Food intake and weight changes in Norwegian hip fracture patients

A descriptive, observational longitudinal study

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Abstract

Background: Norway has the highest rates of hip fractures worldwide. Hip fracture patients represent a vulnerable group with high mortality and morbidity after one year, and as the elderly population is increasing a consecutive increase in hip fractures is expected. Energy and protein requirements are increased during disease and inflammatory state, and muscle wasting can be expected in bedridden patients. The poor nutritional status in hip fracture patients is increasingly recognized, however, little is known about food intake and weight changes in the immediate postoperative period in Norwegian patients.

Objective: To investigate energy and protein intake and weight development during the acute and rehabilitation phase after a hip fracture in Norwegian patients, and to consider the patients nutritional risk.

Methods: Forty patients were recruited to the study during hospitalization for hip fracture, and were investigated at hospital (median 3 days after surgery), at a rehabilitation unit (median 15 days after surgery) and at home (median 63 days after surgery). Energy and protein intake, weight, mid-upper arm circumference and triceps skinfold were collected at all visits. Nutritional risk screening, new mobility score, bioelectrical impedance analysis, handgrip and quadriceps strength were carried out at the rehabilitation unit/ at the home of the patients.

Results: We found a very low energy and protein intake at hospital where no patients reached their estimated requirements, and an improved, but still insufficient energy and protein intake at rehabilitation and at home. Eleven out of 14 patients lost weight from hospital to rehabilitation (median for the group was -2.9 kg, $p = 0.048$) and eight out of 12 patients lost weight from hospital to home (median for the groups was -2.2 kg, $p = 0.147$). Eighty percent of the patients were in nutritional risk at the rehabilitation stay. Due to the small number of patients and the high drop-out rate, most findings did not achieve statistical significance, and therefore the results have to be interpreted with care.

Conclusion: In conclusion, energy and protein intake was very low in hospitalised hip fracture patients, and remained sub-optimal during rehabilitation and after returning home. A significant weight loss and a high number of patients in nutritional risk, suggest that the patients in the present study experienced a critical phase, and this issue should be investigated further.

Definitions

Energy requirement - the energy intake needed to recover energy expenditure in individuals with body weight, body composition and physical activity compatible with good health [1].

Hip fracture - a fracture in the upper quarter of the femur (thigh) bone [2].

Low energy fracture - a fracture resulting from a same-level fall [3].

Malnutrition - a cellular imbalance between the supply of nutrients and energy and the body´s demand for them ensure growth, maintenance, and specific functions [4].

Nutritional risk - a state where at least one of the following is present: a BMI <20.5 kg/ m^2, weight loss the last weeks, a reduced food intake the last weeks, or any serious disease [5, 6].

Nutritional status - the extent to which nutrients are available to meet metabolic needs [7].

Osteoporosis - a systemic skeletal disease characterized by low bone mass (a T-score of - 2 standard deviations) and deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture [8].

Protein requirement - the lowest level of dietary protein intake that will balance the losses of nitrogen from the body, and thus maintain the body protein mass, in persons at energy balance with modes levels of physical activity [9].

Sarcopenia - the loss of skeletal muscle mass and muscle function measured by muscle strength or physical performance [10].

List of abbreviations

25(OH)D - 25-hydroxyvitaminD

BIA - bioelectrical impedance analysis

BMD - bone mineral density

BMI - body mass index

BW - body weight

CRP - C-reactive protein

E %: Energy percent; amount of nutrient as percentage of total energy intake.

ESPEN - the European Society for Clinical Nutrition and Metabolism

FFM - Fat free mass

FM - fat mass

LOS - Length of stay (at hospital)

MUAC - Mid upper arm circumference

N-balance - Nitrogen balance

NNR - Nordic Nutrition Recommendations

NMS - New mobility score

NRS 2002 - Nutrition Risk Score (2002)

PA - Phase Angle

REE - resting energy expenditure

SD - standard deviation

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1 Introduction

1.1 Importance and prevalence of study topic

The world's population is steadily increasing, and the elderly are the fastest growing group in the world, also in Norway [3, 11]. In 2010, 13 % of the population in Norway was 67 years or older, in 2060 the elderly are expected to be 22% of the total population [11]. With the elderly contributing to over 1/5 of the population, new medical challenges arise [12]. Scandinavia, with Norway ranging on the top, has the highest rates of hip fractures worldwide [3, 13]. Every year there are about 9,000 hip fractures in Norway and this number is expected to increase in the future due to an increase in the elderly population [14]. It is estimated that one in six white women will have a hip fracture in their lifetime [15] and about 70 % of the fractures in Norway are found in women [16].

A hip fracture is a fracture in the upper quarter of the femur bone. It can occur from a fall or from a direct blow to the side of the hip. There are three different types/ zones of hip fracture; intracapsular fracture, intertrochanteric fracture and subtrochanteric fracture, and a hip fracture can consist of a fracture in one or more of these zones **(Figure 1)** [2].

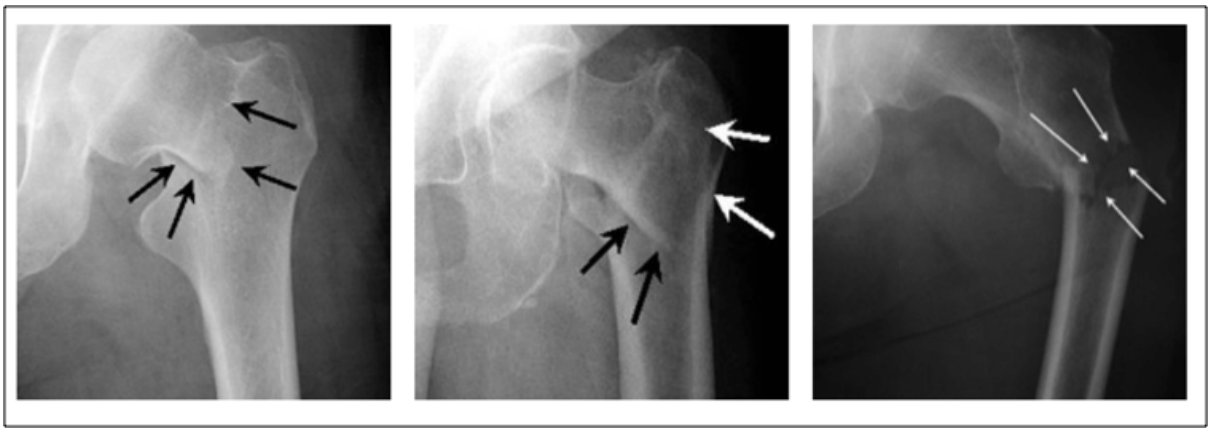

Figure 1. Types of hip fractures.

a) intracapsular fracture: This fracture occurs at the level of the "neck" of the bone and may have loss of blood supply to the bone, b) intertrochanteric fracture: This fracture occurs further down the bone and tends to have better blood supply to the fracture pieces, c) Subtrochanteric fracture: This occurs even further down the bone and may be broken into several pieces. Picture and information from the American Academy of Orthopaedic Surgeons [2].

Elderly hip fracture patients are a vulnerable group. Hip fractures are associated with high mortality rates and prolonged disability, and require long-term medical care. This type of

fracture causes more economic costs, it leads to more disability, and it is associated with higher mortality than other fractures [3]. Hip fracture patients in general have poorer nutritional status than their healthy peers, and the risk of institutionalising is great [17]. Thus, even minor improvements in the treatment of these fractures are of great importance.

1.2 Outcome and prognosis after a hip fracture

For elderly patients, hip fractures lead to a 2-3 fold increased mortality than expected for age within the first year after fracture [15, 18]. This number corresponds to a mortality rate of 20-30 % during the first year after fracture, which gives similar or even higher mortality rates than pancreatic or stomach cancer [18-22]. Most deaths occur the first 3 - 6 months after fracture, and excess mortality decreases thereafter, but is still higher than in the general population. Deaths are in part related to comorbidity and in part due directly or indirectly to the hip fracture event itself (about 25 % of the deaths). The mortality is found to be higher in men than in women, also after accounting for the higher mortality rates for men in the general population [18].

After a hip fracture autonomy is reduced. The risk of institutionalisation after such a fracture is high; about 50 % of patients with a good functional status before a hip fracture are unable to regain their independent lifestyle after a hip fracture [3, 19]. A Norwegian study that investigated hip fracture patients, found that of those who used to be healthy community-dwelling citizens before fracture, one fifth moved to a nursing home, half of the patients used walking aid and half of them needed assistance in their own homes one year after the fracture [22]. Studies often exclude patients with several comorbidities and mental impairment, and it can be assumed that the real hip fracture population is in worse condition than what is captured by investigation [17, 23-27]. This is of importance as it is estimated that 40 % of hip fracture patients are mentally impaired [28].

1.3 Risk factors for hip fracture and osteoporosis

1.3.1 Bone mineral density

Risk factors for osteoporosis are inevitably also risk factors for hip fracture, due to the strong association between hip fracture and bone mineral density (BMD). As BMD peaks in early adulthood and deteriorate during aging, the risk of suffering from a hip fracture increases

exponentially with age [3, 29]. Individuals cannot feel bone deterioration, and therefore a fracture is often the first sign of low bone mass in patients. This fracture is therefore the international barometer for osteoporosis [3]. About 90 % of hip fractures in both sexes results from a simple fall from standing height or less, these are called low energy hip fractures and are the type of fracture associated with osteoporosis [3]. The risk ratio for hip fracture in men and women increases with about 2.9 for each standard deviation (SD) decrease in BMD [8]. As postmenopausal women have a more drastic decrease in BMD than men at the same age and because women generally live longer than men, the majority of low energy hip fractures occur in women [3].

A Norwegian prospective study investigated risk factors for hip fracture among a representative population of middle aged adults, and found several age-adjusted relative risks for hip fracture: They found that two thirds of the fractures occured in women. Also, a body mass index (BMI) <22 increased risk for hip fracture, self-reported low physical activity at work also showed increased risk. Heavy smoking (>15 cigarettes daily) also increased the risk for hip fracture. These variables are all related to BMD and bone loss [29]. Several diseases will also negatively affect BMD, as chronically obstructive pulmonary disease [30], HIV [31] and cancer types [32].

1.3.2 Dietary risk factors

Several dietary factors have been identified as important for maintaining bone health and reducing the risk of osteoporotic fractures [33]. Of relevance to this study dietary protein and dietary protein in association with calcium intake will be presented in more detail, although calcium per se [34], vitamin D [35], alcohol intake [36] and consumption of n-3 fatty acids [37] also influences BMD by different mechanisms.

The role of dietary protein on bone health has been controversial. At high-protein intakes, urinary calcium loss increases, but at the same time protein increases calcium absorption and bioavailability. These seemingly opposite effects makes it uncertain what the net effect of high protein diets is on calcium economy and bone health [38]. Any negative effect of protein might be opposed by an increase in the protein-sensitive anabolic mediator insulin-like growth factor, IGF-1 and enhancement of lean body mass with protein intake [39]. European Food Safety Authority regarded the proof level of the association between bone health and protein intake as inconclusive [40]. Nevertheless, there seems to be an interaction between

protein intake and the intake level of calcium. Several studies suggest that dietary protein works synergistically with calcium to improve calcium retention and bone metabolism [41].

