Methods to evaluate dietary intake of hospitalized patients

Validation of a plate diagram sheet for estimation of energy and protein intake of inpatients

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2012

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Thesis for the degree of Master of Science in Human Nutrition
Faculty of Food Science and Nutrition, School of health Sciences
University of Iceland

HÁSKÓLI ÍSLANDS

Aðferðir við að meta fæðuneyslu sjúklinga á sjúkrahúsum

Mat á gildi einfalds skráningarblaðs til áætlunar á orku- og próteinneyslu inniliggjandi sjúklinga

Rannveig Björnsdóttir

Leiðbeinandi: Ingibjörg Gunnarsdóttir prófessor í næringarfræði

Meistaraprófsverkefni í næringarfræði unnið á Rannsóknarstofu í næringarfræði
við Háskóla Íslands og Landspítala Háskólasjúkrahús

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University of Iceland & Landspitali National University Hospital of Iceland

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ÁGRIP

Bakgrunnur & tilgangur: Skortur er á einföldum gildum aðferðum til að fylgjast með orku- og próteinneyslu sjúklinga á sjúkrahúsum. Markmiðið var að meta gildi einfalds skráningarblaðs til áætlunar á orku- og próteinneyslu inniliggjandi sjúklinga og bera saman við nákvæma skráningu á fæðuneyslu.

Aðferðir: Þátttakendur voru inniliggjandi sjúklingar á hjarta- og lungnaskurðdeild, Landspítala háskólasjúkrahúsi, Reykjavík, Íslandi (N=81). Einfalt skráningarblað var notað til að skrá hlutfall (0%, 25%, 50%, 100%) af heildarskammti aðalmáltíða (morgun-, hádegis- og kvöldverður) og millibita (síðdegis- og kvöldhressing) sem sjúklingar neyttu. Skráningin fór fram í þrjá daga. Næringargildi máltíða frá eldhúsi Landspítalans er þekkt og voru allir matarafgangar vigtaðir og skráðir af þjálfuðum sérfræðingi skráningardagana. Niðurstaða einföldu skráningarinnar var borin saman við nákvæmu skráninguna með pöruðu t-prófi. Tengslin á milli aðferðanna tveggja voru metin með Pearson correlation. Heildarsamræmi fyrir orku- og próteinneyslu milli aðferðanna voru metnar með Bland Altman punktariti og samræmismörk reiknuð (meðalmunur ± 1.96 staðalfrávik frá meðaltali).

Niðurstöður: Að jafnaði ofmat einfalda skráningarblaðið orkuneyslu um 46 kkal á dag (1119±353 kkal/dag miðað við 1074±360 kkal/dag, p=0,008). Ekki var marktækur munur á próteinneyslu milli aðferða (50,2±16,4 g/dag miðað við 48,7±17,7 g/dag, p=0,123). Þegar eingöngu voru skoðaðar máltíðir þar sem áætlað var að sjúklingur hafði lokið við ≤50% af því sem skammtað var reyndist einfalda skráningarblaðið vanmeta neysluna lítillega. Fylgni milli aðferðanna tveggja var r = 0,922, p < 0,001 fyrir orku (kkal/dag) og r = 0,896, p < 0,001 fyrir próteinneyslu (g/dag). Samkvæmt Bland Altman voru samræmismörk fyrir orkuneyslu -231 kkal/dag til 322 kkal/dag og fyrir próteinneyslu -14,0 g/dag til 16,9 g/dag.

Ályktun: Niðurstöðurnar benda til þess að unnt sé að nota einfalt skráningarblað til að áætla orku- og próteinneyslu sjúklinga á sjúkrahúsum, sérstaklega til að meta meðalneyslu sjúklingahópa. Styrkur skráningarblaðsins liggur meðal annars í því að það ofmetur ekki neyslu sjúklinga sem borða lítið.

ABSTRACT

Background & aims: Validation of simple methods for estimating energy and protein intakes in hospital wards are rarly reported in the literature. The aim was to validate a plate diagram sheet for estimation of energy and protein intakes of patients by comparison with weighed food records.

Methods: Subjects were inpatients at the Cardio Thoracic ward, Landspitali National University Hospital, Reykjavik, Iceland (N=81). The ward personnel recorded the proportion (0%, 25%, 50%, 100%) of main meals (breakfast, lunch and dinner) and snack (afternoon- and evening snack) consumed for three days using a plate diagram sheet. The nutrition composition of the meals provided by the hospital kitchen is known and leftover food was weighed by a trained research person during the registration days. Energy and protein intake estimated by the plate diagram sheet was compared with the results from the weighed records by paired t-test. Pearson correlation was used to assess associations between the two methods. The overall agreement for energy- and protein intakes between the methods was assessed by Bland Altman plot and the limits of agreement computed (average difference ± 1.96 standard deviation of the difference).

Results: On average the plate diagram sheet overestimated energy intake by 45 kcal/day (1119±353 kcal/day versus 1074±360 kcal/day, p=0.008). Estimation of protein intake was not significantly different between the two methods (50.2±16.4 g/day versus 48.7±17.7 g/day, p=0.123). If only meals were included where ≤50% of the meals served was consumed according to the plate diagram recording, a slight underestimation of the real consumption was observed. Correlation between the two methods was r = 0.922, p < 0.001 for energy intake (kcal/day) and r = 0.896, p < 0.001 for protein intake (g/day). According to Bland Altman the limits of agreement between the two methods for energy intake were -231 kcal/day to 322 kcal/day and for protein intake -14.0 g/day to 16.9 g/day.

Conclusion: The results show that a plate diagram sheet can be used to estimate energy and protein intakes with fair accuracy in hospitalized patients, especially at the group level. Importantly, the plate diagram sheet does not overestimate intakes in patients with a low food intake.

ACKNOWLEDGEMENTS

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1 INTRODUCTION

Malnutrition is a major health care problem worldwide, but in the western world it is mainly considered a problem in elderly people and hospitalized patients.[1] Malnutrition is associated with several adverse outcomes. Malnourished patients are at higher risk of developing complications, they stay longer in the hospital which increases costs. Increased mortality is also seen in this group.[2-5]

Studies on energy intake in hospitalized patients show that food intake is often insufficient. It is important to implement a clear evidence based treatment plan that can improve the patients' nutritional status or prevent malnutrition and its adverse effects.

The first step to identify those who are at risk of malnutrition, is nutritional assessment. Nutritional assessment has been defined by A.S.P.E.N as "a comprehensive approach to diagnosing nutrition problems that uses a combination of the following: medical, nutrition, and medication histories; physical examination; anthropometric measurement; and laboratory data."[6] A full nutrition assessment is time consuming and expensive. Numerous nutrition screening tools have been developed to identify hospitalized patients at risk of malnutrition, simple, easy-to-use, valid, and reliable screening tool is essential to identify those at risk.[7-8]

In Iceland several studies have been published since 1999 on screening for malnutrition.[9-12] From these studies a simple screening sheet has been developed, with 7 questions about nutritional assessment.

The European Society for Clinical Nutrition and Metabolism (ESPEN) published guidelines for Nutrition Screening 2002.[13] The guidelines are applicable to different settings (community, hospital, elderly) and are based on published and validated evidence available until June 2002. In Iceland a group of experts from Landspitali National University Hospital began working on clinical nutrition guidelines for patients in 2008, which were published in march 2011.[14] Screening was implemented in the patients electronic health record system in December 2011 using the Icelandic screening sheet.

It is essential, that the screening process is followed by action plans aiming at improving the nutritional status, or at least prevent that nutritional status becomes worse during the hospital stay. Some high cost biochemical measurements have been used in order to monitor nutritional status during hospitalization.[15] Energy balance can be estimated by measurements of weight, but this measurement can be misleading due to edema. Therefore an easy way to monitor energy and protein intake is essential. An important part of the Icelandic clinical guidelines is to assess energy and food intake of patients with an acceptable monitoring method. This step is mentioned in the implementation plan of the clinical guidelines. A limited amount of studies is available validating such monitoring methods, e.g. simple estimates of how much of a served meal is eaten, and results of the studies are conflicting.

The aim of this thesis was to validate a simple plate diagram sheet for estimation of energy and protein intake in hospitalized patients by comparison with a weighed food registration. The main results along with interpretation and discussion of the main findings can be found in the manuscript enclosed (Chapter 4): "Validation of a plate diagram sheet for estimation of energy and protein intake in hospitalized patients" Scientific background is presented in the review of literature in this thesis.

2 REVIEW OF THE LITERATURE

2.1 Malnutrition in hospitals

Malnutrition is a major health care problem, mainly affecting elderly people and hospitalized patients in the western world.[1] It might be one of the most important factor that interferes in health and disease, and is the most common disease in the hospital setting.[3] Prevalence of malnutrition in European hospitals has been reported to be 21 – 58%[9,10,12,16,17] and a large part of patients is already undernourished when admitted to hospitals and malnutrition often progresses during their hospital stay.[18-20]

Malnutrition has been defined as "a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein, and other nutrients causes measurable adverse effects on tissue/body form (body shape, size and composition) and function, and clinical outcome".[21] Malnutrition can develop as a consequence of deficiency in dietary intake, increased requirement associated with a disease state, from complications of an underlying illness such as poor absorption and excessive nutrient losses, or from a combination of these aforementioned factors.[20,22] Malnutrition is associated with adverse outcomes, e.g., malnourished patients are at higher risk of developing complications and reduced quality of life as well as increased mortality is seen in this group.[3,18] Furthermore, these patients stay longer in hospitals than patients who are not malnourished with increased costs for the health service.[2,3,18] Malnutrition in hospitalized patients has been studied for decades and there is an increased interest in nutritional interventions with evidence based methods.

