance [6,7].

Malnutrition in hospitalized patients is often caused by several factors. Lack of appetite, early satiety and eating disabilities such as chewing and swelling difficulties, as well as taste end smelling disorders can affect the intake [8–10]. Decreased intake, in combination with increased stress metabolism caused by disease, results in loss of muscle protein and altered energy expenditure, leading to malnutrition [11]. Many studies on malnutrition carried out in hospitals, focus on documentation of the problem and describing the eating problems, rather than aiming at identifying possible solutions to promote food intake in patients at nutritional risk [4,12][,35].

Studies have shown that reaching nutritional requirements in at-risk patients is a challenge when using ordinary energy and protein dense food, and especially covering protein requirements can be difficult [13–15]. Within the last years, a few substantial studies have been carried out, aiming to increase food intake in patients at risk of malnutrition, focusing on energy- and protein fortified food [15–17]. The results from these studies indicate that it is possible to improve the intake of energy and protein with patient

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preferred fortified meals, as seen in the study by Beermann et al. (2016) focusing on breakfast [18].

In-between meals are essential for patients at risk of malnutrition, in order to reach sufficient intake of energy and protein. According to Danish recommendations, 30–50% of the requirement of energy and protein intake should come from in-between meals [19]. A former study aimed to increase energy- and protein intake by *serving bedside in-between meals* at Aalborg University Hospital. In this study, small meals with varying energy and protein density and oral nutritional supplements were served from a trolley. While energy-intake during in-between meals increased, this study however did not show any difference in overall daily intake of energy and protein [13]. An explanation could be the lack of fortification of food items towards the right level of energy and protein required for in-between meals [20,21].Another explanation could be, that the meals were not pre-tested in this specific population, with focus on patient wishes, portion size and satiety, so that the patients would still eat at the next main meal.

Therefore, the *aim* of this study was to examine if total protein - and energy intake in medical and surgical patients at nutritional risk, may be improved by protein fortified, energy rich in-between meals.

Study populations and methods

Study design

A quasi-experimental design with a non-equivalent control group was used. The study was an intervention study based on feasibility in a given time-frame, with a baseline and a follow-up measurement of nutrition intake for all patients admitted to the departments of lung medicine (V) and abdominal surgery (A) at Aalborg University Hospital, Denmark. The departments had 24 (V) and 20 (A) beds, respectively.

The study took place during June 2016 to April 2017 with a 3-month intervention period from January to April 2017. The intervention tested a new developed menu of in-between meals. The process levels in the study are illustrated in Fig. 1.

The existing organization of in-between before baseline

In the existing meal offer, the hospital present in-between meals, available two to three times pr. day at 10 a.m., 15 p.m. and 20 p.m. Each department order the in-between meals three days ahead from a pre-defined menu, with a minimum selection of four items pr. day consisting of something sweet (e.g. flan), something salty (e.g. potato chips), whole meal bread with cheese and butter and fresh fruit. This pre-defined menu has an average of 653 kJ/156 kcal and 2.3 g of protein pr. serving.

In-between meals are served in department V from a small steel trolley in the bed ward hallway. Food items that should be kept cold is placed in a refrigerator in the department kitchen. In department A all the meals is served from a buffet in the department. For both departments some of the food items are served by the patients themselves, others require serving by the staff to secure the hygiene.

Food intake registration system

Nutritional intake was registered for three consecutive days using a paper registration schedule during baseline and follow-up measurements. All food servings and drinks were registered according to the time of serving. All foodstuffs and drinks were written down on the paper registration record when it was served to, or fetched by the patient. When the patient had finished eating, and the patient's tray or dish was taken out, it was noted how much of the portion was taken, measured by what was left of the served portion and drinks on the plate. The registration was done either by the patient or the nursing staff depending on the patient's abilities. Drinks were registered in approximate deciliters and meals were registered as pieces or approximate quartile portion sizes. The registration system was the system used in daily practice and in studies beforehand. It was tested for sensitivity and specificity in an earlier study and found adequate for use in research as well as practice [22]. Translation of portion size and nutritional intake was processed in an electronic calculation program as also used in clinical practice at Aalborg University Hospital, based on premeasured meal- and drink-portions for protein (grams) and energy (calories, kcal). Data were registered in the electronic patient record and in Microsoft Excel.