1.3.3 Non-skeletal clinical risk factors

The pathogenesis of hip fractures is multifactorial, and low BMD alone cannot completely account for their occurrence [42]. Risk factors who are independent of BMD are called non-skeletal clinical risk factors, and they contribute significantly to fracture risk over and above that provided from BMD [43]. Maternal hip fracture is positively associated with hip fractures, even after adjusting for BMD. Tachycardia at rest and previous hypothyroidism is also associated with hip fracture [3, 44]. Impairment with the eyes like poor vision, poor depth perception and poor contrast sensitivity are all associated with hip fracture [43, 44]. Use of systemic corticosteroids, rheumatoid arthritis and neuromuscular disorders are also risk factors of hip fracture independent of BMD [45].

1.3.4 Sarcopenia

Aging is associated with an increase of fat mass (FM) during adult life and a decrease in fat free mass (FFM) from about 40 years of age, and can result in the age-related disease sarcopenia [46]. Aging *per se* does not cause sarcopenia, rather mechanisms caused by inactivity and a diet with low energy and protein intake. Sarcopenia is characterized by a decreased response and/ or sensitivity of otherwise adequate amounts of protein and leads to a higher threshold value for protein synthesis than for others [47, 48]. As it requires larger protein amounts to reach the threshold for protein synthesis at each meal, further protein breakdown can be expected [49]. Sarcopenia affects about 10 % of elderly 60-70 y, and up to 50 % of elderly over 80 y [48]. Low levels of muscle mass and poor muscle strength increase the risk of falls and fracture [50].

1.4 Energy requirement for the elderly with disease

The principle behind the energy requirement is to recover energy expenditure to achieve energy balance, the physiological state where daily energy intake equals energy expenditure over time, and both body weight and body composition are constant. Thus, to estimate energy requirement, energy expenditure must be estimated. The daily energy expenditure can be divided into three components; resting energy expenditure (REE), diet-induced thermogenesis and energy expenditure caused by physical activity [1]. REE depends largely upon FFM, which requires more energy than FM. As FFM tends to decline with age, REE is usually

lower in the elderly than the younger adults [12]. Also, physical activity tends to decline with age. Diet-induced thermogenesis is found to be the same regardless of age [1]. Altogether, total energy expenditure is usually lower for the older than the younger persons [12]. There exist prediction equations for estimation of energy expenditure, which can be used as rough estimates when other assessment methods are unavailable [5, 51].

Surgical stress will however lead to an increased energy expenditure [52]. This is because the inflammatory reaction will lead to production of catabolic cytokines, which increases energy expenditure. A study performed by Paillaud et al. found that hip fracture patients remained in an increased metabolic state throughout their study which lasted two months, and found a significant difference in energy expenditure between healthy elderly and elderly with inflammation [52]. These findings are concordant with results of other studies showing significant effects of trauma and surgery on resting energy expenditure [52-54].

1.5 Protein requirement in the elderly

Protein requirement is met when the supply of nitrogen (via proteins) from the diet corresponds to the body´s loss, a situation of nitrogen balance (N-balance). Measuring the N-balance has been the main procedure for calculating energy requirements the last century [1, 9]. Pedersen & Cederholm have written a systematic review regarding protein requirements in healthy elderly subjects. They found the evidence as *probable* that the estimated average requirement of 0.66 g good-quality protein/kg bodyweight (BW) per day and the subsequent recommended daily allowance (RDA) of 0.83 g good-quality protein/kg BW per day is satisfactory for all adult age groups, including the elderly, based on N-balance studies [55]. However, the authors emphasise that this is the minimum dietary protein need, which corresponds to an average intake of approximately 10 E% from protein. The estimation of an *optimal* level of protein intake in the elderly however, can be higher for several reasons, like sarcopenia and osteoporosis being processes that are too slow to de discovered in short-term N-balance studies. Also, low-protein diets can induce adaptions to spare nitrogen, making it hard to determine the level of optimal protein intake rather than what is needed to avoid deficiency [56].

The Nordic nutrition recommendations (NNR) also emphasize that any protein catabolism and loss due to disease and bed rest (see 1.7) must be replaced from the diet and thus

represent an added need for dietary protein [1]. For these reasons, several organisations have increased the protein requirements for the elderly [1, 49, 56]. Pedersen & Cederholm and NNR recommended that an intake up to at least 1.2-1.5 g protein/ kg BW/day (according to 15-20 E%) is safe and may have beneficial effect for the elderly population, versus the recommended dietary allowance of 0.8-1.0 g protein/ kg BW/ d that is recommended for the younger adults [1, 55]. The European Society for Clinical Nutrition and Metabolism (ESPEN) recommends a recommended dietary allowance of 1.0 - 1.2 g protein/kg BW /d for healthy older adults, and 1.2 - 1.5 g protein/kg BW /d for older adults who have acute or chronic illnesses, with even higher intake for individuals with severe illness or injury [49].

1.6 Energy and protein intake in hip fracture patients

A British study found that hip fracture patients had worse nutritional status at admission to hospital than what was fond in a healthy age-matched community-dwelling group by comparison of anthropometric measures. Further they discovered that a poor nutritional status before the fracture also contributes to a further deterioration in nutritional status that will affect clinical outcome [17]. A Swedish study found that hip fracture patients had a suboptimal energy intakes during hospital stay but did not investigate the group further [23]. Poor nutritional status is one of the strongest predictors of a poor outcome after hip fracture, reported associations between malnutrition and hip fracture are excess mortality, worse mobility and functional outcomes, poorer cognition, function, higher rates of comorbidity and rehospitalisation [39]. Several studies have investigated the energy intake thoroughly at hospital, but few studies consider the rehabilitation phase thoroughly [17, 23, 57]. For follow-up studies, mortality is often the main outcome investigated [20, 27].

1.7 Nutritional risk and weight loss in elderly hip fracture patients

Nutritional risk screening (NRS 2002) is a validated tool to assess information about nutritional risk [5]. Nutritional risk is identified by pronounced unintentional weight loss, chronically low BMI, a reduced dietary intake or severe illness. Patients who have one or more of these conditions requires urgent intervention [58].

A BMI <20.5 kg/ m^2 is used to identify hospitalised patients at nutritional risk [58, 59]. A low BMI is related to mortality in the elderly population, while no excess mortality is found in

overweight elderly individuals versus normal-weight elderly [60, 61]. Following a study of elderly nursing home residents in Istanbul, the authors suggested that better functional status was associated with higher BMI values even in BMIs >30 kg/ m^2 [62]. A possible reason for this is that a low BMI in the elderly is associated with low muscle mass, not necessarily low fat mass. FFM, in particular muscle and bone, is positively associated with strength, physical function and overall quality of life, while a low FFM is associated with adverse outcomes as presented for sarcopenia [50]. These findings can also possibly be explained by the decrease in height expected with aging which will lead to an increase in BMI without a gain in body mass [62].

Involuntary weight loss in the elderly is associated with undesirable health outcomes like decreased functional status, institutionalization and increased mortality. Weight loss is both a marker of, and an independent contributor to, these adverse health outcomes [63]. A widely used definition for clinically important weight loss is 5 % or more over 6-12 months [59], although a weight loss of 3 % of body weight also was associated with adverse health outcomes in frail elderly [64, 65]. A study in Caucasian female hip fracture patients found that weight loss is associated with weakness during hip fracture recovery [59].

It is found that patients who are bedridden for several days will experience a loss of muscle mass, mainly due to a decrease in muscle protein synthesis [66]. Also, healthy elderly participants in an intervention study (mean 67 y) experienced a greater muscle mass loss in ten days (= 1 kg muscle from the lower extremities) than younger participants [67]. This decreased muscle mass due to bed rest in older subjects is associated with large reductions in strength. The hypermetabolic state during illness and disease mentioned earlier may also result in alteration in body composition, with severe muscle wasting [66].

Compared to younger adults, older adults usually eat less, including less protein. Due to the higher needs for the diseased, sarcopenic and bedridden elderly, this leads to an imbalance between protein supply and protein requirement, and represent a challenge in the elderly [49]. Loss of muscle mass is associated with mobility disorders, increased risk of falls, reduced ability to function in activities of daily living, loss of independence and reduced life expectancy [50].

1.8 Current health measurements

1.8.1 Anthropometric measures

A quite direct marker of nutritional status are anthropometric indices, such as weight in relation to height (BMI), triceps skinfold for body fat, and mid upper arm circumference for muscle mass and fat mass [68]. Classification of underweight, normal weight, overweight and obesity is obtained by using BMI, and it is calculated by dividing weight in kilograms with square height in metres (kg/m^2) [69]. A BMI under 20.5 kg/m^2 is categorized as underweight for the elderly [58]. BMI alone may not be sufficient to establish risk of adverse outcomes, as it does not take into account the distribution between different tissues [62]. Also, weight and height data may be unrealistic to perform at sick geriatric patients [70].

Significant changes in body composition occur with aging, which cannot be discovered by BMI [71]. Bioelectrical impedance analysis (BIA) is a non-invasive, inexpensive and portable method that can been used for body-composition [72]. The BIA measures body resistance and reactance, and by a suiting formula FM and FFM can be obtained. However, obtaining FM and FFM from BIA relies on the assumption that hydration level is constant. This is often not the case for elderly, especially not when ill [73].

To avoid any oedema, dehydration or other disturbances in hydration level, mid-upper arm circumference (MUAC) can be used to assess information about body composition. A study found that MUAC has a better association with mortality than BMI in older men and women [74]. Another study found that decreases in MUAC had the strongest association of mortality among eight anthropometric measures [75].

1.8.2 Phase Angle

Phase angle (PA), a value calculated directly from BIA measurement as the arc tangent of the ratio of resistance and reactance, has been shown to be predictive for prognosis and mortality in different diseases and in geriatric patients [76]. PA relates to the distribution of intra- and extracellular fluid and also with the cell membrane integrity, and is normally calculated automatically on the BIA device [77]. Men usually have a wider PA than women, younger individuals has wider PA than older, and also PA is inversely related to BMI [72]. A narrow PA is associated with frailty and mortality in geriatric patients and healthy elderly women and men. It is therefore suggested that PA can be interpreted as a global marker of health and a predictor of poor outcome in the elderly [70, 72, 77]. PA has also been shown to decrease

with increased nutritional risk, and indicates a loss of cell mass in malnutrition. Studies suggest that a low PA is associated with low body weight and poor outcome [76]. There are no uniform consensus regarding reference values, however, 6.2° and 5.6° are commonly used for men and women, respectively [72]. Kyle et al defined low PA as <5.0° in men and <4.6° in women [78].

1.8.3 Strength

Older adults with reduced muscle strength have higher mortality [79]. Handgrip dynamometer is an easy and non-invasive tool to measure handgrip strength. There is an agreement that handgrip strength can characterise overall strength [80]. The strength of handgrip can also be used as a health screening tool due to its relationship to physical activity, nutritional status, future disability and mortality [79-81]. Knee extension exercise, which measures strength in quadriceps muscle, is also a strong and independent predictor of mortality in older adults [79]. Both strength measurements mentioned is associated with mortality also when adjusted for muscle mass, hence the association cannot be contributed to sarcopenia [79].

1.8.4 Biochemical markers

It is normal to use biochemical markers for assessing nutritional information in individuals, but these methods are hampered by their response to acute illness and injury. Inflammation follows surgery and leads to several changes in the body that replaces the normal homeostatic mechanisms, e.g. the production of acute phase proteins and the decrease in micronutrient concentration in plasma [82]. This makes it important to follow the evolution of a systemic inflammatory response in nutrient assessment situations for sick patients; this can be conducted by measuring the acute phase protein C-reactive protein (CRP) which can increase a thousand-fold during an inflammatory response, and is easy to measure [82, 83].