2.2 Nutrition assessment

A nutrition assessment provides the basis for a nutrition intervention. It is both used to find patients at risk of malnutrition as well as to follow them up on nutritional status. It is a process that includes obtaining diet and medical history, current clinical status, anthropometric data (e.g. body weight), laboratory data (e.g. plasma concentration of serum proteins such as albumin and prealbumin), physical assessment information (e.g. muscle strength) and often functional and economic information, estimation of nutrient requirements and usually selecting a treatment plan.

A full nutrition assessment is time consuming and expensive. Especially laboratory tests, when static biochemical tests are used (e.g. nutrient in biological fluids or tissues or the urinary excretion rate of the nutrient or its metabolite). Anthropometric methods can be easier to conduct but they also have their limitations, e.g. in the case of edema. There is no single best parameter for measuring nutritional status, therefore measurements of several different parameters are used together.

Screening methods have been widely studied and a simple screening tool is now considered acceptable to assess status in clinical practice.[13]

Persónuatriði sjúklings

Mat á
næringarástandi

Eyðublaðið skal nota til þess að greina líkur á vannæringu á fullorðinsdeildum. Merkið við eftirfarandi atriði og gefið stig eftir því sem við á.

Spurning	Svar	Mat	Stig
1. Hæð: _____ m þyngd: _____ kg	Líkamsþyngdar-stuðull skv. töflu á bakhlið	>20 0 stig 18-20: 2 stig <18: 4 stig	
2. Ósjálfrátt þyngdartap undanfarið? Ef já, hve mikið _____ kg, á hve löngum tíma _____ mán	☐ Já ☐ Nei ☐ Veit ekki þyngdartap % _____	Ósjálfrátt þyngdartap undanfarið? >5% sl. mánuð eða >10% sl. mánuð 4 stig 5-10% sl. mánuði 2 stig Veit ekki 2 stig Annars 0 stig	
3. Eldri en 65 ára?	☐ Já ☐ Nei	Spurningar 3 til 6: Já: 1 stig Nei: 0 stig	

4. Vandamál sl. viku eða mánuði?
 	
  A. Dagleg uppköst í meira en þrjá daga?
 	
  B. Daglegur niðurgangur
    (þunnar hægðir þrisvar á dag eða oftar)?
  C. Viðvarandi léleg matarlyst eða ógleði?
 	
  D. Erfiðleikar við að kyngja eða tyggja?
	
	☐ Já ☐ Nei
	
	☐ Já ☐ Nei
	☐ Já ☐ Nei
	☐ Já ☐ Nei
	☐ Já ☐ Nei		

5. Hefur legið á sjúkrahúsi í 5 daga eða lengur sl. 2 mánuði?	☐ Já ☐ Nei		
6. Hefur gengið undir aðgerð sem telst veruleg sl. mánuð? Ef já hvað var gert? _____	☐ Já ☐ Nei		
7. Sjúkdómar ☐ Bruni >15% ☐ Innlögn v/vannæringar ☐ Fjöláverkar (multiple trauma)		5 stig	

Stig samtals:

Útfyllt af _____   Dags. _____
Undirskrift

5 stig eða fleiri => Sterkar líkur eru á vannæringu.
Fyrir lungna - og krabbameinssjúklinga skal miða við 4 stig eða fleiri

Figure 1. Nutritional screening sheet used at Landspitali National University Hospital.

2.3 Screening for malnutrition

Screening is a simple and low cost process which aims to identify those who are either malnourished or at significant risk of malnourishment. Screening can be cost-effective by reducing hospitalization.[23] Numerous nutrition screening tools have been developed but it needs to be a simple, easy-to-use, valid and reliable tool.[7,8] Nutritional screening tools typically use a questionnaire format to examine

factors known to lead to or be associated with malnourishment. Each question examines a known risk factor for malnutrition, and the score may lead to identification of an appropriate course of action.

Nutrition screening should be routinely performed at admission in an attempt to reduce nutrition-related complications. It is an important part of patients care and is critical to the appropriate identification of patients who may benefit from nutrition intervention. Results of screening should lead to referral to an appropriate professional for in-depth assessment, usually a dietitian or other health care professionals.

In Iceland screening for malnutrition has been studied for more than a decade, initiated by a quality management project that aimed to diminish malnutrition among hospitalized patients.[10] Recently screening was implemented in the patients' medical record at Landspitali National University Hospital and it is recommended that patients should be screened on admission.[14] The screening tool is based on validation studies conducted during the past 10 years at Landspitali, in different patient groups.[9,10,12,17] The main parameters in the screening sheet is Body Max Index (BMI) and weight loss, age and a few questions about problems associated with diseases (see Figure 1). Screening is well studied and an important factor in dealing with malnutrition but it would be useless without a follow up. Assessment of dietary intake is therefore necessary as recommended in the Icelandic clinical guidelines[14] but to be able to do that it is important to find an acceptable monitoring method to record dietary intake.

2.4 Nutrition in the hospital setting

Malnutrition is a common problem among hospitalized patients and often a large part of these patients is already undernourished when admitted to hospitals which progresses during their hospital stay.[1,18-20] Studies on energy intake in hospitalized patients show that food intake is often insufficient.

2.4.1 Studies on energy intake in hospitalized patients

A literature search was performed to review studies conducted from 2000 to 2012, presenting results of food intake (energy and protein intake) in hospitalized patients. Studies written in other languages than English were excluded as well as studies on children.

The electronic database PubMed was used for the literature search. The search terms used were: energy intake, hospital, patients and malnutrition.

A total of 28 publications were reviewed and included in Table 1, ordered by the publication year. Twenty one of the publications present results from European countries (Netherland, United Kingdom, Switzerland, Denmark, France, Sweden and Belgium), three from American countries (United States of America and Canada), and four from Australia.

The number of participants varied from 9 to 291 in the studies included. Food recording was the most commonly used method, 13 studies used weighed food records and 12 studies used estimated food records. Only three studies used the 24-hour recall method. The average energy intake was from 594 to 1748 kcal/day and in most cases lower than estimated energy need.[24-27]

A very limited amount of similar studies have been conducted in Iceland. A three-day-weighed food records was used in a study on cancer patients (n=30) in chemotherapy 2008.[9] The energy intake was 2032 ± 500 kcal/day, range 1100-3200 and the study showed that 20% of these patients were malnourished. Another study from 2002 used a four-day-weighed dietary records to evaluate energy intake among hospitalized patients with chronic obstructive pulmonary disease (n=10).[17] The median energy intake was 1820 kcal/day (range = 1560 -1996) and median protein intake was 90 g/day (range = 76-98) and 3 of 10 patients were found to be malnourished. The authors conclusion was that the energy and proteinintake was not sufficient to improve nutritional status of the malnourished patients during the hospital stay. A study from 2009 measured energy expenditure (EE) of critically ill patients and compared it with estimated EE and evaluate nutritional support.[28] EE was measured with indirect calorimetry in a broad group of Intensive Care Unit (ICU) patients (n=56) and nutritional support during ICU stay was registered. Mean measured EE was 1820 ±419 kcal/day, mean nutritional support was 1175 ± 442 kcal/day and mean protein administration was 0.44g/kg/day. The conclusion of the study was that measured EE of ICU patients was less than nutritional support recommended by international guidelines.

Table 1. Studies showing mean energy and protein intake in hospitalized patients

Author Year Country	Participants Age group	Type of study	Type of patients	Dietary assessment Method	Mean energy intake (kcal/day)	Mean protein intake (g/day)	Main messages
Van Bokhorst-de van der Schueren et al. 2012 Netherland[29]	n=42 69 ± 12	Cross-sectional validation study	Patients in cardiology and acute coronary care	Weighed food records	1105 ± 594	47 ± 27	The standard meals provided by the hospital kitchen provide adequate amounts of energy and protein. However, most patients do not consume complete meals.
Nip et al. 2011 UK[30]	n=88 69 ±15	Consecutive cohort study	Stroke patients	Weighed food records	1384 ± 689	53.6 ± 20.4	Inadequate energy intake was common even in less impaired and relatively independent stroke patients, and demonstrated insufficient intake accompanied by a persistent and rising risk of malnutrition throughout hospitalization. There is clearly scope for the multidisciplinary development of nutritional support for stroke patients to improve rehabilitation outcomes.
Hoekstra et al. 2011 Netherland[31]	n=66 (control) 80 ± 9.3 n=61 (intervention) 80.6 ±7.2	Controlled prospective cohort study	Patients with hip fractures	Estimated food records	Control 1127 ± 309 Intervention 1292 ± 280	Control 48 ± 14 Intervention 57 ± 12	Among elderly patients with a hip fracture, a multidisciplinary postoperative approach of nutritional care was associated with an increase of energy and protein intake during hospitalization. After three months follow-up there were fewer malnourished patients in the intervention group, and the decline in quality of life was lower than in the control group.
Mudge et al. 2011 Australia[32]	n=134 80	Prospective Cohort study	Older medical inpatients	Estimated food records	1220 ± 440	-	Inadequate nutritional intake is common and patient factors contributing to poor intake should be considered in designing nutritional interventions.
Starke et al. 2011 Switzerland[33]	n=66 (control) 75 ± 11 n=66 (intervention) 70 ± 16	Randomized controlled intervention study	Patients in general medical ward	Estimated food records	Control 1115 ± 381 Intervention 1553 ± 341	Control 43.9 ± 17.2 Intervention 65.4 ±17.2	Malnourished patients profit from nutrition support regarding nutrition status and quality of life. They have fewer complications, need fewer antibiotics and are less often re-hospitalised.