Requirements

All included patients were screened with the Nutritional Risk Screening tool 2002 (NRS-2002) on admission [23,24] in order to estimate nutritional risk. Requirements were calculated in the hospital IT-system based on a standardized, modified scale of Harris–Benedict equation. Protein requirements were calculated in the program as 1.3 g/kg/d, as recommended by the National Board of Health [19].

Inclusion criteria

Adult (>18 years old) patients screened and found to be at nutritional risk by NRS-2002, hospitalized with an expected hospitalization at >48 h, able to eat orally and not rely on enteral and/or parenteral nutrition were included.

Exclusion criteria

Patients diagnosed with cognitive dysfunction, progressive and terminal illness, and patients on special diets including potassium and/or sugar restrictions as well as enteral and/or parenteral nutrition and language barriers were excluded from the study. Registration schedules with missing data were excluded. Missing data were defined as if a meal serving, or food items (incl. drinks) was not or unclearly registered on the schedules.

Intervention

Prior to the intervention, a product development phase of nutritionally adequate in-between meal recipes was performed. The aim was to reach an average of a least 700 kJ/167 Kcal and 10 g of protein per serving. Energy and protein content was calculated based on the average needs to sufficiently nourish the patients with in-between meals contributing to at least 30% of their total energy -and protein intake. Further, the product development phase was based on knowledge collected using semi-structured qualitative interviews with 14 randomly selected patients (seven participants from each department).

Interview

The patients were interviewed three times on 1 day at the specific time of an in-between meal serving approximately at 10 a.m., 15 p.m. and 20 p.m. In the first interview, patients were asked about their preferences and habits regarding eating in-between meals, and about how the existing in-between meal menu in the hospital lived up to their expectations and preferences. In the following interview sessions, to further elucidate the patients' "on-time" in-between meal preferences, the interview was combined with a visual method consisting of showing pictures of various