Serum albumin is an established biochemical marker of nutritional status [26]. As albumin is a negative acute phase protein, the rate of albumin synthesis is affected by both nutrition and inflammation [84]. Also 25-hydroxyvitaminD (25(OH)D), the component that is normally collected to assess vitamin D status, is affected by inflammation. A rapid significant decrease in plasma concentrations of 25(OH)D is found during the evolution of an inflammatory response, and it also stayed low for three months [85]. Routine biochemical assessment in the hospital includes also measurement of haemoglobin and serum creatinine. Haemoglobin is usually measured to monitor any risk of huge blood losses, and from a nutritional point of view, it can reflect iron status and indicate iron-deficient anemia, although the sensitivity and

specificity are limited [86]. Serum creatinine reflects bot the renal function and the muscle mass, as it is excreted by the kidneys and formed at a constant rate in the skeletal muscles [87].

1.8.5 Length of stay at hospital

Length of stay (LOS) at hospital thoroughly associated with nutritional status [57, 88]. LOS is an easily measurable outcome parameter, and beside nutritional status the variable could be an integration of the severity of illness and patients health status in general - and is affected by the severity of trauma and disease, overall medical or surgical treatment, quality of care, resources available and the environmental conditions outside the hospital [88].

1.8.6 New Mobility score

Towards the end of the 20th century, Parker & Palmer validated the new mobility score (NMS), which at a high significant prediction can forecast mortality in hip fracture patients at one year [89]. The NMS is also associated to the regain of independence in basic mobility after surgery [90]. To our knowledge, new mobility score has not previously been associated with nutritional status.

1.9 Aim and hypothesis of the research project

The poor nutritional status in hip fracture patients is increasingly recognized, however, little is known about food intake and weight changes in the immediate postoperative period in Norwegian patients. Up until now, most investigations have been performed by identifying outcomes one year after the fracture, without paying specific attendance to the early post-fracture period, or are conducted in different settings where procedures for hospitalisation and rehabilitation are different from Norway [22, 25, 52]. Hip fracture patients represent a vulnerable group with adverse outcomes after one year, yet more acute outcomes are unknown.

We hypothesize that old hip fracture patients will have a sub-optimal energy and protein intake during the acute and rehabilitation phase after the fracture, and this will be associated with weight-loss and placing the patients at nutritional risk

2 Methods

2.1 Study Design

To investigate the acute and rehabilitation phase for elderly hip fracture patients, a longitudinal study from surgery to the end of the rehabilitation stay was conducted. Data were collected from patients at the hospital shortly after surgery, during rehabilitation at a nursing home (which is a common procedure for most hip fracture patients in Norway), and when the patients returned home **(Figure 2)**. The study was a descriptive, observational study, and it was conducted from August 2014 to February 2015. The Research Ethics Committee of Western Norway approved all procedures involving humans. Participants in the current study were also requested to join a larger randomised control study, Fish Intervention Studies.

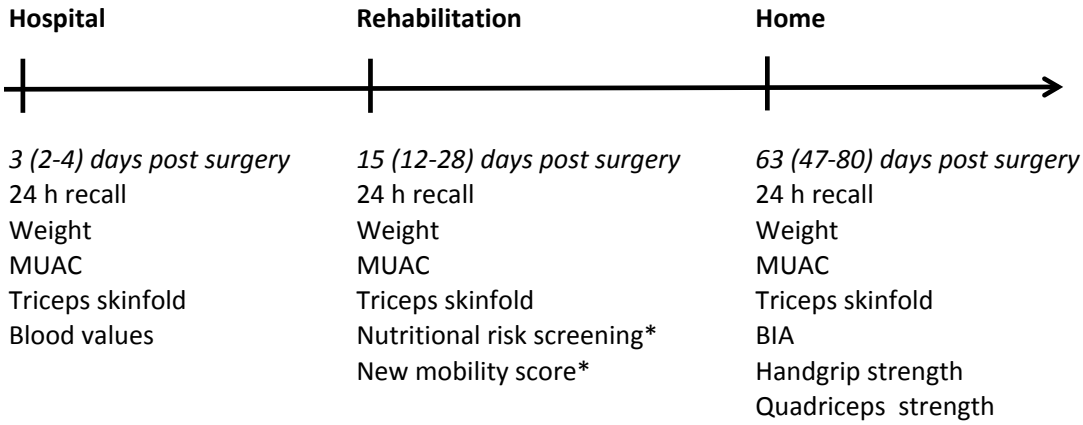

Figure 2. Study timeline.

Hospital visit was median 3 days after surgery, rehabilitation visit was median 15 days after surgery while home visit was median 63 days after surgery. Interquartile ranges are presented in parenthesis.

* Nutritional risk screening (NRS) and new mobility score (NMS) was conducted at second visit. If rehabilitation visit was not conducted, these measurements were conducted at home.

2.2 Study Population

A total of 40 patients, 14 men and 26 women, were recruited by a researcher in two hospitals in Bergen. The hospitals monitored were Haukeland University Hospital and Haraldsplass Deacon Hospital. The patients were over 60 years old, and had to be hospitalized for their first hip fracture. The patients included were in normal cognitive function; nurses working at the current departments excluded persons with signs of cognitive impairment /dementia. Two patients were excluded due to their homes being to far from the hospital. Also, patients with

walking aid pre-fracture were also excluded. A complete list of the inclusion -and exclusion criteria's is found in **Table 1**.

To recruit patients, a researcher visited the relevant departments in Haraldsplass Deacon Hospital and Haukeland University Hospital on workdays to check whether new patients, suitable for the project, had arrived. The researcher recruited willing patients. The patients were informed about the study design orally and written, and signed the consent forms *(appendix 1)*. Rehabilitation facilities was informed, and consented to this cooperation.

Table 1. Inclusion criterias for the study patients

Inclusion Criterias
> 60 years
Recent first Hip Fracture
Normal cognitive function
Community dwelling pre-fracture
Must live near Bergen
No walking aids pre fracture

2.3 Energy intake and requirement

To assess the food consumption of patients at all visits, 24 h recalls were conducted, all by the same person. The 24 h recall was carried out in that the interviewer asked the patients to recall the exact food intake during the preceding day and night. To collect the 24 h recall, the interview guide from Gibson was used *(appendix 2)* [91]. Energy and macronutrient intake were estimated by use of *Kostholdsplanleggeren* (the diet planner) [92]. The nutritional content in Kostholdsplanleggeren are based on data from the Norwegian food composition table [93].

Numbers for estimating energy requirements were found in Haukeland university hospitals guidelines for good nutritional practise *(appendix 3)* [94], which is based on the Norwegian national professional guidelines for prevention and treatment of malnutrition [51]. We

estimated protein requirement as proposed by ESPEN [49]. During hospital stay, we used the mean value of the protein recommendations for elderly with disease, 1.35 g protein/ kg BW/ d, to calculate each patient's protein requirement. For rehabilitation and home visits, we used the mean value of the protein recommendations for the healthy elderly, 1.1 g protein/ kg BW / d, to calculate each patients protein requirement [49].

2.4 Nutritional risk screening

To detect patients at risk of malnutrition, the *first four questions* of the Nutritional Risk Screening (NRS 2002) was used [58] as in the study by Tangvik et al. [6] *(appendix 4)*. As suggested by Tangvik et al., answering yes to at least one question placed the patients in nutritional risk [6]. The four questions were:

Is BMI < 20.5 kg/m2?

Has the patient lost weight within the last weeks?

Has the patient had a reduced dietary intake in the last weeks?

Is the patient severely ill?

2.5 Weight and anthropometry

To conduct the weight of the patients, a SECA chair scale, model 952 was used during hospital stay. If the patients were unable to leave the bed, self reported weight was collected. During the two following visits, an electronic scale SECA flat scale, model 877 was used. During hospital stay the patients were wearing light hospital clothes, while at rehabilitation stay and home clothing was heavier. This was taken to account by withdrawing 1 kg from gross weight. The two different weights used in the study had a systematic disparity of 0.2 kg, and was considered unimportant. Height was measured at home visit with Seca stadiometer, model 217 to the closest 0.5 cm. If patients did not attend this visit, self-reported height was used. Body weight and BMI were estimated to the closest 0.1 kg and kg/m^2 respectively.

MUAC was measured with Seca measuring tape, model 201. The triceps skinfold measurement used, was a precision thickness caliper from Lange skinfold caliper (Beta technology). Bedridden patients were not asked to rise from the bed, although patients should be standing with the arm hanging loose. Except for this, the manufacturers` guidelines were followed.

Body Composition was acquired by using the BIA 101 Anniversary Sport edition (AKERN). It measures body resistance and reactance, and by the use of the formula of Kyle [95], as suggested by Genton [96], the amount of FFM in kg was calculated. Patients who did not have a pacemaker attended the measurement. Further, the manufacturers guidelines were followed. Phase angle was directly calculated from the BIA measurement.

2.6 Handgrip and Quadriceps strength

Handgrip strength was measured at the home visit with the JAMAR hydraulic hand dynamometer (Sammons Preston). Quadriceps strength was measured at the home visit on the leg with no fracture, with knee extension apparatus Chatillon force measurement, the DFE-II series (AMETEK). Both tests were carried out three times and the mean value, estimated to the closest 0.5 kg, was recorded. Otherwise, the manufacturer`s guidelines were followed.

2.7 New Mobility Score

Functional level after returning home was evaluated with the NMS. The NMS is a composite score of the patient's ability to perform indoor walking, outdoor walking, and shopping after the hip fracture, providing a score between 0 and 3 (0 = not at all, 1 = with help from another person, 2 = with an aid, and 3 = no difficulty and no aid) for each function, resulting in a total score ranging from 0 (no walking ability at all) to 9 (fully independent) *(appendix 4)* [89].

2.8 Blood Samples and remaining values

Blood values for albumin, hemoglobin, 25(OH)D, CRP and creatinine were collected from patient journal from mainly one-day pre surgery. Remaining values, such as length of stay at hospital and other information like the presence of osteoporosis, type of hip fracture and type of fall, were also collected from the patient journal.

2.9 Statistical analysis

The data was analysed in IBM SPSS Statistics 22 [97]. The Shapiro-Wilks test was used to assess normality. As most of the data were not normally distributed, and the number of participants was relatively small, we used non-parametric tests on our data. Results are

presented as medians with interquartile ranges (Tukeys Hinges), and minimum and maximum score. Baseline characteristics were also presented as means and standard deviations. The Wilcoxon Signed Rank test was used to evaluate if changes inside a group was statistically significant between hospital and rehabilitation, and hospital and home. The Kruskall-Wallis test was used to evaluate if differences between groups were statistically significant, e.g. between groups with and without nutritional risk. Spearman's rho was used to detect any statistical significant correlation between two variables. Any changes in groups or differences between groups were considered statistically significant if $p < 0.05$.

Due to substantial amounts of missing data, patients who only completed the first visit were excluded from analysis, except at the baseline characteristics (Figure 3). For the presentation of nutritional and weight status (Table 4 & 5), all patients who completed more than one visit were included. Visit at hospital was compared with rehabilitation visit. Visit at hospital was also compared with home visit. **Figure 3** shows how the current dataset led to 16 patients for comparing hospital and rehabilitation stay, and 15 patients for comparing hospital and home stay. Complete case analysis was performed to see individual data of those who conducted all visits.

Some post-hoc power testing were performed to calculate how many patients would be required to achieve statistical significant results regarding changes in % weight and BMI. We aimed for a significance level of <0.05 and a power of 90 %.