Author Year Country	Participants Age group	Type of study	Type of patients	Dietary assessment Method	Mean energy intake (kcal/day)	Mean protein intake (g/day)	Main messages
Peterson et al. 2010 USA[34]	n=50 59.1 ± 14.5	Observational study	Critically ill patients in intensive care unit	24- hour recall	594 ± 399	26	Although more research is needed, these data call into question the use of restrictive oral diets and suggest that alternative medical nutrition therapies are needed to optimize nutrient intake in this unique patient population.
Rüfenacht et al. 2010 Switzerland[35]	n=18 69.2 ± 12.6	Interventional study	Undernourished patients in the department of medicine	Weighed food records	1178 ± 389	39.5 ± 17	Both interventions caused a significant increase in energy and protein intakes and quality of life. Undernourished patients should be counseled individually by a dietitian.
St-Arnaud Makenzie et al. 2009 Canada[36]	n=32 78.8 ± 6.6	Prospective study	Geriatric patients	Estimated food records	1464 ± 316	61 ± 13.9	Results from this study offer strong evidence that when cachectic/inflammatory conditions are controlled for, standard nutrition care is compatible with the maintenance or improvement of nutritional status during the hospital stay.
Wright et al. 2008 UK[37]	n=29 81.8 ± 8.7	Cohort study	Elderly disphagic patients	Weighed food records	905 ± 431	39.8 ± 21.1	Nutritional intake can be improved by targeted feeding assistance in hospitalized elderly dysphagic patients on texture modified diets.
Hansen et al 2008 Denmark[38]	n=119 71 (median) (40-83)	Observational study	Patients in a gynaecological, an orthopaedic surgery ward and dep. of internal med	Estimated food records	1529 (median)	54 (median)	In-patients at nutritional risk focus should be on ordering the correct type of food for the main courses and especially on increasing the intake from snacks.
Gaillard et al. 2008 France[39]	n=36 77.3 ± 8.0	Cross-sectional evaluation study	Elderly hospitalized patients	Weighed food records	23.5 ± 6.3 kcal/kg/day	0.99 ± 0.24 g/kg/day	Safe protein intake (that would be adequate to ensure that 95% of patients remain in positive nitrogen balance) is difficult to establish.

Author Year Country	Participants Age group	Type of study	Type of patients	Dietary assessment Method	Mean energy intake (kcal/day)	Mean protein intake (g/day)	Main messages
Walton et al. 2008 Australia[40]	n=9 89 ± 4.6	Cross-sectional validation pilot study	Elderly patients	Weighed food records	905 ± 431	39.8 ± 21.1	When volunteers were present, the average protein intake increased and there was also a trend to increased energy intake. Observations indicated that the volunteers, when compared to the nurses, socialized more with patients, encouraged them to eat more often and spent more time feeding them.
Bauer et al. 2007 Australia[41]	n= 49 71.2 ± 14.1	Retrospective Study	Patients who have fallen in an acute care setting	24-hour recalls	-	-	There was a high prevalence of malnutrition and poor intake in this sample of patients who had fallen in hospital. Nutrition assessment and intervention for patients who have fallen in the acute care setting should be considered.
Hickson et al. 2007 UK[24]	n=57 75 (median) 55.8-83.5 (IQR)	Cross-sectional validation study	Various patients not at nutritional risk	Weighed food records	-	-	Patient intakes did not meet their estimated requirements. The patients in this study were eating well and not at nutritional risk, thus patients with a poor appetite will be even less likely to meet their nutritional requirements.
Foss et al. 2007 Denmark[42]	n=291 83 (77-89)	Prospective, descriptive study	Hip fracture patients	Estimated food records	Day 1 594 ± 401 2 1296 ± 631 3 1280 ± 576 4 1299 ± 634	-	Perioperative medical complications and dementia restricted nutritional intake in the perioperative phase. These factors help identify hip fracture patients in whom increased nutritional support is necessary.
Alix et al. 2007 France[43]	n=90 79.7 ± 7.5	Cross-sectional evaluation study	Geriatric patients in acute care	Weighed food records	Men 1748 ± 311 Women 1470 ± 340	-	The mean resting energy expenditure of the geriatric patients studied was 18.8 kcal/kg per day, whereas energy intake was just sufficient to cover minimal requirements. Thus, hospitalized elderly patients are likely to benefit from higher calorie intake.

Author Year Country	Participants Age group	Type of study	Type of patients	Dietary assessment Method	Mean energy intake (kcal/day)	Mean protein intake (g/day)	Main messages
Eneroth et al. 2006 Sweden[44]	n=40 (control) 78 ± 8 (median) n=40 (intervention) 84 ± 7 (median)	Prospective, randomized, controlled clinical trial	Patients with cervical or trochanteric hip fracture in Orthopaedic department	Estimated food records	Control 916 Intervention 1296	-	The risk of fracture- related complications was greater in the control group (70%) than in the intervention group (15%). The comprehensive balanced nutrition supplement resulted in lower complication rates and mortality at 120 days postoperatively.
Nematy et al. 2006 UK[25]	n=25 85.3 ± 1.5	Prospective study	Patients in orthopaedic ward with a fractured neck of femur (NOF)	Estimated food records	1008 ± 76	-	This group of patients with fractured NOF is likely to be malnourished on admission and to show a rapid deterioration in its nutrition status during admission. Energy needs were not met in up to 50% of patients. These results reinforce the need to screen, supplement and monitor fractured NOF patients.
Foley et al. 2006 Canada[45]	n=91 69 ± 11.3	Prospective observational study of an inception cohort	Stroke Patients	Estimated food records	20.0 ± 5.4 kcal/kg	0.84 ± 0.28 g/kg/day	On average, newly diagnosed, well-nourished, hospitalized patients consumed 80-91% of their both their energy and protein requirements, in the early post stroke period.
Miller et al. 2006 Australia[26]	n=68 84(83,86)	Observational study	Patients in orthopaedic ward	Estimated food records	Men 1184 Women 865	Men 53 Women 39	Orthopaedic fracture patients at greatest nutritional risk, including those with cognitive impairment, do not achieve estimated energy or protein requirements from diet alone. Effective methods of achieving requirements in this vulnerable group are needed before improvements in outcomes will be observed.
Dambach et al. 2005 France[46]	n=56 57-97	Open, case-control study	Ulcer pressure patients	Weighed food records	Men 1558 ± 499 Women 1241 ± 294	-	Malnutrition within diseased elderly patients with pressure ulcers is most likely the result of low energy intake.

Author Year Country	Participants Age group	Type of study	Type of patients	Dietary assessment Method	Mean energy intake (kcal/day)	Mean protein intake (g/day)	Main messages
Pedersen 2005 Denmark[47]	n=135 (control) 76(65-97) n=107 (intervention) 76(65-95	Quasi-experimental study	Patients with hip fracture /hip or knee replacement	Estimated food records	Men (control) 1313 ± 322 Women 1255 ± 319	Men 48 ± 13.2 Women 47 ± 12.1	An individualized patient care will increase the intake of energy and protein during hospitalization. Patients who did not consume enough energy and protein compared with their current requirements were quickly identified, and the appropriate action was taken.
Perier et al. 2004 France[48]	n=49	Prospective study	Hospitalized geriatric patients	Weighed food records	1535 ± 370 (steady state) 1375 ± 500 (catabolic state)	1 ± 0.3 g/kg/day 0.9 ± 0.4 g/kg/day	Protein-caloric undernutrition should be diagnosed early during hospitalization in order to allow appropriate dietary supplementation. However the incidence of protein undernutrition among elderly patients as a cause or a consequence of adverse pathophysiological processes remains a cause of debate.
Edwards and Hartwell 2004 England[49]	n=13 36-89	Cross-sectional validation pilot study	Hospitalized patients	Weighed food records	Patients: at the table 1632 ± 314 by the bed 1348 ± 336 in bed 1363 ± 287	-	Results show a significant increase (p<0.05) in the mean daily energy intake for those sitting around a table in the presence of others. Although a small pilot study, the results confirm the value of social facilitation in improving the under-consumption of food when in hospital.
Almdal et al. 2003 Denmark[27]	n=69	Cross-sectional validation study	Hospitalized patients	Weighed food records	1074 ± 454	46 ± 12	Despite a supply of food, which was much higher than the patients' needs, the patients have only approx. 60% of their energy need covered. We suggest a reorganization of nutrition in hospitals, so that this is made the responsibility of specific staff members.
Joosten and Vander Elst 2001 Belgium[50]	n=50 82.5 ± 5.5	Prospective study	Hospitalized geriatric patients	Estimated food records	1475 With nutrit. supplements 1825	-	In conclusion, short-term nutritional supplementation has a beneficial effect on the total daily caloric intake in elderly hospitalized patients with and without malnutrition, but the wastage remains high.

Author Year Country	Participants Age group	Type of study	Type of patients	Dietary assessment Method	Mean energy intake (kcal/day)	Mean protein intake (g/day)	Main messages
Lumbers 2001 UK[51]	n=75 80.5 ± 11.9	Cross-sectional study	Hip fracture patients in orthopaedic ward	24-hour recall	1025 ± 299	43.9 ± 13	There was evidence of under-nutrition as key anthropometric values were low and many individual had low dietary intakes for specified nutrients.
Barton et al. 2000 UK[52]	n=14 75 ± 11	Cohort study	Elderly hospitalized patients	Weighed food records	1425 ± 136	47 ± 6.5	We conclude from our own data and that of others that it is possible for elderly patients to achieve their nutritional targets using a combination of smaller portions of increased energy and protein density and between-meal snacks.

2.5 Clinical guidelines

Clinical guidelines were published in Iceland 2011[14] which were based on guidelines from the European society for Clinical Nutrition and Metabolism (http://www.espen.org/espenguidelines.html), American Society for Enteral and Parenteral Nutrition (http://nutritioncare.org/library.aspx) and Canadian Clinical Practice Guidelines (http://www.criticalcarenutrition.com/).

A plan for implementation was made and these are the four main factors.