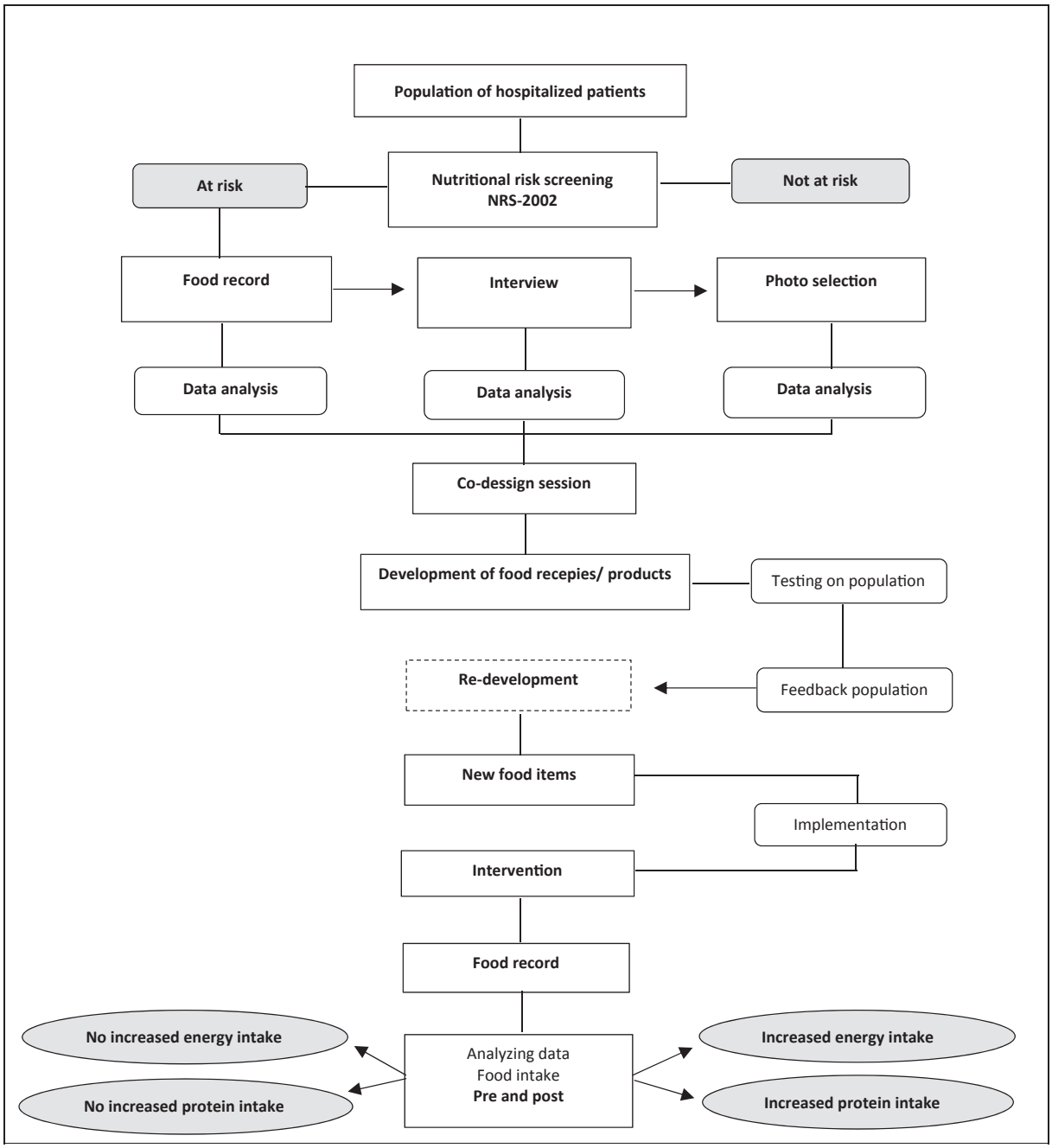

Fig. 1. Process diagram: Illustrating the phases in the study.

in-between meals to the patients. From the pictures, the patients were asked to select which in-between meals they would prefer to eat at the time of the interview. The visual method was based on the concept of visual ethnography [25].

Co-design session

Recipes and servings for new in-between meals were developed from the collected qualitative data results by an innovation team consisting of four specialists in food preparation, a menu planner, a supply manager and a food scientist. A model of food sensory quality to promote food intake was used as framework for the development. The model was based on a motivation to eat theory, dividing patients at nutritional risk into the three categories, eating for *pleasure, comfort or survival* as suggested by Sorensen J et al. [26].

Development and testing of improved in-between meals

Protein was integrated using both high protein products such as egg and shun (high protein density soured milk product) and using protein powder supplements as fortifications. No energy fortifications were used. The protein powder used was either whey, gelatin or pea protein depending on application as protein powders have different properties making them suitable for different applications. All new developments were sensory tested by the team to ensure high sensory quality of all meal items. If any doubt or disagreement occurred in the team regarding sensory quality, the products were sensory tested by all available patients at the two departments. Afterwards adjustments were made according to the findings from the sensory tests (Table 1).

Implementation

The new in-between meals were designed as *ready-to-serve products* making it easy for the staff to serve. The offer consisted of nine available in-between meals per day, three at each serving time. Some of the products were served as a snack plaid others as to items servings. The nurses and service staff at the two departments were thoroughly introduced to the new menu, and how to serve it. This was done in order to provide knowledge and experience of the products with respect to taste, texture and nutritional content. The staff was also trained to guide patients in their choice of food as well as to arranging and serving it. During the intervention, the departments were asked to order within all categories of in-between meals from the menu. The staff was initially (first three weeks) supervised by a food consultant on a daily basis. After three weeks, they were supervised by the food consultant occasionally or on request, if they needed further supervision.

Baseline measurement

The baseline measurement was performed prior to the intervention using the food intake registration schedule in both departments, lung medicine and abdominal surgery. All eligible patients at the two departments had their food intake registered for three consecutive days. The mean nutritional intake for 24 h was calculated for each patient and related in percentage to the daily requirements. Daily fulfilling of requirements were set to be met when 75% of the total requirements were fulfilled [27,28].

Follow-up measurement

The follow-up measurement was performed after 12 weeks of intervention by the same method used in the baseline measurement, in the same two departments.

Statistics

Nutritional intake, age, gender and BMI were compared between baseline and follow-up measurements using unpaired t-tests. Number of patients receiving ≥75% of the total daily requirements or of 30% requirements during in-between meals were compared using χ^2-tests between baseline and follow up measurements. Significance was predetermined as $p \leq 0.05$. Data were normally distributed.

Ethical considerations

Patients were given written and oral information about the study prior to participation. They were informed that they could withdraw from the study at any time during the intervention period. The study was presented to the local ethic committee, which did not find reason for submission to the committee, according to Danish law of ethical code of conduct in intervention studies.