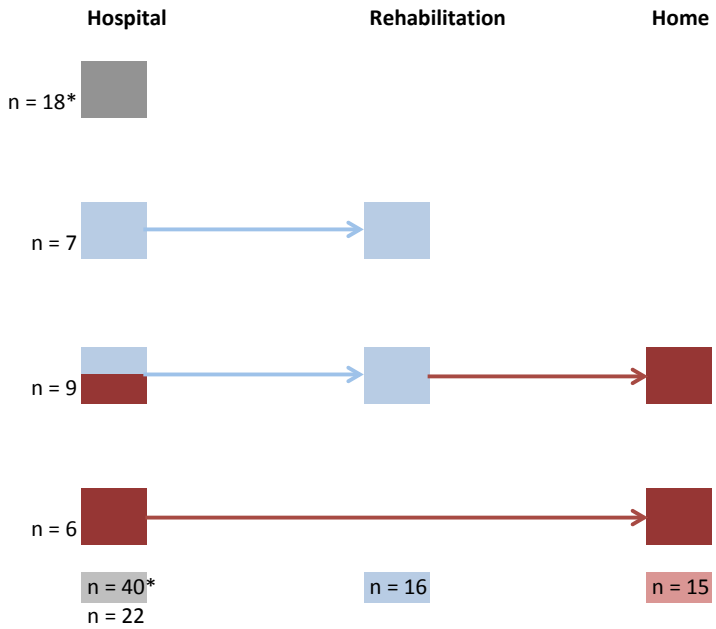

Figure 3. The current dataset and the distribution of patients among the visits.

* 18 patients only participated in the first visit, and this data is only used for baseline characteristics.
Seven patients attended visit at hospital and rehabilitation. Nine patients attended all visits. Six patients attended visit at hospital and home.
16 patients could therefore be compared between hospital and rehabilitation, and 15 patients could be compared between hospital and home.

3 Results

3.1 Flow of subjects

Forty patients, 26 of them women (65 %) were included in the study after surgery during hospital stay for hip fracture **(Figure 4).** Eighteen patients withdrew from the study after the first visit. Sixteen patients conducted the second visit at rehabilitation, and fifteen patients conducted the last visit, at home. The patients who only participated in one visit, dropouts, (n=18) were withdrawn from the analysis, except for the baseline characteristics (**Table 2)**.

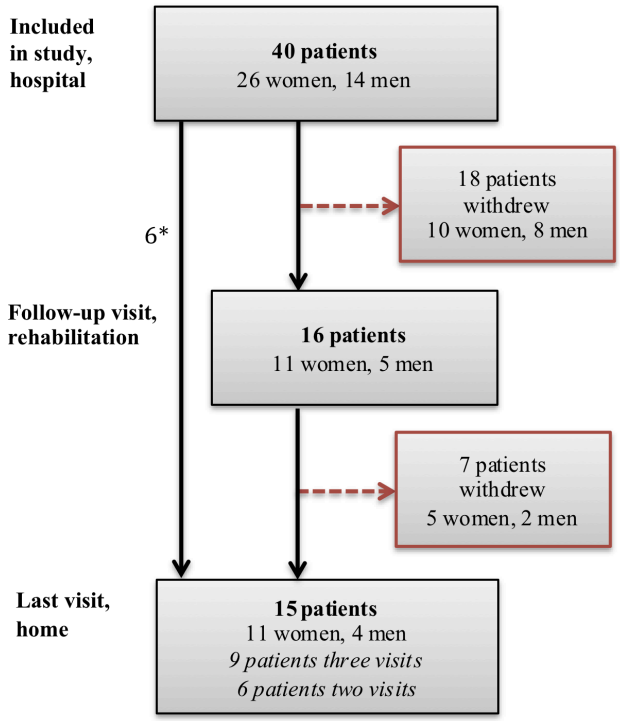

Figure 4. Flowchart of study subjects.

* Six patients did not undergo the second visit (at rehabilitation), but conducted the third visit. Twenty-two patients conducted thereby more than one visit.

3.2 Baseline Characteristics

The median age of the 40 patients who were included at baseline was 81 years, 78 years for the men, and 81 years for the women **(Table 2)**. Blood values, mainly from a sample drawn one day before surgery were available for albumin, hemoglobin, vitamin D status (25(OH)D), CRP and creatinine, and are also presented for all patients in Table 2.

Almost 70 % (n = 27) of the patients fractured the hip from standing height or less in their homes (low-energy hip fracture), four patients fell down the stairs, two patients were in a bicycle-accident, two patients fell during syncope and five patients fell outside. The highest fraction of types of fracture was intra-capsular (60 % of the fractures, n = 23). There was only one sub trochanteric fracture, and the rest (n = 14) were inter-trochanteric fractures. Seven of the forty patients were diagnosed with osteoporosis. Seventeen of the patients did not have osteoporosis, while for 14 patients the diagnoses were not available.

There were no significant differences in LOS for those who only conducted visit A (drop-outs) and those who conducted more than one visit (p = 0.419). The dropouts were apparently older (81 years vs. 75 years), and had a lower energy intake at hospital (1070 kcal versus 1670 kcal), but none of these findings were statistically significant, p = 0.195 and p =0.205 respectively.

Baseline characteristics for the patients who conducted more than one visit are presented in **Table 3.** The median BMI was 22.8 kg/m^2 and 23.1 kg/m^2 for men and women, respectively. The median energy intake at hospital was 1710 kcal for men and 1060 kcal for women. The median LOS at hospital for those who conducted more than one visit was 6 days, and there was a significant positive association between LOS and age (r = 0.618, p =0.008) *(All correlation information are found in appendix 5)*. No nutritional or weight related variables had any correlation with LOS (energy intake at hospital, weight/BMI at hospital, nutritional risk or weight loss during study period).

Table 2. Baseline characteristics of all the 40 hip fracture patients recruited at hospital

Baseline characteristics from all patients

	All patients				Men					Women				
	n	**Mean (SD)**	**Median (IQR)**	**Min / max**	**n**	**Mean (SD)**	**Median (IQR)**	**Min / max**	**Reference value**	**n**	**Mean (SD)**	**Median (IQR)**	**Min / max**	**Reference value**
n	40				14					26				
Age	39	77.6 (9.4)	81.0 (70.5-83.5)	59 / 95	13	75.5 (10.2)	78.0 (67.0-82.0)	61 / 95		26	78.6 (9.1)	81.0 (73.0-86.0)	59 / 93	
LOS	38	6.5 (2.5)	6.0 (5.0-7.0)	3 / 14	13	6.7 (3.2)	5.0 (4.0-9.0)	4 / 14		26	6.3 (2.0)	6.0 (5.0- 7.0)	3 / 11	
Number of days before surgery*	38	0.95 (0.6)	1 (1-1)	0 / 2	13	0.7 (0.5)	1 (0-1)	1 / 1		26	1.08 (0.6)	1 (1-1)	0 / 2	
Albumin, g/l	33	41.6 (2.7)	42.0 (40.0-44.0)	37 / 49	12	40.4 (2.1)	42.0 (40.5-44.0)	37 / 44	39 - 48	21	41.8 (3.0)	41.0 (40.0-44.0)	37 / 49	36 - 48
Haemoglobin, g/dl	38	13.3 (1.9)	13.5 (12.4-14.6)	9.10 / 16.3	13	13.5 (2.3)	14.6 (12.3-15.5)	9.1 / 15.6	13.4 - 17.0	25	13.2 (1.7)	13.5 (12.5-14.0)	9.7 / 16.3	11.7 - 15.3
25(OH)D, nmol/ l	23	72.3 (27.5)	67.0 (58.5-88.5)	18.0 / 130.0	8	59.9 (24.9)	63.5 (44.5-76.5)	18.0 / 92.0	50 - 113	15	78.9 (27.3)	70.0 (60.0-101.0)	36.0 /130.0	50 - 113
CRP, mg/ l	38	12.2 (29.7)	2.0 (1.0 - 6.0)	<1 / 159	13	15.5 (43.3)	2.0 (1.0-4.0)	<1 / 159	< 5	25	10.5 (20.3)	2.0 (1.0-6.0)	<1 / 80	< 5
Creatinine, µmol/ l	38	76.3 (34.0)	68.5 (56.0 - 83.0)	47 / 252	13	92.2 (50.5)	79.0 (66.0-93.0)	56.0 /252.0	60 - 105	25	68.0 (17.3)	64.0 (55.0-75.0)	47.0 / 106.0	45 - 90

LOS = Length of stay (at hospital).
25(OH)D - 25-hydroxyvitaminD
CRP = C-reactive protein.
* Number of days before surgery the blood samples was collected.
Results are presented as means with Standard Deviation (SD), medians with interquartile ranges (IQR) and minimum and maximum values.
Reference values for blood samples are presented for men and women.
Number of blood samples varies as not all samples was analysed at hospital.

Table 3. Baseline characteristics for hip fracture patients who conducted more than one visit

	All patients who completed more than one visit				Men				Women			
	n	Mean (SD)	Median (IQR)	Min / max	n	Mean (SD)	Median (IQR)	Min / max	n	Mean (SD)	Median (IQR)	Min / max
n	22				6				16			
Age, years	22	78.5 (10.2)	80 (72 - 87)	61 / 95	6	75.7 (12.8)	77.0 (62.0 - 82.0)	61 / 95	16	79.5 (9.2)	82.0 (72.5 - 87.0)	62 / 93
Weight, kg	19	65.5 (10.9)	62 (59.5 - 69.5)	47 / 94	5	71.9 (10.4)	70.0 (69.9 - 70.0)	60.7 / 89.0	14	63.2 (10.5)	60.1 (58.0 - 68.0)	47 / 94
BMI, kg/m2	17	24.0 (3.5)	23.0 (22.5 - 24.3)	19.7 / 35.4	4	23.2 (2.2)	22.8 (21.8 - 24.6)	20.9 / 26.2	13	24.2 (3.9)	23.1 (22.5 - 24.3)	19.7 / 35.4
LOS, days	17	5.9 (1.9)	5.0 (5.0 - 7.0)	3 / 11	5	5.8 (2.2)	5 (4 - 7)	4 / 7	12	5.9 (1.9)	6.0 (5 - 7)	3 / 11
MUAC, cm	14	27.8 (2.7)	27.3 (27.0 - 29.0)	23 / 34	4	27.4 (3.0)	28.0 (25.0 - 29.3)	23.0 / 29.5	10	28.0 (2.8)	27.3 (27.0 - 29.0)	24 / 34
Triceps skinfold, mm	14	14.8 (4.4)	15.0 (14.0 - 16.0)	6.0 / 14.0	4	10.5 (3.7)	10.5 (8.9 - 13.0)	6.0 / 15.0	10	16.6 (3.5)	15.0 (14.5 - 16.0)	14 / 24
Energy intake, kcal	17	1240 (530)	1200 (920 - 1670)	410 / 2040	6	1490 (620)	1710 (850 - 2000)	630 / 2040	11	1110 (440)	1060 (920 - 1290)	410 / 1920
Energy intake, % of requirement	15	63 (21)	61 (51 - 74)	27 / 94	5	69 (25)	75 (53 - 88)	35 / 94	10	59 (20)	61 (51 - 72)	27 / 93
Protein intake, g	17	53 (25)	53 (33 - 79)	12 / 86	6	71 (25)	85 (58 - 87)	26 / 87	11	44 (20)	45 (31 - 55)	12 / 79
E % from protein	17	18.4 (26)	18 (16 - 21)	9 / 27	6	20 (4)	18 (17 - 23)	16 / 27	11	18 (5)	18 (15 - 20)	9 / 27

BMI = body mass index, kg/m^2.
LOS = Length of stay (at hospital).
MUAC = mid upper arm circumference.
E %: Energy percent; amount of nutrient as percentage of total energy intake.
Results are presented as means with Standard Deviation (SD), medians with interquartile ranges (IQR) and minimum and maximum values.
Energy requirements were calculated by assuming 29 kcal/kg/day. For patients > 70 y: estimated energy requirement was reduced with 10 % [51].
Due to the severity of the patients, n varies between measurements. Not all patients were able to e.g. rise from the bed.