1. *Implementation of screening*

   The first step was to implement screening for malnutrition in the patients electronic health record system and that was achieved in December 2011.

2. *Energy and protein balance assessment*

   The second step was to find an easy way to assess the patients energy and protein intake. A study has been conducted to validate a simple plate diagram sheet for estimation of energy and protein intake (see manuscript). This sheet has been taken in use in the CardioThoracic ward at Landspitali National University Hospital and the plan is to add it in the electronic health record system.

3. *Education*

   Clinical guidelines were introduced 2011 on a special nutrition day and main results of the validation were presented in March 2012. Nutrition day will be held every year to educate and discuss nutrition in hospitals. It is also planed that clinical guidelines will be a part of students curriculum in the department of health science.

4. *Achievement evaluation*

   An evaluation will be made on how many patients in risk of malnutrition will be screened every year and has already started. A plan will be made to increase research on patients nutritional state in Landspitali National University Hospital.

Before nutritional treatment begins a treatment goal has to be defined, whether it is to maintain nutritional status or to increase energy intake. On admission or after reassessment antropometric measurement has to be done such as weight, height and BMI and the following factors should be calculated: energy and protein need, energy and protein intake (per os, enteral or parenteral), energy and protein balance and liquid balance. Screening is the first step to analyze the risk of malnutrition. Figure 2 shows the categories in which patients are classified after screening. Although nutritional screening indicates that the patient is unlikely to be malnourished (0-2 points scored on the screening sheet) it is recommended to monitor the energy and protein intake every 1-2 weeks and reassess nutritional treatment if the patients intake is less than 75% of estimated energy need for more than a week or if weight loss is more than 0.5 – 1 kg per week. Greater attention is needed for patients scoring 3-4 points in the nutritional screening, as there are some propabilities of malnutrition. Evaluation of energy and protein intake for this group recommended every 2-4 days.[14] All patients scoring 5 points or more are very likely to be malnourished and should be reffered to a dietitian, who
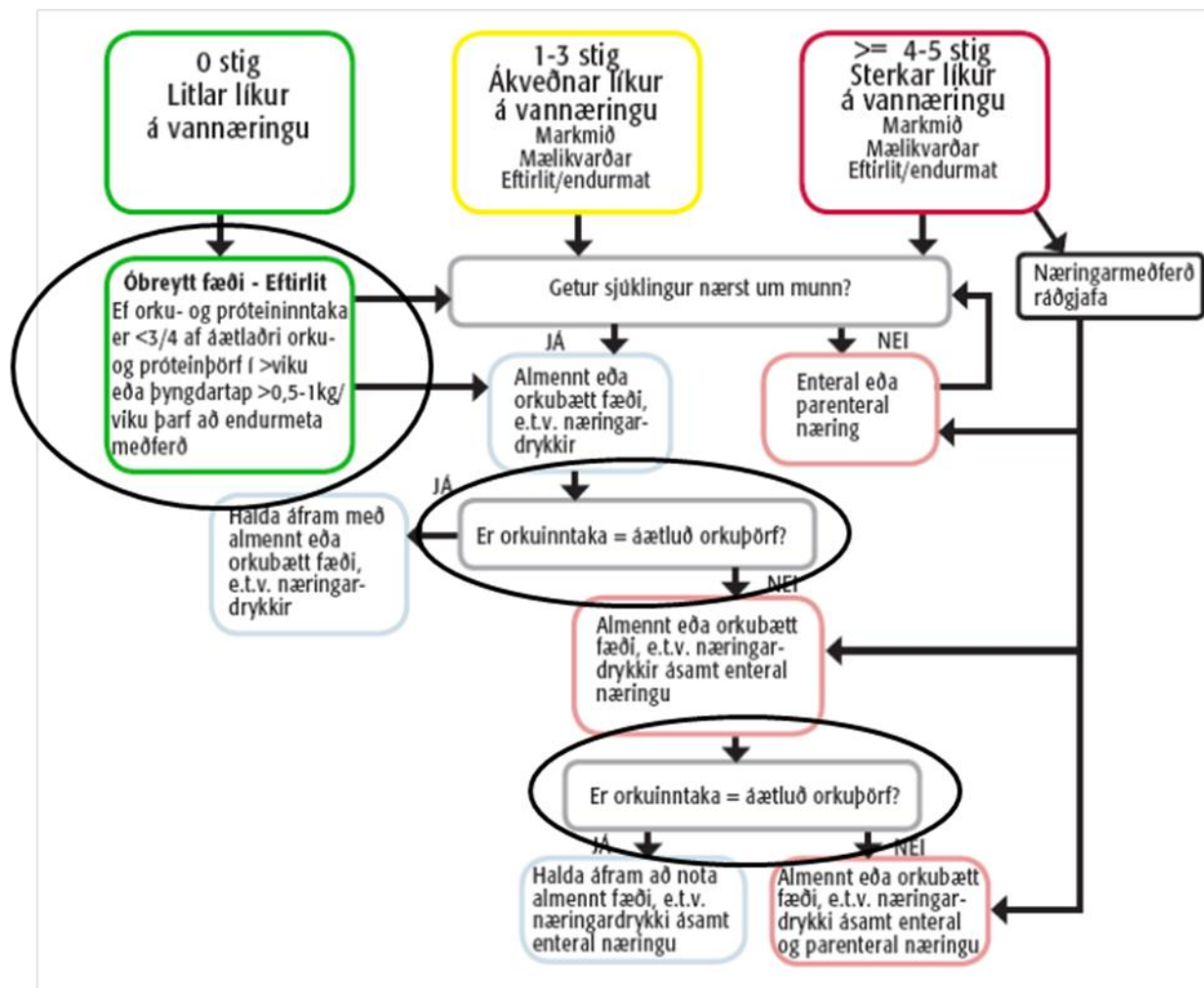
Figure 2. Assessment of nutritional status and a follow up plan according to points scored on the nutritional assessment.

will make a clinical judgement on the individual level on how to procede with the nutritional management. To be able to follow the treatment plan estimation on energy and protein intake should be done and be compared with estimated energy need.

Weightloss is common in hospitals, attributable to energy and/or protein need is not met.[53] To be able to prevent weightloss of these causes it is necessary to monitor energy intake and compare it to energy need. The patients energy and protein need is estimated from body weight. For patients, other than intensive care unit patients, energy need is considered to be 25-30 kcal/kg/day according to ideal body weight and protein need is considered to be 1,2-1,5 g/kg/day.[14] To be able to estimate energy and protein needs of patients, weight is needed.

Results from a study made at the Landspitali National University Hospital in 1999 showed that information on weight, and thus BMI was only available for 25% of the patients.[10] A patient's weight is often an indicator of his or her clinical condition and nutritional status, and is a crucial parameter in determining drug doses. A lack of consistent weighing policy in conjunction with the use of unsuitable or inaccurate weighing equipment, hinders optimal patient care.[54]

2.5.1 Anthropometric methods

Antropometric methods involve measurement of the physical dimensions and gross composition of the body.[15]. They are particularly useful in circumstances where chronic imbalances of protein and energy are likely to have occurred.[15] In some cases they can detect moderate and severe degrees of malnutrition, but the methods cannot be used to identify specific nutrient deficiency states. The measurements can be performed relatively quickly, easily, and reliably using portable equipment, provided standardized methods and calibrated equipment.[15]

Weight loss is a common variable considered in clinical nutritional assessment. A weight loss of more than 10% of initial weight in 6 months, or more than 5% in the 1 months before admission to the hospital, is often clinically significant.[15]

Body weight is the sum of protein, fat, water, and bone mass in the body. Changes in body weight do not provide any information on the relative changes among these components.[15] In conditions in which edema, ascites (fluid in the abdominal cavity), dehydration, diuresis, massive tumor growth and organomegaly occur, body weight is a poor measure.[15] Edema is common after surgery, therefore other parameters are essential to measure nutritional status e.g. monitoring patients energy intake.

2.5.2 Dietary assessment methods

Dietary assessment methods are used to determine the nutritional status of individuals or populations groups. Dietary intake estimation encompasses the collection of information on the quantity of food eaten and the calculation of intake of energy, nutrients and possibly other components of these foods.[55]

When selecting an appropriate dietary assessment method one must keep in mind the purpose, level (e.g. group or individual), characteristics of the subjects (e.g. age, healthy or hospitalized) and parameters (e.g. energy or nutrients). To measure food consumption of individuals the most common methods are 24-hour recall, food record (estimated or weighed), dietary history or food frequency questionnaire (FFQs). The types of nutritional assessment systems used in the community have been adopted in clinical medicine to assess the nutritional status of hospitalized patients.[15] Retrospective methods, FFQs and dietary history are long term dietary assessment methods and are used to collect information on usual food intake over the previous months or years and are therefore not relevant for patients in a clinical setting. Short term dietary assessment methods collect dietary information on current intake. They vary from recalling the intake from the previous day (24-hour recall) to keeping a record of the intake of food and drinks over one or more days. Food record is either by estimating food consumption over a periods from one to seven days or by weighing consumed food by the subject, caretaker or assistant over a defined period.[15,55]

Prospective methods are more relevant in a clinical setting and for the purpose of this thesis, food recording method is described in detail.