Results

In total, 46 patients (25 from V and 21 from A) completed the food intake registration at baseline, and 46 patients (27 from V and 19 from A) completed the food intake registration during the follow up measurement. The study included 102 food registrations (7 discarded – insufficient registrations) at baseline and 85 registrations (15 discarded) in the follow-up measurement.

No difference among gender, age and BMI were seen between the baseline and follow up groups (Table 2.).

As shown in Table 3, the average energy intake during three in-between meal servings improved from 55% to 118% of the daily requirements aimed to be covered by in-between meals (30% of total daily requirements) ($p < 0.00$). Similar, the average protein intake increased from 30% to 112% of daily requirements (30% of total daily requirements) during three in-between meal servings ($p < 0.00$). The total daily intake of energy and protein improved as well. The average total amount of energy consumed per in-between meal serving increased from 385 kJ/92 Kcal to 886 kJ/212 Kcal and the average total amount of protein consumed per in-between meal increased from 2.6 g to 10.3 g.

Number of patients having received ≥75% of recommended intake of energy and protein (30% of total daily intake) during three in-between meal serving increased significantly from baseline to follow-up. Patients receiving ≥75% of energy recommendations increased from 26% to 80% ($p < 0.000$) and for protein intake, the increased was from 11% to 80% ($p < 0.000$) (Fig. 2).

The number of patients receiving ≥75% of individually measured total daily requirements was also improved. For energy, intake raised from 39% to 91% of patients having reached recommended levels ($p < 0.000$) and for protein intake, the number of patients having ≥ 75% of protein requirements fulfilled increased from 17% to 72%.

Discussion

The present study aimed to increase average intake from in-between meals to meet at least 30% of calculated needs for both energy and protein, in contribution to overall daily intake.

The main findings of the present study underline the possibility of improving oral energy -and protein intake in hospitalized surgical and medical patients using fortified food, as seen in previous

Table 2
Demographic information about the sample.

Variables	Baseline	Follow-up	p-value
Number of patients included	46	46	–
Number of registrations included	102	85	–
Gender %	M:46%	M:43%	
M = Male, F = Female	F:54%	F:57%	0.84
Age, years mean (SD)	69.28 (14.52)	68.7 (13.21)	0.84
BMI mean (SD)	25.36 (6,12)	25.0 (6.13)	0.83

Table 1
Examples of protein fortified in-between meals.

In-between intervention	Size/g/por	Energy/kJ/por	Energy/Kcal/por	Protein/g/por	Collagen/g	Whey/g	Pea/g
Recipe/products							
Milkshake - orange	150	856	205	16	7,6	7,1	–
chocolate cake	56	662	158	7,6	2,87	2,6	–
Pizza bun	40	332	79	6	1,0	1,0	0,6
Fruit salad	65	535	128	8,4	3,8	3,8	–
Bun	40	435	104	4,9	–	1,34	0,8
Cheese crackers	10	158	38	1,4	–	0,7	0,5
Sandwich - ham	40	464	111	5,3	–	1,0	–
Jelly - apple and cream	50	515	123	9,5	5,5	–	–

Table 3
Mean energy and protein intake during in-between meals servings.

Average nutritional intake % (Range)	Baseline	Follow-up	p-value
Total daily energy intake	74 (10–137)	109 (40–165)	0.00
Total daily protein intake	49 (11–101)	88 (30–167)	0.00
Energy intake from in-between meals[a]	55 (0–176)	118 (21–232)	0.00
Protein intake from in-between meals[a]	30 (0–144)	112 (9–231)	0.00

[a] 30% of total daily requirements.