Regarding the blood samples, one patient was below the reference value for albumin and one patient was below the reference value for creatinine. For hemoglobin and 25(OH)D, nine and three patients were below reference value, respectively. Eleven patients had higher CRP than the reference value. Patients below reference values for hemoglobin and patients above the reference value for CRP were apparently older than patients within reference values, median 81 years and 77 years for hemoglobin ($p = 0.068$), and 82 years and 78 years for CRP ($p = 0.171$). Other than this, there were no apparent or significant differences between groups below and within reference values.

3.3 Energy and protein intake

Energy and protein intake by 24-h recall was collected at the hospital (n = 17), the rehabilitation unit (n = 16) and at home (n = 15), and are presented in **Table 4.**

Table 4. Energy and protein intake during study period as observed by single 24-h recalls

Energy intake for patients who participated in more than one visit

	A: hospital			B: rehabilitation			C: home		
	n	**Median (IQR)**	**min/ max**	**n**	**Median (IQR)**	**min/ max**	**n**	**Median (IQR)**	**min/ max**
Energy intake, kcal	17	1200 (919-1670)	414 / 2040	16	1630 (1300-2050)	899 / 2790	15	1550 (1180-1810)	824 / 2380
Energy intake, % of requirement	15*	61 (51-74)	27 / 94	15**	92 (74-124)	51 / 228	15	93 (72-115)	46 / 139
Protein intake, g	17	53 (33-79)	12 / 87	16	60 (48-82)	32 / 112	15	55 (42-71)	21 / 116
E% from protein	17	18 (16-21)	9 / 27	16	17 (13-19)	10 / 44	15	14 12-17)	4 / 23
Protein intake, % of requirement	15*	56 (35-76)	15 / 94	15**	88 (79 - 115)	43 / 184	15	89 (67-104)	32 / 174

E %: Energy percent; amount of nutrient as percentage of total energy intake.
* Two sets of data missing due to lack of weight data.
** One set of data missing due to lack of weight data.
Data are presented as medians with interquartile ranges and minimum and maximum values.
At hospital, energy requirements were calculated by assuming 29 kcal/kg/day [51].
At rehabilitation and home, energy requirements were calculated by assuming 33 kcal/kg/day [51].
For patients > 70 y: energy requirement was reduced with 10 % [51].
Protein requirement were calculated by assuming 1.35 g/kg BW/day at hospital, and 1.1 g/kg BW/day at rehabilitation and home [49].
p-values are not calculated; patient-groups at the different visits are not the same (nine patients are the same in all visits).

Median energy intake during hospital stay was 1720 kcal for men, estimated to cover 74 % of energy requirement. For the women, energy intake at hospital was 1060 kcal, estimated to cover 61 % of the energy requirement. The protein intake during hospital stay was median 86 g for men, which was estimated to be 72 % of protein requirement. For women, the protein intake at hospital was median 43 g, which was median 47 % of estimated protein requirement. None of the patients reached their estimated energy and protein requirements at the hospital. The energy percent from protein was within recommendations at hospital. Both energy and protein intake at hospital was significantly negatively associated with age. Energy and protein intake from hospital was collected at different times vs. the surgery, from one to nine days after surgery (median 3 days).

Median intake during rehabilitation was 1860 kcal for men and 1410 kcal for women. Ten out of fifteen patients did not reach their estimated energy requirement in the rehabilitation clinic. Protein intake was sub-optimal in rehabilitation clinics, median 59 g for men and 58 g for women. Ten out of fifteen patients did not reach their estimated protein requirements, although median protein consumption reached median 88 % of estimated requirements. Energy and protein intake at rehabilitation was collected at varying times concerning the date of surgery, from eight to 46 days (median 15 days).

Median energy intake at home was 1990 kcal for men and 1410 kcal for women. Eight of fifteen patients did not meet their estimated energy requirement at home. The protein intake was 71 g for men and 52 g for women at home. Ten out of fifteen patients did not meet estimated protein requirement at home, although median protein consumption reached 89 % of estimated requirements. The time of the home visits also varied widely between patients; from 38 to 118 days (median 63 days).

For the men there was a tendency towards correlation between days since surgery visit was conducted and energy intake; $r = 0.794$ ($p = 0.059$) at hospital and $r = 0.500$ ($p = 0.391$) during rehabilitation. Other than this, there was not observed any significant or apparent correlation between days since surgery and energy intake in any of the visits.

Plots of energy intake for individuals are shown in **Figure 5.**

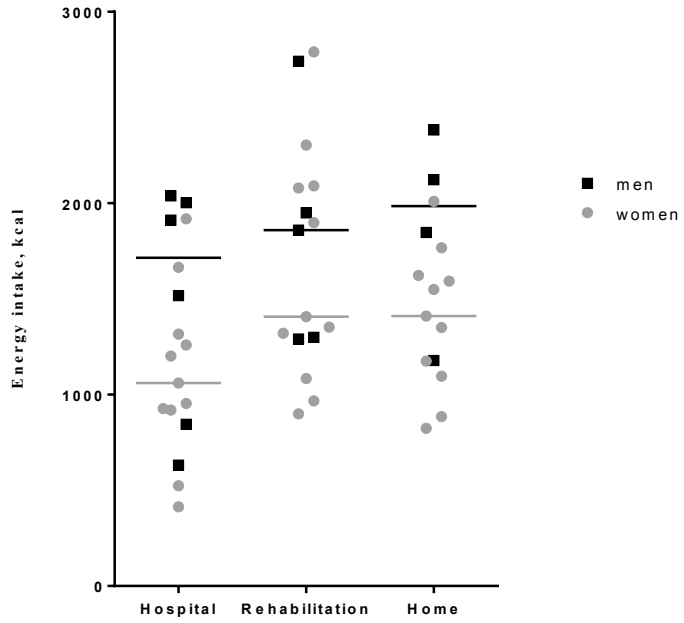

Figure 5. Energy intake for individuals during hospital, rehabilitation and home (kcal)

Scattered dot plot showing energy intake at hospital, rehabilitation and home for individuals.
Black squares show the men, grey circles show the women.
Black plain lines shows median energy intake for men.
Grey plain lines shows median energy intake for women.
p-values are not calculated; patient-groups at the different visits are not the same (nine patients are the same).

For the nine patients who completed surveys at all visits (hospital, rehabilitation and home), individual energy and protein intake (development) is presented in **Figure 6** and **figure 7**.

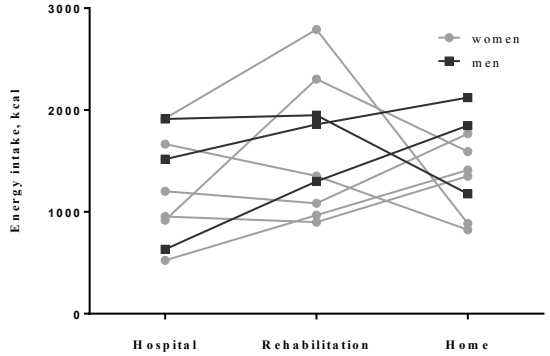

Figure 6. Energy intake for individual patients who completed all visits (kcal)

Graph presenting repeated measurements of the patients who completed all 24-h recalls.
Grey lines = women, black lines = men.

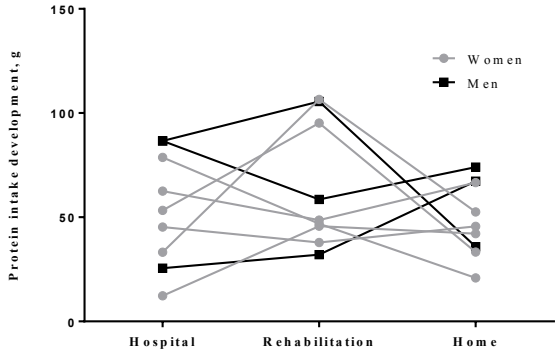

Figure 7. Protein intake for individual patients who completed all visits (kcal)

Graph presenting repeated measurements of the patients who completed all 24-h recalls.
Grey lines = women, black lines = men.

There was a significant increase in energy intake from hospital to rehabilitation for the patients who completed these visits (p = 0.02). There was an apparent, although not significant median increase in energy intake from hospital to home (p = 0.139) (**Figure 8**). The findings on changes in protein intake between visits were not significant, although there was a significant increase in protein intake as a percent of protein requirements between hospital and rehabilitation (p = 0.009) (**Figure 9**).

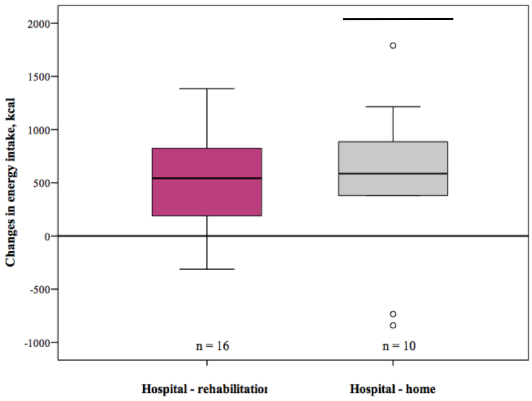

Figure 8. Boxplots of changes in energy intake between hospital - rehabilitation, and hospital - home (kcal)

Box = 25th and 75th percentiles; bars = min and max values.
Vertical line spanning the figure represents zero change between hospital and rehabilitation and home, respectively.
The Wilcoxon Signed ranked test is used to reveal significant changes between visits.
Line over bars indicates no significant changes when (p > 0.05).

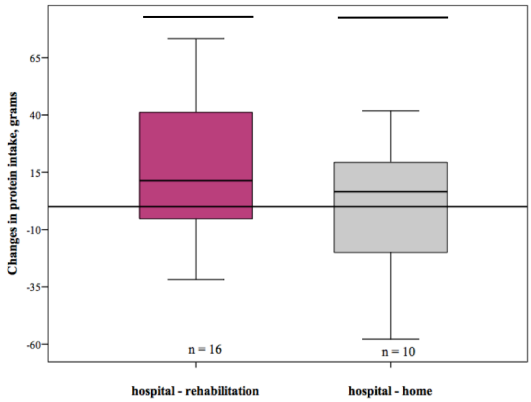

Figure 9. Boxplots of changes in protein intake between hospital - rehabilitation, and hospital - home (grams)

Box = 25th and 75th percentiles; bars = min and max values.
Vertical line spanning the figure represents zero change between hospital and rehabilitation and home, respectively.
The Wilcoxon Signed ranked test is used to reveal significant changes between visits.
Line over bars indicates no significant changes when (p > 0.05).