2.5.2.1　　　*Food record*

Food record is used to assess actual or usual intakes of individuals, depending on number of measurement days.[15] The amount of food consumed is found by weighing food and leftovers or estimated by using household utensils (e.g. cups, tablespoons) or food models (e.g. plate diagram sheet, photographs) and nutrient intakes are calculated using food composition data.[55] In general, a record of three days, randomized to cover seasonal and weekday variations, is recommended to get information on mean food consumption and its distribution.[55] The reporting must be done at the time of consumption either by the persons investigated, who will then have to be trained or by a skilled interviewer who can make reports more accurate.[55]

The food record is fairly accurate with respect to the food consumed. The weighing method is often regarded as the „golden standard" among the dietary assessment methods. It relys on literate, motivated and willing participants or well-trained professionals but habitual eating patterns may be influenced or changed by the recording process.[15,55] It is time consuming and expensive and therefore not suitable in a clinical setting e.g. all hospitalized patients. An acceptable monitoring method has to be simple, reasonably precise and easy to use by all hospital staff with minimal training. But such a monitoring method to record food intake which will detect patients at risk of malnutrition is lacking.[13] A limited amount of studies is available validating such monitoring methods, e.g., simple estimates of how much of a served meal is eaten, and result are conflicting.

2.5.3 Validation of dietary assessment methods

Validity describes the degree to which a dietary method measures what it is intended to measure.[15] There are difficulties in measuring the absolute validity of dietary intake data, therefore researchers have adopted an approach that measures relative validity. Relative validity can be defined as the comparison of the „test" method with another method, termed as the „reference" method performed on the same subjects.[15] A study is considered valid if the findings can be taken as a reasonable representation of the true situation.[55]

As mentioned before, even though weighing food is considered the most accurate way to measure food intake, it is time consuming and expensive and therefore not practical in a clinical setting. Studies have been made to validate a more simple and inexspensive method to measure food intake in hospitalized patients (see manuscript).

3 METHODS

3.1 Hospital diet

The hospital meal plan covers a five-week period. Technically it was challenging to use real energy for each meal because it varies by days, therefore it was decided to make an average of the five weeks for each meal, every day of the week. This approach also makes the validation study more practical as we are assessing validity of using proportion of average energy and protein content of meals in the hospital setting. The method could therefore be implemented without the direct connection between the software keeping the information about nutrient composition of each different meal and the software calculationg the estimated energy and protein intake using information from the plate diagram registration. As a reference method we used the nutrient compostition of each meal as it was served on the day of each registration. Table 2 shows the average energy which was used to compare with weighed records.

Table 2. Average energy of each meal over 5 weeks period.

Meal (kcal)	7MJ	8MJ
Breakfast	320	320
Lunch	517	588
Afternoon snack	248	248
Dinner	489	585
Evening snack	156	156
Total	1732	1895

3.2 Authors' contribution

I started the data collection in September 2012. The data collection had already started in June by two B.Sc. students in nutrition conducting a pilot study (n=13), and training of the staff had already occured.

The food intake data was entered into the Swedish nutrient calculating program KOSTPLAN. The B.Sc. students started the data input for the 13 participants in the pilot study, which I continued with 70 participants. I changed some input from the pilot study to coordinate the data. Every food item that was not part of to the standard meal was registered as other e.g. milk, juice, extra fruits and build up drinks. All food that came from outside the hospital was also registered as other even though it was substituted for a meal.

After calculating the energy and protein contents of the food in KOSTPLAN, which is supported by the Icelandic nutrient composition database (ISGEM), I entered the data into Excel calculation program which was then converted into SPSS program where statistical analyses were performed.

4 MANUSCRIPT

Validation of a plate diagram sheet for estimation of energy and protein intake in hospitalized patients.

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Validation of a plate diagram sheet for estimation of energy and protein intake in hospitalized patients

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Short title: Validation of a plate diagram sheet

SUMMARY

Background & aims: Validation of simple methods for estimating energy and protein intakes in hospital wards are rarly reported in the literature. The aim was to validate a plate diagram sheet for estimation of energy and protein intakes of patients by comparison with weighed food records.

Methods: Subjects were inpatients at the CardioThoracic ward, Landspitali-National University Hospital, Reykjavik, Iceland (N=73). The ward personnel used a plate diagram sheet to record the proportion (0%, 25%, 50%,100%) of meals consumed by each subjects, for three days. Weighed food records where used as a reference method.

Results: On average the plate diagram sheet overestimated energy intake by 45 kcal/day (1119±353 kcal/day versus 1074±360 kcal/day, p=0.008). Estimation of protein intake was not significantly different between the two methods (50.2±16.4 g/day versus 48.7±17.7 g/day, p=0.123). By analysing only the meals where ≤50% of the served meals was consumed, according to the plate diagram recording, a slight underestimation was observed.

Conclusion: A plate diagram sheet can be used to estimate energy and protein intakes with fair accuracy in hospitalized patients, especially at the group level. Importantly, the plate diagram sheet did not overestimate intakes in patients with a low food intake.

Keywords: Energy intake, protein intake, validation, patients.

Introduction

Malnutrition is a known health care problem among hospitalized patients.[1] Prevalence of malnutrition in European hospitals has been reported to be 21 – 58%.[2-6] Usually, a large part of patients is already undernourished when admitted to hospitals and malnutrition often progresses during their hospital stay.[7-9] Malnutrition is associated with higher risk of developing complications. Furthermore, malnourished patients stay longer in hospitals than patients who are not malnourished, which increases hospital costs.[10,11]

The European Society for Clinical Nutrition and Metabolism (ESPEN) has provided guidelines for nutrition risk screening. Hospitals should also have appropriate nutritional care plans and their effectiveness should be monitored by defined measurements and observations, such as recording of dietary intake.[12] Precise measurements of dietary intake (e.g., food records) are time consuming and expensive and thus discouraging for the hospital employees. An acceptable monitoring method has to be simple, reasonably accurate and easy to use by hospital employees with minimal training. The lack of an acceptable and simple monitoring tool to record dietary intake is a limiting factor for improvement.[12]

Limited amount of reports describing results of studies assessing the validity of simple monitoring tools can be found in the literature, and results are conflicting. Some studies suggest that simple estimates can be useful to quantify patients' intake in a clinical setting[13-15] but with some limitations, like only being valid in situations of reduced intake in malnourished patients,[14] or useful mainly on a group level.[13] Results of one of these studies are presented in German, thus limiting its recognition to others than German speaking individuals.[15] Other studies indicate that simple estimates might be inaccurate with a tendency to overestimate food intake, which can lead to that inadequate food intake among patients remains unrecognized by caregivers and therefore the patients are not followed up for further nutritional assessment.[16-18] One possible explanation for conflicting results could be different methods used in the previous studies along with differences in the level of training to those responsible for recording the intake.

One potentially useful method for estimating patients' meal consumption is a simple plate diagram sheet.[15] Thus, the aim of the present study was to evaluate a plate diagram in order to estimate energy and protein intake in hospitalized patients. Prior to the study the hospital employees were trained in how to use the plate diagram sheet correctly.

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Materials and methods

Subjects

Patients (age 19-94 years) admitted to the Department of Cardio Thoracic Surgery, at the National University Hospital in Reykjavik, Iceland, in the period June 20th to December 14th 2011 were invited to participate in the present study. The inclusion criteria was a planned hospital stay of at least five days. Eighty one subjects gave their written consent. The study was approved by the Local Ethical committee at the National University Hospital, Reykjavik. The following descriptive information was obtained from each subject's medical record: age, gender, height, body weight and reason for hospitalization.

Nutrient composition of the hospital diet

Five main meals with known nutritional composition are served daily at the National University Hospital, i.e., breakfast, lunch, afternoon snack, dinner and evening snack. The nutrient composition of the diets is in line with the recommendations on diet and nutrients from the Public Health Institute of Iceland[19] and the Swedish Recommendations for Hospital Patients[20]. Based on the patient's appetite and condition, assessed by a clinical dietitian or by a nurse in the ward, the meal portion size is chosen for each patient individually. In the present study subjects where served with meals that provided either 7 MJ/day (1732 kcal/day) or 8 MJ/day (1895 kcal/day). Average protein content of the 7 MJ menu was 77.6 g/day and the 8 MJ menu provided 89.6 g protein/day.

The plate diagram sheet recording

Training in how to fill in the plate diagram sheet took place at the Department of Cardio Thoracic Surgery prior to the study period. Meetings were held with the clinical hospital employees who were trained how to record food intake using the plate diagram sheet. After each meal, trained hospital staff estimated and recorded the proportion of the meal consumed by the subjects (0%, 25%, 50% or 100%). The recording was made for three days. Energy and protein intakes were estimated using the known energy and protein content of the meals.

The reference method

All leftover food was weighed by a trained research person on a digital scale (Philips Essence HR 2393). The leftovers (grams of each individual food item left on the plate) were then subtracted from the standard portion provided to each subject. In order to get information about the total energy and protein intake of the subjects, food and drinks consumed in between the five main meals were also recorded by the study personnel. Energy and protein intake was analyzed using Kostplan for Windows, version 1.0 (AIVO AB, Stockholm, 1996), supported by the Icelandic nutrient composition database (ISGEM).

Statistical analysis

Statistical analyses were performed using the program SPSS for Windows (Version 20, 2011, Inc, Chicago, IL). Distribution of baseline data are described as mean ± standard deviation (SD). The mean energy- and protein intakes over the three-day period estimated by the plate diagram sheet were compared with the results from the weighed records by paired t-test. We made a separate analysis, only including meals where the hospital staff estimated the consumption to be either 25% or 50% of the served meals in order to estimate the agreement between the two methods at low food intake. Pearson correlations were used to assess associations between the different methods. The overall agreement for energy- and protein intakes between the two methods was assessed by Bland-Altman plot and the limits of agreement estimated (average difference ± 1.96 SD of the difference). A P-value ≤ 0.05 was regarded as statistically significant.

Results

Complete registration was gathered from 73 subjects. The main reason for drop-out was that the patient was discharged from the hospital earlier than expected. The baseline characteristics of the study population can be seen in Table 1. The subjects consumed on average 1074±360 kcal/day from the five main meals provided by the hospital kitchen, and additional 286±207 kcal/day were provided by in between meals. Average protein intake from the main meals was 48.7±17.7 g/day, and 13.3±10.4 g protein/day where provided by in between meals (Table 2). About 60% of energy content of the served meals was actually consumed by the subjects.