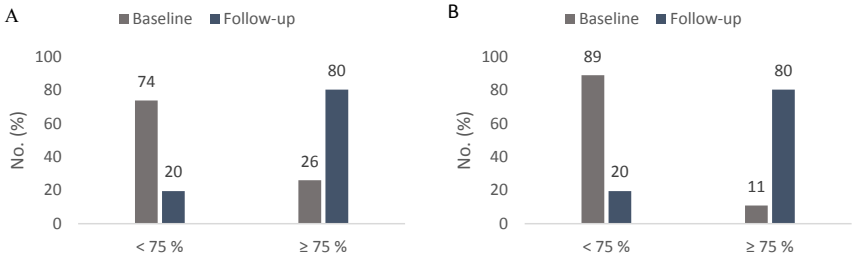

Fig. 2. Number of patients having <75% and ≥75% of recommendations during three in-between meals. A. Energy intake and. B. Protein intake.

studies [15,29,30]. As opposed to a previous in-between meal study carried out at Aalborg University Hospital [13] both goals were achieved in the present study. The differences between the two studies might be explained by the used protein fortification, but also by the different study designs. In this study patient's preferences were studied and used in the planning of the menu, while this was not a part of the previous study. All food items were developed with a high level of energy and protein in small portions, which was not done systematically in the previous study, where also candy and drinks without protein was served. In the present study, the in-between meals were served by the patient's primary nurse, mainly served at the same time of the day, between the main meals. In the former study, in-between meals were served from a manned trolley, which served two departments at a time, thus coming quite close to main meals for those patients served first and last. This might be one of the explanations to why in the former study, it was not possible to increase intake at in-between meals, without the expense of the total daily intake, while in the present study it was.

Protein sources

Working with protein powder was associated with some challenges related to taste, texture and appearance. Especially products with a naturally low level of protein was a challenge, as juice based drinks, fruit salad and jellies, but also baking products as buns, were a challenge. There are many different types of protein fortification powders on the marked, with varying quality and functionality. We tested different kinds of protein, and could conclude that i.e. whey is not just whey, different types are on the marked as hydrolyzed and isolate, with different technicality and absorption levels.

A broader knowledge and experience with different types of protein sources might have led to improved recipes and products with a higher sensory level.

According to Danish recommendations for patients at risk of malnutrition, 30–50% of energy and protein intake should come from in-between meals [19]. The choice of using a limit of 30% instead of 50% was based on an uncertainty related to the possibility of reaching high intake in protein and energy.

Using 10 g as a goal for protein per served in-between meal was based on the aim of reaching 30 g in total intake divided on three in-between meals pr. day. It is recommended that patients in risk of undernutrition are served at least three in-between meals a day because many patients suffer from early satiety, and can only eat a little at a time [19]. Studies have indicated that 25–30 g of protein as an optimal intake divided into three main meals [31,32]. This way of distributing protein at the main meals does not fit very well with the recommendation regarding serving three in-between meals for patients at risk of malnutrition. The level of 10 g of protein pr. in-between meal was calculated in relation to reach a goal of 30 g in total for three in-between meals. A level of 10 g of protein per serving seems to be related to some uncertainty compared to 30 g of intake in order to secure an optimal synthesizes of the protein in the body. However, in most patients, 75–90 g of protein by main meals will not cover 1.3 g kg/d, and may moreover challenge consumption in the little eating patients, suffering from early satiety.

This study indicates that in-between meals can improve the intake of energy and protein in hospitalized patients and the importance of serving in-between meals for patients at risk of malnutrition, if requirements especially focusing on protein should be met, without reducing the patient's intake at the main meals. This study only included patients able to communicate well. Thus, in order to reach the more weak patients, it may also be important to be aware that some patients are so weak that they only eat to survive. This group might still benefit from oral nutritional supplements [26].

The uncertainty related to level of amount of protein per servings and optimal synthesizes in relation to the effect of protein distributed among 6–8 meals and impact on muscle mass needs to be investigated even further.

Conclusion

Protein fortified, energy rich in-between meals, based on a patient preference investigation, improved protein -and energy intake in surgical and medical patients for in-between meals as well as for total daily intake, to meet recommended requirements.

Conflicts of interest

None declared.

Authors' contributions

All authors were responsible for the study design, data collection and analysis. M N Mortensen drafted the manuscript and wrote

the final edition together with M Holst. Rasmussen H H provided scientific guidance and language check.

Acknowledgments

M N Mortensen, L H Skadhauge and R H Høgsted wrote the protocol and collected the data together with T Beermann, A K Larsen and M Cook together with the nursing staff at the departments of abdominal surgery and lung medicine at Aalborg University Hospital. M N Mortensen and A K Larsen drafted the article and M Holst, H H Rasmussen and B E Mikkelsen supervised the study set up and participated in the final article writing. All authors revised the manuscript drafts critically. Financial support was given by an unrestricted grant from the hospital nutrition committee and the hospital central kitchen.

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