3.4 Weight and anthropometric data

Weight and anthropometric data was collected at hospital, during (n = 19) rehabilitation (n = 15) and at home (n = 15), and are presented in **Table 5.**

Table 5. Weight and body composition during the study period

Weight development for patients who participated in more than one visit									
	A: hospital			B: rehabilitation			C: home		
	n	Median (IQR)	min/ max	n	Median (IQR)	min/ max	n	Median (IQR)	min/ max
Weight, kg	19	62 (59 - 69)	47 / 94	15	62 (56 - 67)	47 / 86	15	64 (56 - 66)	46 / 72
BMI, kg/m2	17	23.0 (22.5 - 24.3)	20 / 35	13	22.0 (21.6 - 23.9)	17.1 / 26.0	15	23.6 (21.0 - 24.5)	16.5 / 25.0
MUAC, cm	14	27.3 (27.0 - 29.0)	23.0 / 34.0	15	28.0 (24.7 - 28.3)	21.2 / 34.5	15	28.0 (27.0 - 29.3)	22.8 / 30.3
Triceps skinfold, mm	14	15.0 (14.0 - 16.0)	6.0 / 24.0	12	11.5 (8.0 - 12.0)	4.5 / 17.0	14	11.5 (9.0 - 15.0)	7.0 / 26.0
Fat free mass, kg		n.a.			n.a.		10	40.4 (37.4 - 48.9)	34.0 /50.5
Fat mass, kg		n.a.			n.a.		10	22.1 (15.1-22.9)	11.5 / 30.0
Fat mass, % of BW		n.a.			n.a.		10	32.8 (25.2 - 36.8)	23.0 / 43.1
Phase Angle, °		n.a.			n.a		10	5.5 (4.8 - 6.6)	4.2 / 7.5

BMI = Body Mass Index, kg/m^2.
MUAC = Mid Upper Arm Circumference.
BW = body weight.
n.a. = Not available
Data are presented as medians with interquartile ranges, and minimum and maximum values.
Fat mass (FM) and Fat free mass (FFM) are calculated from BIA, with the formula of Kyle [95].
Due to the severity of the patients, n varies between measurements. Not all patients were able to e.g. rise from the bed, unclothe etc.
p-values are not calculated; patient-groups at the different visits are not the same (nine patients are the same in all visits).

Median weight at hospital was 70 kg for men and 60 kg for women. Median BMI at hospital was 23.1 kg/m^2 for men and 22.8 kg/m^2 for women. At hospital, one patient had a BMI < 20.5 kg/m^2. The median weight for patients in rehabilitation was 67 kg for men and 59 kg for women. Median BMI in rehabilitation was 22.6 kg/m^2 for men and 22.0 $kg/m^2$for women. Three of 13 patients had a BMI < 20.5 kg/m^2 at rehabilitation.

At home, the median weight was 66 kg for men and 60 kg for women. Median BMI was 23.8 kg/m^2 for men and 23.5 kg/m^2 for women at home, and four of the patients had a BMI < 20.5 kg/m^2. BMI showed no correlation to strength or NMS. The median percentage of body fat (FM) was 23.7 % for the men and 35.5 % for the women. The median phase angle was 6.6° for the men and 5.3° for the women. There was an apparent positive association between BMI at the different visits and phase angle. There was also an apparent association between phase angle and percent weight loss (r = -0.714, p = 0.071). Plots for individuals weight at hospital, rehabilitation and home are shown in **Figure 10**.

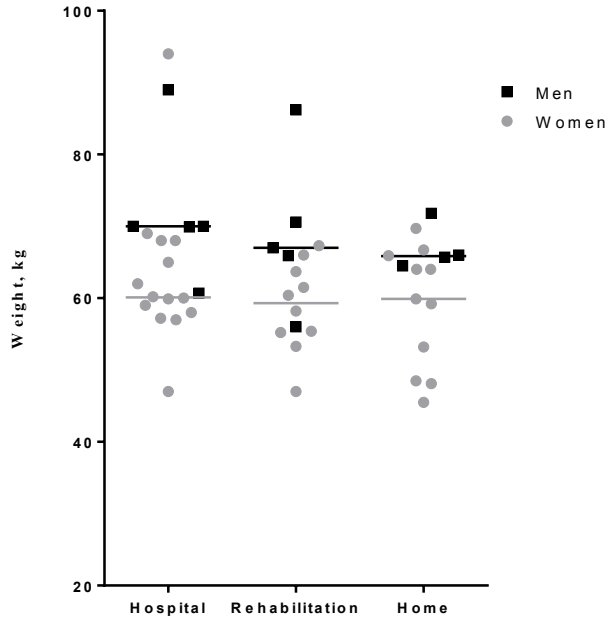

Figure 10. Weight for individuals during hospital, rehabilitation and home (kg)

Scattered dot plot showing weight in kilos at hospital, rehabilitation and home for individuals.
Black squares show the men, grey circles show the women.
Black plain lines show median weight for men.
Grey plain lines show median weight for women.
p-values are not calculated; patient-groups at the different visits are not the same (eight patients are the same in all visits).

For the nine patients who completed all visits (hospital, rehabilitation and home), eight of them conducted all weight measurements, which is presented in **Figure 11**. Six of these eight patients lost weight during the post-operative period of their hip fracture. For these patients, median weight loss was apparently -2.5 kilograms (p = 0.075) from hospital to rehabilitation, and median -3.4 kilograms (p = 0.080) from hospital to home.

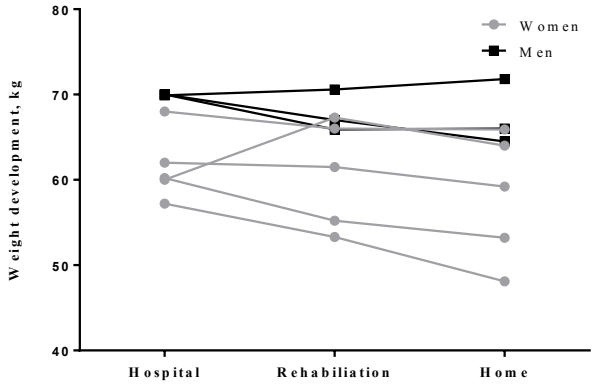

Figure 11. Weight development for individual patients who conducted all visits (kcal)

Graph presenting repeated measurements of the patients who completed all weight measurements.
Grey lines represent women, black lines represent men.

Most of the current findings on changes in BMI and weight were not significant: the median change in BMI from hospital to rehabilitation was - 0.7 kg/m^2 (p = 0.158) **(Figure 12).** This refers to a decrease of median 2.9 kg (p = 0.048) or 3.7 % of body weight (p = 0.056) after median 15 days. The median change in BMI from hospital to home was -0.8 kg/m^2 (p = 0.158), which was equivalent to a decrease of median 2.2 kg (p = 0.147) or 3.2 % of body weight (p = 0.182) after median 63 days. 11 out of 14 patients lost weight from hospital to rehabilitation, where six patients lost over 5 % of bodyweight. Eight out of 12 patients lost weight from hospital to home, where four patients lost over 5 % of body weight.

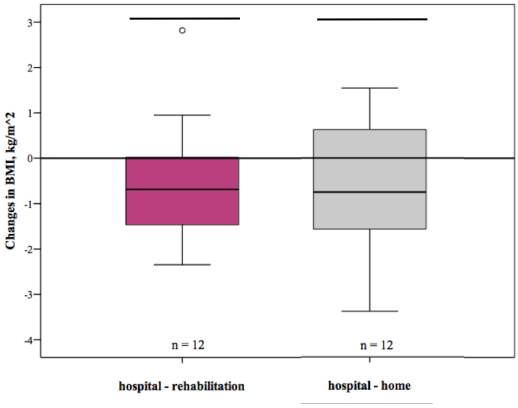

Figure 12. Boxplots of changes in BMI between hospital - rehabilitation, and hospital - home

BMI = body mass index, kg/m^2.
Box = 25th and 75th percentiles; bars = min and max values.
Vertical line spanning the figure represents zero changes between hospital and rehabilitation and home, respectively.
The Wilcoxon Signed ranked test is used to reveal significant changes between visits.
Line over bars indicates no significant changes (p > 0.05).

There was a significant decrease in triceps skinfold from hospital to rehabilitation, with a median of -3 mm in the total patient group (p = 0.04). Other than this, no significant changes were observed in triceps skinfold and mid-upper arm circumference measurements.

3.5 Nutritional risk screening

From the easy nutritional screening conducted at the second visit (the four first questions of NRS 2002), 16 out of 20 patients were categorized as in nutritional risk (4/6 men, 12/14 women). No patients had all four questions answered yes, while three patients had three question answered yes. The presentation of which questions are mostly answered yes are found in **Table 6**. An exploratory analysis was conducted to see whether the risk-group and non-risk-group varied in different variables, see **Table 7.**

Table 6. Questions answered yes at the nutritional screening

Questions of NRS2002	n
Is BMI < 20.5 kg/m2?	4
Has the patient lost weight within the last weeks?	14
Has the patient had a reduced dietary intake in the last weeks?	9
Is the patient severely ill?	0

Table 7. Differences between groups with and without nutritional risk

	Nutritional risk (n = 16)	**Not in nutritional risk (n = 4)**	**p-value**
Number of men / women	2 / 12	2 / 4	0.342
Age	82.0	74.5	0.477
BMI at hospital	23.1	23.0	1.000
BMI at rehabilitation	21.9	24.6	0.133
BMI at home	22.6	24.0	0.296
Energy intake at hospital, kcal	1130	1910	0.248
Protein intake at hospital, kcal	53	84	0.219
LOS	6	5	0.945
Phase Angle	5.5	5.4	0.600
Handgrip strength, kg	18	36	0.051
Quadriceps strength, kg	50	53	0.782
NMS	4	6	0.642
FFM, kg	40	50	0.068

BMI = body mass index, kg/m^2.
LOS = Length of stay (at hospital)
NMS = New mobility Score
FFM = Fat free mass
Quadriceps strength is measured with knee extension measurement
Energy requirements were calculated by assuming 29 kcal/kg/day [51].
For patients > 70 y: energy requirement was reduced with 10 % [51].
Protein requirement were calculated by assuming 1.35 g/kg BW/day [49].
Any differences between groups are detected by Kruskall-Wallis test.

3.6 Strength and mobility

Handgrip and quadriceps strength tests were performed when the patients were at home. Median grip strength for both sexes was 23 kg, and 38 and 18 kg for men and women respectively (right hand) **(Figure 13).** Handgrip strength was almost perfectly correlated to FFM (r = 0.973, p = 0.000), and significantly associated with protein intake at hospital (r = 0.818, p = 0.024). Handgrip strength was seemingly correlated to new mobility score (r = 0.542, p = 0.069) and phase angle (r = 0.424, p = 0.222), but not to weight loss, energy or protein intake beside protein intake at hospital.

For quadriceps strength, median value was 51 kg for both sexes, 60 kg for men and 33 kg for women **(Figure 14).** Energy and protein intake at home was significantly correlated with quadriceps strength; r = 0.699 (p = 0.011) for energy intake and r = 0.720 (p = 0.008) for protein intake. Quadriceps strength also had an apparent positive association to protein intake at hospital (r = 0.703, p = 0.078). Quadriceps strength had a significant association to NMS (r = 0.633, p = 0.027) and an apparent, though not significant association to phase angle (r = 0.469, p = 0.172).