Energy and protein intake estimated by the two methods where highly correlated (Figure 1a and Figure 1b). Differences between the estimated intakes, using the plate diagram sheets and the weighed intakes are illustrated in Table 2. On average, daily energy intake was slightly overestimated by the plate diagram sheet compared with the weighted records, mainly attributable to an overestimation of the dinner meal. Estimated protein intake was not significantly different between the two methods. If only meals with recorded consumption of equal to or less than 50% of the meals served where included in the analysis, a slight underestimation of the actual consumption was observed, resulting in on average 97 kcal/day higher energy intake estimated by the plate diagram sheet compared with the weighted records. Corresponding figures for protein intake were an underestimation of 4.3 g protein/day.

The Bland Altman plot can be seen in Figure 2. The limits of agreement between the two methods for energy intake were -231 kcal/day to 322 kcal/day and for protein intake -14.0 g/day to 16.9 g/day.

Discussion

The aim of the present study was to assess the validity of a simple plate diagram sheet for estimation of energy- and protein intake in hospitalized patients. The results show that the plate diagram sheet method delivers fairly accurate estimates at a group level, however as expected, a larger variation was observed when intake was compared to the reference method at an individual level. The plate diagram sheet did not overestimate intakes of meals where ≤50% of the served meal was consumed.

Studies have shown that many patients do not meet individual nutrition requirements while hospitalized[21]. In the present study about 60% of the energy provided by meals served by the hospital kitchen was actually consumed by the patients. Recording of dietary intake is essential in hospitals to make it possible to follow nutritional care plans in order to reduce the risk of patients developing malnutrition during the hospital stay[12]. The plate diagram sheet used in the present study tended to overestimate the actual energy intake, by 45 kcal per day, which is only about 2.5% of a typical daily hospital menu of 1800 kcal/day. The results suggest that the plate diagram sheet can be used to estimate energy and protein intake at a group level in the hospital ward with fair accuracy and could be useful for example for monitoring dietary intake.

Only few other studies have investigated simple monitoring methods to estimate energy- and protein intakes in hospitalized patients or nursing home residents. Rüfenacht et al.[15] used a simple plate diagram sheet similar to the one used in the present study. The authors concluded that it can be used to identify patients with insufficient food intake. Berrut et. al.[14] tested the validity of a meal-portion (MP) method, when nursing staff evaluated the portion of the meal that had been eaten. They concluded that calorie and protein consumption could be estimated by MP method and it appeared to be valid in situations of reduced intake such as in malnourished elderly persons. Førli et al. suggested that even a self-administered estimation forms could provide acceptable estimates of intake.[13]

However, not all studies have come to the same conclusion[16,17]. Pokrywka et al[16] conducted a study in a nursing home where the staff generally overestimated the actual consumption, sometimes by as much as 63%. One possible explanation could be the lack of staff training, but this important part was not mentioned in the Pokrywka report. In the present study emphasis was placed on training of the hospital employees to use the plate diagram sheet correctly. However, facing fluctuations in staff, employees' sick leaves, communication problems with hospital employees neither speaking Icelandic nor English, we got reminded that this study took place in a real-world clinical setting rather

than in a pure research setting. These above mentioned difficulties possibly explain why the difference between the two assessment methods was found to be greatest for dinner meal. During the daytime shifts, when the first four meals of a day were estimated, usually the same staff was working and showed great interest in the task. However, during the evening shifts, there was a lot of fluctuation in hospital employees which showed quite variable interest and thus the quality of the estimates might have suffered. If the process of estimating patients' food is to become a useful monitoring method, a thorough and practical training and monitoring of staff must occur. It is important to focus on a standardized training program that would be presented to staff at regularly scheduled intervals to instruct them on the proper method of assessing consumption. Keeping the employees interested by training and reporting of success is likely to be encouraging for the employees to continue recording.

In the present study, when only looking at those meals where the hospital staff recorded that 25% or 50% of the meal had been consumed, we see a slight underestimation of the actual intake by the diagram sheet, which might be considered to be a strength rather than limitation. Overestimation of the actual intake could lead to that inadequate food intake among residents remains unrecognized, and therefore places them at risk for developing nutritional deficiencies.

Conclusions

The results of the present study show that a plate diagram sheet can be used to estimate energy and protein intakes with fairly good accuracy in hospitalized patients, especially at the group level. Importantly, the plate diagram sheet does not overestimate intakes in patients with a low food intake.

Statement of authorship

IG and ITh design of the study. RB, FRTh and EO in data collection and data management, RB, AR and IG in data analysis and interpretation of results. RB wrote the first draft in collaboration with IG. All authors made a significant contribution to the final version of the manuscript.

Conflict of interest

The authors have no conflicts of interest

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Table 1. Characteristics of the subjects (n=73, 53 males and 20 females).

Age (year)	63 ± 17
Height (cm)	173.2 ± 9.3
Weight (kg)	82.0 ± 18.9
Underweight n (%)	1 (1.3)
Overweight n (%)	30 (42.2)
Obese n (%)	17 (23.9)
Cardiovascular surgery patients n (%)	50 (68.5)
Thoracic surgery patients n (%)	14 (19.2)
Other patients n (%)	9 (12.3)

Data is presented as mean ± standard deviation or percentages

Table 2. Energy (kcal/day) and protein (g/day) intake estimated by the plate diagram sheet (estimated) compared to weighed food intake (weighed).

	Energy			Protein		
	Estimated (n=73)	Weighed (n=73)		Estimated (n=73)	Weighed (n=73)	
	Mean ± SD	Mean ± SD	*p*-value	Mean ± SD	Mean ± SD	*p*-value
Breakfast	220 ± 80	216 ± 95	0.593	9.5 ± 3.5	9.2 ± 4.2	0.326
Lunch	319 ± 133	320 ± 127	0.951	18.1 ± 7.7	17.7 ± 7.8	0.460
Afternoon snack	170 ± 77	166 ± 81	0.283	2.5 ± 1.1	2.7 ± 1.3	0.114
Dinner	327 ± 131	288 ± 122	< 0.001	17.1 ± 6.9	16.4 ± 7.3	0.185
Evening snack	83 ± 49	85 ± 55	0.694	2.9 ± 1.7	2.8 ± 2.0	0.432
Other food/drinks	-	286 ± 207	-	-	13.3 ± 10.4	
All five meals*	1119 ± 353	1074 ± 360	0.008	50.2 ± 16.4	48.7 ± 17.7	0.123