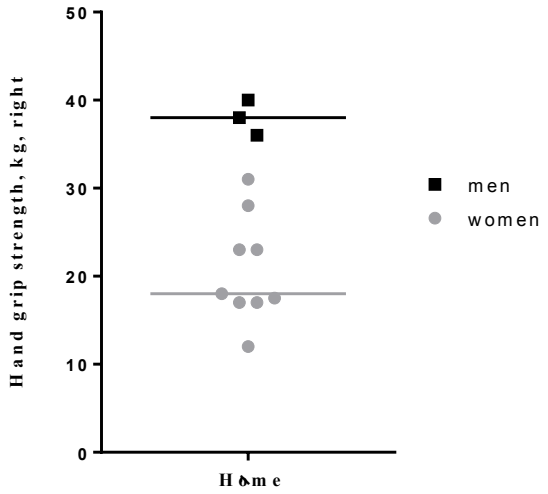

Figure 13. Handgrip strength at home showing right hand (kg)

Scattered dot plot showing handgrip strength for the twelve patients who conducted that measurement.
Black squares show the men, grey circles show the women.
Black plain line shows median strength for men, grey plain line shows median strength for women.

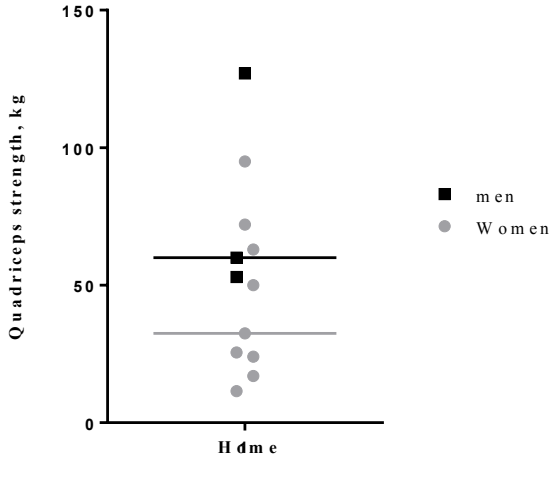

Figure 14. Quadriceps strength at home measured with knee extension (kg)

Scattered dot plot showing knee extension for the twelve patients who conducted that measurement.
Black squares show the men, grey circles show the women.
Black plain line shows median strength for men, grey plain line shows median strength for women.

NMS was conducted at rehabilitation (or home if visit at home was not carried out). Median score was 4.5 (of maximum 9 points) for the 18 patients who answered this. Ten of the patients reported that they were not able to do grocery shopping after returning home, while only one patient reported that this action was done effortlessly. Seven of the patients could not walk outside at all or without a helper, and nine of the patients were dependent on walking aids inside. There was a significant inverse correlation between NMS and age ($r = -0.544$, $p = 0.020$). There was an apparent though not significant correlation between NMS and FFM ($r = 0.533$, $r = 0.112$). There was no correlation between NMS and any other variable (energy- or protein intake, weight loss, phase angle, BMI, nutritional risk or blood values).

4 Discussion

The aim of this observational study was to investigate energy and protein intake and weight development after a hip fracture in Norwegian patients. The main findings were a very low energy and protein intake at hospital where no patient reached the estimated requirements. Energy and protein intake at rehabilitation were higher but still insufficient, about two thirds of the patients did not meet estimated energy and protein requirements at rehabilitation and home. Eleven out of 14 patients lost weight from hospital to rehabilitation (median weight loss for the group was 2.9 kg, $p = 0.048$) and eight out of 12 patients lost weight from hospital to home (median weight loss for the group was 2.2 kg, $p = 0.147$). The low energy intake and the weight loss were the main reasons that 80 % of the patients were in nutritional risk at the rehabilitation phase of the hip fracture. This was a study that depended on the willingness of patients to be included, and as their motivation to participate was limited, a small number of patients were included. For this reason most findings did not achieve statistical significance, and therefore the results have to be interpreted with care.

4.1 Energy intake and requirements

The low energy intake at hospital in the present study (median 1200 kcal) is comparable as to what was found in a Swedish study of hip fracture patients where average daily energy intake during hospital days was 1300 kcal/ day, about 62 % of their estimated energy requirements [23]. In a somewhat older study from Switzerland, Jallut et al. also found comparable energy intake; mean 1100 kcal from day three to eight after surgery [24]. Both mentioned studies excluded patients with mental impairment, while a study that included these patients found an even lower energy intake three days after surgery (≈760 kcal) [28]. The mechanisms leading to insufficient nutrient intake in patients with hip fracture may be disease-related (pain and nausea) and/ or iatrogenic like fasting before and after surgery and interruption during mealtime. Also, unfamiliar hospital setting might lead to depressed mood and poor appetite [98]. Fear and anxiety after a hip fracture may also decrease energy intake. Catabolic conditions such as inflammation increases the nutrient requirement and thus increases the gap between energy intake and nutritional needs [52-54].

There are few other studies that have investigated energy intake, expenditure and weight loss in acute situations. Jallut et al measured REE by indirect calometry and found an estimated

daily energy deficit of mean -235 kcal at the third day after surgery and mean -13 kcal the eight day after surgery eight days after surgery, and no statistically weight loss was found [24]. This suggests that energy intake increased throughout hospital stay.

It is difficult to estimate the energy deficit in the patients from the present study during their hospital stay, as we obtained only one 24 h recall, and did not assess energy expenditure. When using the estimated requirement of 29 kcal/ kg BW / day, and assuming that the energy intake as obtained by the 24 h recall remained the same throughout the hospital stay, and also assuming that weight loss was due to the catabolism of adipose tissue with an energy value of 7,000 kcal/ 1 kg [99], an average weekly weight loss of 0.6 kg could have been expected. In fact, we observed a median weight loss of 2.9 kg from hospital to rehabilitation, which was on average covering a period of 16 days. Thus, other factors than low energy intake, most likely hypermetabolism due to inflammation, triggered the weight loss in the patients. This is also supported by the fact that was no correlations between energy intake and weight loss.

The energy intake was significantly higher during rehabilitation than at hospital, but there was not a significant difference between the low energy intake at hospital and at home. The new mobility score in the present study revealed that about half of the patients were not able to do grocery shopping after returning to their own home, and for people living alone this could reduce food availability. Also, almost half of the patients were not able, or needed help from another person, to walk outside. Osnes et al. found that almost 30 % of hip fracture patients lost their ability to cook their own dinner, and 20 % lost their ability to prepare their own breakfast one year past fracture [22]. The physical limitations of the patients, found in our and other studies, could explain some of the low energy intake at home versus at rehabilitation, where all meals were prepared and served by the staff.

4.2 Protein intake, breakdown and requirements

As the protein intake during hospital stay was lower than the estimated requirement, a higher incidence of protein degradation versus protein synthesis was likely. Jallut et al found a negative protein balance based on urinary nitrogen excretion in hospitalized hip fracture patients at both days three and eight after surgery, -17.3 g and -24.3 g respectively. They found no weight loss during hospital stay, and energy intake increased during this period [24]. The low energy intake during hospital stay in the present study, confirmed by the weight loss

found, may have aggravated the protein breakdown, since circulating concentration of glucose must be obtained and amino acids become the main substrate for gluconeogenesis [100]. It should be of importance to investigate nitrogen balance and muscle loss in this patient group further, as it is not necessarily weight loss per se, but the loss of FFM which is mostly associated with adverse health outcomes [61].

The proportion of protein in the diet was adequate at hospital and rehabilitation stay according to NNR recommendation of 15 - 20 E% protein for the elderly (>65 y) [1]. However, NNR emphasizes that at low energy intakes, below 1900 kcal/d, the protein E% should be further increased [1]. The high E% from protein in hospital and rehabilitation implies good meal planning at institution level, since the recommended protein E% for planning purposes in the elderly is 18 % [1]. It seems likely that the challenge is to get the patients to eat *enough* food, not necessarily a different balance between macronutrients in the meals being served.

Protein recommendations for the elderly have until recently been based on findings on N-balance, and have to a large extent concluded that adults and elderly have the same RDA. Recently this knowledge was put to test, and both ESPEN and NNR have now published that a higher protein intake should be recommended for the elderly, although some of the studies lack sufficient power to draw firm conclusions [49, 55, 101]. ESPEN also provided protein requirement for older adults with acute or chronic illnesses. They emphasised that elderly with inflammatory conditions can benefit from increased dietary protein intake, but further research is needed to identify and develop tools that can precisely define protein need in older sick individuals [49]. Hip fractures are associated with a development of an inflammatory response, but huge individual differences are found in inflammatory state, between individuals and time periods. Hence, there is probably massive variation regarding protein requirements in sick individuals, and the selected value for protein recommendation in this and other studies must be regarded as rough estimates.

4.3 Weight development

Weight loss in the elderly is associated with poor outcomes and increased mortality. Therefore, it was worrying that a third of the patients lost more than 5 % of body weight from hospital to home (median 9.5 weeks). A study from the UK reported that 24 % of the hip fracture patients had lost over 5 % body weight after eight weeks [102]. There was a

significant weight loss from hospital to rehabilitation of median 2.9 kg ($p = 0.048$), which corresponds to a decrease of 3.7 % of body weight ($p = 0.158$). It is stated that small weight losses, e.i 1 kg or 3% of body weight may be clinically important in frail elderly [65]. An unintentional weight loss of 4% - 5% of body weight within *one year* is associated with increased mortality and progressive disability [65]. The weight loss observed in the present study, although not all statistically significant, should therefore not be ignored.

4.4 Nutritional risk and nutritional status

The nutritional screening in the present study found that 80 % of the patients were in nutritional risk as measured during rehabilitation. This is by far a higher prevalence than in the general patient population in Haukeland University Hospital, were 35 % was in nutritional risk [6]. Although, these numbers are not directly comparable as we conducted the screening after hospital stay and have therefore included any consequences from disease state, while Tangvik et al. would capture any nutritional risk from before admission to hospital. Also, we did not conduct the whole screening as validated by ESPEN [5, 58]. Rather we used the first four questions of the NRS 2002 as proposed by Tangvik et al. They found that the four initial questions identified all the patients at nutritional risk in Haukeland University Hospital as compared to the more complex scoring questions of the complete NRS 2002. They concluded that this way of conducting nutritional risk will robustly identify nutritional risk and are a strong predictor of morbidity and mortality [6]. It is anyway a concern that 80 % of hip fracture patients are in nutritional risk after hospitalisation for a hip fracture.

The differences between the nutritional risk and non-risk groups are not significant due to small sample sizes (Table 6), but they are presented to suggest further research and to describe a possible pattern. The higher ratio of men in the non-risk group can probably explain some of the apparently big differences between groups.

Handgrip strength at 9.5 weeks post surgery was almost perfectly correlated to FFM in the present study, and is found to correlate well with overall muscle strength [80]. Handgrip strength for the men in the present study was not within the confidence interval for healthy men in the same age-interval [103], while the handgrip strength for the women were within their confidence limits [81]. Both handgrip strength and quadriceps strength in the present study had correlations related to energy intake, suggesting that patients with the highest

energy intake were the strongest. Also, strength measurements had apparent positive associations with PA, which could strengthen the theory that PA is a marker of overall health and nutritional status.

The present study did not find any association between LOS and nutritional status as is found in other studies [57, 76, 88]. There was a big difference between LOS in the present study (median 6 days) compared to other Scandinavian and American studies who found 13, 14 and 15 days, respectively [22, 23, 104]. As most patients in the present study were not sent directly home but to a rehabilitation stay for further care, it might be logical that nutritional status did not affect LOS at hospital.

PA as a measure of overall health and nutritional status in increasingly recognized [105]. It was recently found to have negative relationship to LOS [76], although this was not prominent in the present study. We found a PA comparable to the reference values for the healthy elderly population [72], and one in seven women and one in three men were categorized as having low PA as presented by Kyle et al [78]. We found no differences in PA in patients with and without nutritional risk. It has to be noticed that other authors have questioned the use of the PA in the elderly, as it would merely reflect hydration level as high body cell mass. This would fit with our finding of an apparently high, although insignificant association between PA and percent weight loss, which could indicate that patients with the greatest weight loss had the highest PA. [70]. We assume that the reason for the high PA in patients with the greatest weight loss in the present study is explained by hydration level and chance, not necessarily by overall health and nutritional status.