* In between meals provided on average additional 286±207 kcal/day and 13.3±10.4 g proteins/day to the energy and proteins provided by the five main meals.
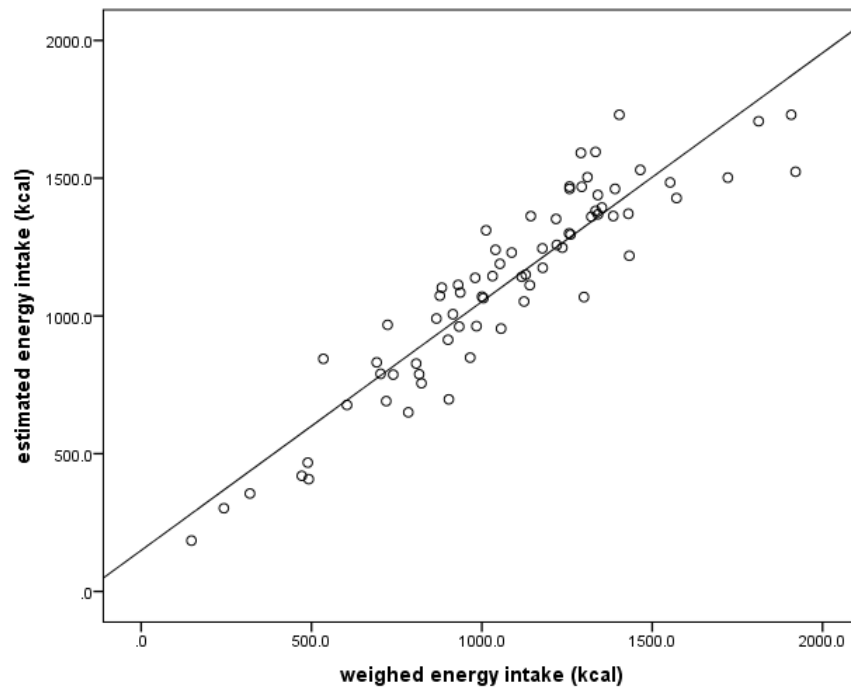
Figure 1a. Pearson correlation between estimates (plate diagram) and weighed food values of energy intake (kcal/day), r=0.922, p<0.001.
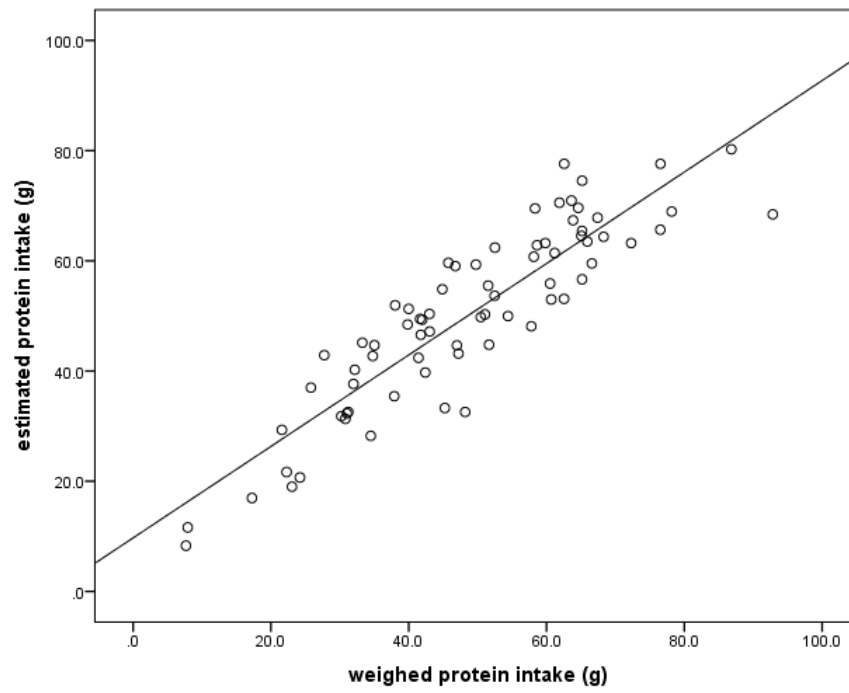
Figure 1b. Pearson correlation between estimates (plate diagram) and weighed food values of protein intake (g/day), r=0.896, p<0.001.
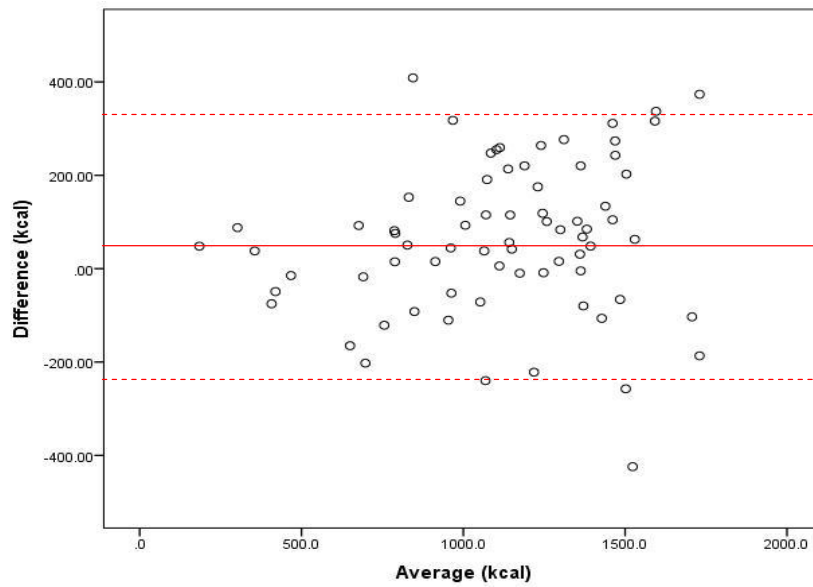
Figure 2a. Bland-Altman representation of the difference in energy intake kcal/d between estimates (plate diagram) and weighed food values. The solid line represents the mean difference and the broken line the ± 1.96 SD.
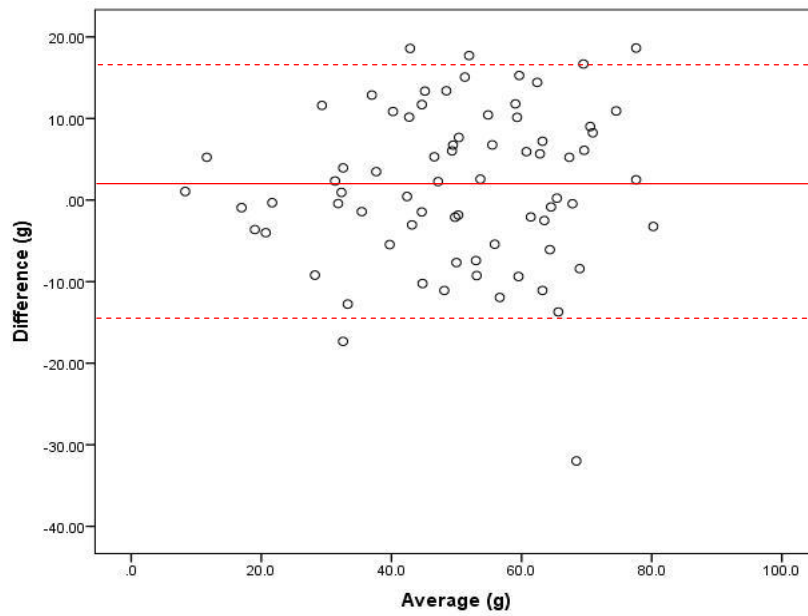
Figure 2b. Bland-Altman representation of the difference in protein intake g/d between estimates (plate diagram) and weighed food values. The solid line represents the mean difference and the broken line the ± 1.96 SD.

5 DISCUSSION AND FUTURE PERSPECTIVES

Main results of this thesis are interpreted and discussed in the manuscript (Chapter 4).

It is necessary to secure adequate nutrition for patients and prevent disease related malnutrition in hospitals. It is not only beneficial for the patients themselves but could affect health care costs in the society.[3,4] Malnutrition at Landspitali National University Hospital has been reported to be 20-60%[9-12] which is a high proportion of hospitalized patients and a clear need for paying more attention to.

In response to the problem, the first step is to implement screening on admission to the hospital. In December 2011 the screening sheet was implemented in the hospitals electronic health record system (SAGA) at Landspitali. But screening has no meaning without following it through. Therefore it is also necessary to monitor energy intake in patients who are at risk of malnutrition and to find an acceptable tool to do that.

A plate diagram sheet (see Appendix II) has been validated and concluded to be useful to estimate energy and protein intake even though it is not very accurate on the individual level (see manuscript). Hospital employees have been monitoring liquid intake and recording it on a special sheet for patients which has become habitual for them, but they have not been recording food intake which should not be any more difficult than the liquid recording is. But to make recording more easy it would be necessary to record both liquid and food intake on the same sheet, which already exists since 2001 (see Appendix III). An effort should be made to make this sheet simpler, including plate diagrams instead of ratios. It would also make things easier to have an electronic form in order to make calculations more effective and quicker.

The plate diagram sheet is fairly accurate on the group level in the hospital ward and could therefore be a useful and inexpensive research tool for quality control e.g. energy intake compared to nutrition requirement in patients or waste of hospital meals.

Training is an important factor when using an estimation form to monitor energy intake (e.g. plate diagram sheet described in the manuscript) Studies show that estimation done by untrained staff can be inaccurate.[56] Other limitation of the plate diagram sheet is definition of portions. It is also important to define exactly the portion of each standard meal which is being measured e.g. is milk part of the meal and how much is 1 glas of milk, or if the patient consumed 50% of the meal, was it mainly protein or mainly carbohydrates?

When individuals at risk of malnutrition have been found with screening and recording of energy intake, it is essential that a clear treatment plan takes place. Intervention studies have shown that when energy and protein intake was increased in hospitalized patients, towards meeting their energy and protein requirements, it results in increased quality of life and decreased complications (see further details in Table 1).[31,33,35,44] Many more studies are needed to be able to make a treatment plan that is evidence based on clinical nutrition that can prevent or improve malnutrition.[57] It seems that evidence based knowledge on clinical nutrition is mainly based on knowledge regarding enteral or parenteral nutrition or special nutritional drinks, not food. One reason might be lack of a practical and validated ways to assess energy and protein intake for hospitalized patients. But food is difficult to

define, should only energy and protein be assessed or could total nutritional composition also be assessed?

Studies show that low energy intake is common among hospitalized patients in Iceland as elsewhere.[9,17,28] Results from a recent study (see manuscript) showed that the mean energy intake was generally 1370 ± 422 kcal/day and protein intake was 61 ± 20 g/day. Less than 15% of the patients met their daily energy and protein need according to the Icelandic clinical guidelines.[14] From the results of these studies there is a need to act and increase energy and protein intake of those patients who are at risk of malnutrition, with evidence based knowledge e.g. with more energy dense food or nutrition drinks. The hospital food and nutrition services at Landspitali has already started working on a new menu, which will take place in the autumn 2012. Hopefully it will have a positive effect for the patients, together with the plate diagram sheet and the plate diagram sheet can also be a useful tool to measure that.

Registered dietitians are an essential part of nutritional care plans in hospitals. There are only 7.9 positions of dietitians at Landspitali National University Hospital, which has nearly 800 beds. The dietitians serve both inpatients and outpatients. The outpatient service is about half of the service and 2011 each dietitian had over 1000 communications with patients. It is important to increase positions of dietitians at Landspitali to be able to follow care plans through in order to make them effective.

Many studies have been conducted and much has been achieved since malnutrition was first recognized as a problem in hospitalized patients. But despite of all these studies and a great interest and willingness to nutrition therapy, there is an insufficient nutritional practice mostly because of lack of nutritional knowledge and the standards suggested from the ESPEN are not fulfilled.[58,59] All healthcare professionals who are directly involved in patient care should receive education and training relevant to their post, on the importance of providing adequate nutrition. Perhaps additional support, such as volunteers, carers and family members, can be trained to assist with feeding patients or encouraging them to eat. Studies have shown that feeding assistance can improve food intake[37] and the presence of others e.g. volunteers, can increase energy and protein intake.[40,49]

What can be done if employees are not screening and/or not recording food intake? Can we require them by law to do so, or would it be more effective to reward them for performance. It is my opinion that a positive attitude towards the project is important and when implementing new things e.g. screening and recording food intake, it is important first to educate the employees about malnutrition and convince them of the importance of responding to the problem. First to activate the most positive and empowering employees and then follow the implementation through until it has become a routine.

Nutrition is an important part of medical treatment and in patient care and great interest and willingness to respond to malnutrition in hospitalized patients is an important step. An increasing number of successful initiatives are improving the situation with respect to the nutritional treatment that have been documented from all over Europe[53] and this is a continuous project. But it seems to be time to combine the experiences from all these efforts to secure adequate nutrition for patients and prevent disease related malnutrition in hospitals. This thesis is only one link in the chain, further research is needed in the future.

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7 APPENDIXES

7.1   Appendix I

Information on patients energy and protein consumption estimated (via plate diagram) compared to weighed food intake by proportion.

Tables A-1 to A-3

7.2   Appendix II

Plate diagram sheet.

7.3   Appendix III

Food and liquid recording sheet.

7.4   Appendix IV

Informed written consent.

7.1 Appendix I

Information on the patients' energy and protein consumption estimated (via plate diagram) compared to weighed food intake by proportion, Tables A-1 to A-3.

Table A-1. Energy (kcal/day) and protein (g/day) consumption estimated (via plate diagram) compared to weighed food intake of 100% consumed meals.

	Energy			Protein		
	Estimated	Weighed		Estimated	Weighed	
	Mean ± SD	Mean ± SD	*p*-value	Mean ± SD	Mean ± SD	*p*-value
Breakfast (n=118)	320± 0	292,3± 98,5	0,003	13,8± 0	12,9± 4,0	0,016
Lunch (n=94)	527,9±29,3	447,4±132,3	<0,001	30,0±2,6	24,5±7,2	<0,001
Afternoon snack (n=142)	248,0±0	239,9±62,4	0,124	3,7±0	3,9±1,4	0,145
Dinner (n=108)	501,6±38,0	387,7±114,6	<0,001	26,3±2,1	22,9±7,8	<0,001
Evening snack (n=111)	156±0	155,0±63,5	0,874	5,5±0	5,2±2,5	0,236
All five meals	1753,5	1522,3		79,3	69,4	

Table A-2. Energy (kcal/day) and protein (g/day) consumption estimated (via plate diagram) compared to weighed food intake of 50% consumed meals.

	Energy			Protein		
	Estimated	Weighed		Estimated	Weighed	
	Mean ± SD	Mean ± SD	*p*-value	Mean ± SD	Mean ± SD	*p*-value
Breakfast (n=70)	160± 0	174,1± 69,8	0,095	6,9± 0	6,9± 3,4	0,985
Lunch (n=71)	264,0±17,2	312,7±125,5	0,001	15,0±1,4	17,9±8,9	0,004
Afternoon snack (n=24)	124,0±0	127,0±58,1	0,804	1,9±0	2,0±1,0	0,395
Dinner (n=60)	252,6±20,4	278,2±97,5	0,037	13,3±1,1	15,3±7,5	0,039
Evening snack (n=21)	78,0±0	90,5±36,7	0,135	2,8±0	2,8±1,3	0,952
All five meals	878,6	982,5		39,9	44,9	

Table A-3. Energy (kcal/day) and protein (g/day) consumption estimated (via plate diagram) compared to weighed food intake of 25% consumed meals.

	Energy			Protein		
	Estimated	Weighed		Estimated	Weighed	
	Mean ± SD	Mean ± SD	*p*-value	Mean ± SD	Mean ± SD	*p*-value
Breakfast (n=27)	80± 0	85,3± 52,1	0,599	3,5± 0	3,5± 2,9	0,881
Lunch (n=44)	129,3±0	184,1±107,8	0,002	7,3±0	9,7±6,5	0,017
Afternoon snack (n=16)	62±0	50,1±44,2	0,297	0,9±0	0,9±0,9	0,991
Dinner (n=43)	123,4±5,1	145,9±96,7	0,126	6,5±0,3	7,8±6,8	0,201
Evening snack (n=6)	39,0±0	58,5±84,1	0,595	1,4±0	1,3±1,4	0,868
All five meals	433,7	523,9		19,6	23,2	

7.2 Appendix II

Plate diagram sheet

LANDSPÍTALI

NÚMER _____

HAKIÐ VIÐ HVERSU STÓRT HLUTFALL AF HVERRI MÁLTÍÐ SJÚKLINGUR NEYTIR.

	1/1 skammtur	1/2 skammtur	1/4 skammtur
	●	◐	◔
MORGUNVERÐUR	●	◐	◔
HÁDEGISVERÐUR	●	◐	◔
SÍÐDEGISHRESSING	●	◐	◔
KVÖLDVERÐUR	●	◐	◔
KVÖLDHRESSING	●	◐	◔
Build-up með nýmjólk (200 ml)	●	◐	◔
Nutridrink venjulegur	●	◐	◔
Nutridrink prótein	●	◐	◔

Annað (matur/drykkur)   **Áætlað magn**

_____

_____

_____

_____

_____

_____

_____

Leiðbeiningar

Morgunverður: Ef sjúklingur klárar brauð en ekki spónamat skal skrá 1/2 skammt og öfugt

Hádegis og kvöldverður: Við mat á því hvort um 1/1, 1/2 eða 1/4 skammt

er að ræða skal aðallega horfa til þess hversu stórt hlutfall af matnum án

grænmetis er klárað.

7.3 Appendix III

Food and liquid recording

LANDSPÍTALI
HÁSKÓLASJÚKRAHÚS

Matar- og vökvaskrá
NÆRINGARSTOFA

Dags.

Skráið fasta fæðu vinstra megin á blaðið en alla drykki (einnig næringardrykki)
og spónamat (grauta, súpur, búðinga, súrmjólk o.þ.h.) hægra megin.
Þarf ekki að skrá grænmeti en skráið alla millibita.

Matarskrá — Borðað af þeim skammti sem settur er inn

Morgunverður	Inn	0	1/4	1/2	3/4	1
Brauð						
Álegg						
Viðbit						
Morgunkorn						

Hádegisverður						
Aðalréttur og sósa						
Kartöflur/pasta/hrísgrjón						

Síðdegishressing						
Kaka/kex						
Bauð og álegg						
Viðbit						

Kvöldverður						
Aðalréttur og sósa						
Kartöflur/pasta/hrísgrjón						
Brauð						
Álegg						
Viðbit						

Kvöldhressing						
Kaka/kex						
Brauð og álegg						
Viðbit						

Vökvaskrá

Kl.	Drykkir/grautar/súpur	Inn	Drukkið/ Borðað
	Samtals vökvi:		

Landspítali – háskólasjúkrahús, Næringarstofa, 2001 Svansprent

5 690939 014534

50

Appendix IV

Informed written consent.

HÁSKÓLI ÍSLANDS

Upplýst samþykki fyrir þátttöku í rannsókninni
Orku- og próteinjafnvægi sjúklinga. Mat á gildi skráningareyðublaðs.

Ágæti viðtakandi.

Einstaklingum sem leggjast inn á sjúkradeildirnar 12 E og 12 G sumarið 2011 býðst að taka þátt í rannsókn sem felur í sér gildismat á einföldu skráningareyðublaði sem ætlað er að meta orku- og próteininntöku sjúklinga. Rannsóknin er hluti af innleiðingarferli klínískra leiðbeininga um næringu sjúklinga á Landspítala.

Ábyrgðarmaður rannsóknarinnar er:
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Rannsóknastofa í næringarfræði við Háskóla Íslands og Landspítala
Eiríksgata 29, 101 Reykjavík
Sími 543 8416/ 8917017
Netfang: ingigun@landspitali.is

Aðrir sem koma að rannsókninni eru:
Kristinn Sigvaldason yfirlæknir, Inga Þórsdóttir forstöðumaður, Brynja Ingadóttir sérfræðingur í hjúkrun,Jón Örvar Kristinsson sérfræðilæknir, Páll Helgi Möller yfirlæknir, Ari J Jóhannesson sérfræðilæknir, Rannveig Björnsdóttir MS nemi í næringarfræði, Dagný Ösp Vilhjálmsdóttir MS nemi í næringarfræði, Erna Sif Óskarsdóttir BS nemi í næringarfræði, Harpa Hrund Hinriksdóttir BS nemi í næringarfræði, Þórhallur Ingi Halldórsson lektor og Fríða Rún Þórðardóttir næringarfræðingur.

Þátttaka í rannsókninn felur í sér eftirfarandi: Svörun á spurningum er tengjast næringarástandi, hafi það ekki þegar verið gert við innlögn (tekur u.þ.b. 5-10 mín í svörun), vigtar og hæðarmælingu (hafi það ekki þegar verið gert við innlögn), að veita rannsakendum og starfsmönnum sjúkradeildar leyfi til þess að skrá niður allan mat og drykk sem þú neytir í þrjá daga, skrá niður ástæðu innlagnar sem og legutíma.

Áhætta við þátttöku í rannsókninni er hverfandi. Ávinningur af rannsókninni snýr aðallega að aukinni meðvitund þeirra sem annast þig um mikilvægi næringar. Brugðist verður við á viðeigandi hátt reynist þú vannærð(ur) eða í hættu á vannæringu.

Ekki verður greitt fyrir þátttöku í rannsókninni. Siðanefnd Landspítala hefur samþykkt rannsóknaráætlunina og hefur vinnslan verið tilkynnt til Persónuverndar. Það skal tekið fram að samþykkir þú þátttöku í rannsókninni er þér heimilt að hætta þátttöku í rannsókninni á hvaða stigi sem án útskýringa og án afleiðinga á aðra meðferð.

Mér hefur verið kynnt eðli og umfang þessarar vísindarannsóknar og ég er samþykk(ur) þátttöku.

_____   Dags. og undirskrift
Undirskrift þátttakanda

_____
Undirskrift þess sem leggur samþykkið fyrir.

Ef þú hefur spurningar um rétt þinn sem þátttakandi í þessari vísindarannsókn eða vilt hætta þátttöku í rannsókninnigetur þú snúið þér til Siðanefndar Landspítala, Fossvogi, 108 Reykjavík. Sími: 5437465, fax: 543 2339, tölvupóstur: sidanefnd@landspitali.is