4.5 Methodological considerations

4.5.1 Study strengths

Hip fracture patients in the present study were thoroughly monitored during the acute and vulnerable phases after surgery. A longitudinal study during the acute and rehabilitation phase after a hip fracture has to our knowledge not been conducted in Norway until now, and it is important to perform such a study among different populations as the procedure for hospital and any rehabilitation stay for hip fracture patients vary between countries. We collected energy and protein intake and weight at three different phases, to compare and describe the development regarding these variables.

4.5.2 Statistical analysis

As most of the data were not normally distributed, non-parametric tests were used in statistical analyses. Non-parametric tests are robust and handle extreme values well. On the other hand, they are not as sensitive as parametric tests, and the probability to detect marginal differences between data are thus lower. In general, non-parametric tests should not be used for dietary data as these are seldom normally distributed [106]. The dataset for the study contains a lot of missing data, due to high drop out rates. Thus, there was varying number of patients at each visit. After consulting a statistician, we decided not to conduct imputation of missing data since too many missing values would have had to be compensated for.

4.5.3 Study sample and drop out rate

We did not include patients with mental impairment, patients living in nursing homes, patients with previous hip fracture and who previously needed walking aids, which is a patient group in which other studies found even higher mortality and worse nutritional status than in healthier hip fracture patients [18, 107]. The dropout rate of 45 % (20 out of 42) is similar to what is found in studies on the same patient group, with dropout numbers at 47 % and 56 % [108, 109]. In the present study, patients who dropped out were apparently older and had lower energy intake at hospital than the patients who conducted more than one visit. It was reported that dropouts in a study of hip fracture patients were on average 5 years older, had a higher proportion of patients living alone and who used walking aids indoors [108]. It is reasonable to assume that the general health status of patients with hip fracture might be considerably worse than our findings would indicate, and that the dropout group is in worse physical condition than the remaining patient group.

The present study had a relatively low number of patients. With a small n, any change in or difference between groups is hard to detect. A type II error occurs when found no effect in the population, when in reality, it is. The probability of this error (the β-level) increases when the number of patients is low [110]. Although we did not perform a formal power calculation before the study, due to the lack of reliable data, a post-hoc power calculation revealed that we would have needed 30 patients to detect a weight change of 3 % (assuming a SD of 5 %), or 80 patients to detect a change in BMI of one unit (kg/m^2) (assuming a SD of 4 kg/m^2). This explains the lack of statistical significance in our study.

4.5.4 Energy and protein intake

The 24 h recall is normally carried out several times in order to capture a person's diet. It is generally accepted that three 24 h recalls is optimal for estimating long-term energy intake [111]. This was however not our intention, we wanted to collect data regarding energy intake at three different stages after hip fracture surgery. Questions can therefore be asked regarding using the 24 h recall for our purpose, however, assessment methods that would demand more effort from the patients were unacceptable for this patient group. Some of the patients expressed that they had trouble remembering their food intake the previous day due to the difficulty of distinguishing one day from another at the hospital. The recommended method for monitoring energy intake in hospitalised patients is the staff administered dietary record [112]. However, we wanted to compare all collections, and therefore chose to use the same assessment method at all visits.

There was a strong apparent association between the number of days after surgery the first visit was conducted, and energy intake, for men ($r = 0.794$, $p = 0.059$). This finding could suggest that the energy intake increases during the hospital stay as is found in other studies [23, 24], and could add doubt to our method for only conducting one 24-h recall during hospital stay. The estimated weight change from calculations found a weight loss in the present study, although not as big as the actual weight loss. This calculation confirms that the energy intake estimated by *one* 24 h recall and the estimated energy expenditure at hospital predicts a weight loss in the present population, and also provides an argument that energy intake maybe did not increase much during hospital stay in the present study. As the actual weight loss was higher than the theoretical estimate, closer monitoring during hospital stay and rehabilitation stay is encouraged.

4.5.5 Weight and anthropometric data

The patients were rarely weighted at admission to hospital and it was too painful for some patients to rise from the bed for weighting at the time of visit. For these patients self-reported weight was collected, and for elderly as for all age groups weight is often over-estimated or under-estimated [113]. Patients with self-reported weigh at hospital were included in the weight calculations as the patient number were quite low, and this could be a limitation of the study as we would not know whether these patients weight loss were true or not. However, the median weight loss appeared to be the same between the groups of self-reported and

weighted patients at the hospital; - 3 kg and -2.8 kg (p = 0.947) between hospital and rehabilitation, respectively. Between hospital and home, median weight loss was -2.1 kg in the group that self-reported weight at hospital, and -2.3 kg in the weighted group at hospital (p = 0.644). As the weight loss between groups were similar, it could imply that the weight loss of those who self-reported weight at hospital is actually true.

Also, the data collected of triceps skinfold and MUAC at hospital could be unreliable since most patients were bedridden, and the manufacturers guidelines points out that patients should be standing for these measures. Therefore, these data has not been paid much attention.

4.5.6 Further research

Further research should aim to include a sufficient amount of hip fracture patients to be able to detect any significant changes between visits, and differences between groups. Also, hip fracture patients could be investigated thoroughly for a longer time (e.g 6 months) to see whether the acute adverse outcomes after a hip fracture are continuing, plateauing or decreasing. Further research should aim to find a reliable measure of body composition to investigate any changes in FFM, and include a more exact way of determining energy expenditure. When the acute and rehabilitation phase are better mapped, interventions should be initiated to decrease the gap between energy / protein intake and requirement. Energy and protein intake and weight development should be monitored of all hip fracture patients, not only those who were healthy before the fracture to get more representative data. The optimal energy and protein requirement for this population requires further research is necessary.

4.6 Conclusion

In conclusion, energy and protein intake was very low in hospitalised hip fracture patients, and remained sub-optimal during rehabilitation and after returning home. A significant weight loss and a high number of patients in nutritional risk, suggest that the patients in the present study experienced a critical phase, and this issue should be investigated further

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Appendix 1

HELSE BERGEN
Haukeland universitetssjukehus

Forespørsel om deltakelse i forskningsprosjektet

"Helseeffekt av fisk- eller kjøttinntak hos eldre hoftebruddspasienter"

Bakgrunn og hensikt
Dette er et spørsmål til deg om å delta i en forskningsstudie for å se på helseeffekten av å spise fisk eller kjøtt etter at man har hatt et hoftebrudd, og du har nylig hatt et slikt brudd. Vi er spesielt interessert i å se på det som har med din helse og funksjon å gjøre, for eksempel hvilke sammenheng det er mellom det du spiser og din muskelmasse. Klinisk institutt ved Universitetet i Bergen i samarbeid med Haukeland Universitetssykehus er ansvarlig for studien.

Hva innebærer studien?
Deltagelse i studien innebærer at du blir valgt ut til og enten spise fisk eller kjøtt 4 ganger pr uke i 16 uker. Råvarene til middag og fisk/kjøtt som pålegg vil bli levert hjem til deg. Ved studiens start, underveis og i slutten vil vi ta noen målinger av deg, blant annet blodprøver, vekt, høyde og blodtrykk. Vi vil gjøre analyser av gener (genetiske varianter) som kan ha sammenheng med hoftebrudd og proteininntak. Vi vil også teste din muskelmasse og muskelstyrke. Dette gjøres ved hjelp av enkle øvelser, et spørreskjema og bioelektrisk impedansemåling. Det siste er en metode hvor to elektroder festes til hver fot og hånd. Du vil ikke kjenne noe under denne undersøkelsen. Hvis du har pacemaker/defibrillator kan du ikke gjennomgå denne delen av undersøkelsen. Vi vil også intervjue deg ang ditt matinntak siste døgnet og om hvordan matlysten din har vært siste tiden. Vi vil også reise hjem til deg eller ringe ukentlig underveis i studien, både for å bringe deg mat og for å høre hvordan det går med deg. Vi er spesielt opptatt av om du har falt siste uke og om du klarer å spise maten du har fått av oss.

Hvis du samtykker til å delta i studien ønsker vi å registrere opplysninger om deg som rutinemessig samles inn i forbindelse med ditt sykehus- og rehabiliteringsopphold. De fleste opplysninger vil være tilgjengelig fra din sykehusjournal, men vi ønsker også å benytte

opplysninger fra Nasjonalt hoftebruddsregister angående din selvrapporterte livskvalitet.

Mulige fordeler og ulemper
Du vil få fisk eller kjøtt tilsvarende to middagsporsjoner og pålegg til brødmåltider pr uke levert hjem til deg. Du må selv tilberedet to middager pr uke av disse råvarene. Hvis du havner i kjøttgruppen, har du lov å spise fisk til middag en gang per uke, men ikke oftere. Hvis du havner i fiskegruppen har du lovt til å spise fisk til middag en gang til middag utover de to fiskemåltidene du får av oss. Hvilken gruppe du havner i, blir tilfeldig og kan ikke påvirkes av oss eller deg.

Hva skjer med prøvene og informasjonen om deg?
Prøvene tatt av deg og informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. Alle opplysningene og prøvene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger og prøver gjennom en navneliste som er hold hemmelig og innelåst.

Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som kan finne tilbake til deg. Etter studieslutt i januar 2020, vil informasjonen om deg avidentifiseres. Prøvene vi har tatt av deg og opplysninger fra intervjuer og sykehusopphold vil med din tillatelse bli oppbevart i en biobank. Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres eller blir offentliggjort på andre måter.

Frivillig deltakelse
Det er frivillig å delta i studien. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta i studien. Dette vil ikke få konsekvenser for din videre behandling. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke uten at det påvirker din øvrige behandling. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du kontakte Professor **Jutta Dierkes** eller klinisk ernæringsfysiolog **Hanne Rosendahl Gjessing** på telefon 55973085 (mellom kl 8-15.30).

Ytterligere informasjon om studien finner du på neste side. Deretter følger informasjon om biobank, personvern og forsikring.

Samtykkeerklæring finner du på siste siden, og den må du signere for å delta i studien.

Utfyllende informasjon om studien

Kriterier for deltakelse
    - Over 65 år og innlagt for første hoftebrudd
    - Bor hjemme før hoftebruddet
    - Kunne gå uten hjelpemiddel før hoftebruddet
    - Kunne signere et informert samtykke
- Bakgrunnsinformasjon om studien
    - Hensikten med studien er å undersøke om fisk- eller kjøttinntak påvirker helsen etter et hoftebrudd. Spesielt ønsker vi å undersøke endringer i muskelmasse og funksjon etter bruddet.
- Følgende undersøkelser du må gjennom i studien: blodprøver, urinprøve, veiing, måling av høyde (eller tilsvarende), gripestyrke, kneekstensjon, måling av muskelmasse vha bioimpendansemåling, hudfoldsmåling, kostholdsintervju og intervju ang din vektutvikling og matinntak
- Tidsskjema – hva skjer og når skjer det?
    - Under sykehusoppholdet
        - Signere samtykket og bli inkludert i studien
    - Når du er på rehabiliteringsopphold
        - For noen deltakere: en prosjektmedarbeider vil ta ekstra blodprøver og intervjue deg om ditt kosthold under rehabiliteringsoppholdet
        - Vi kontakter deg når du har kommet hjem fra oppholdet, 3-8 uker etter utskrivelse fra sykehus
    - Når du kommer hjem og 16 uker deretter
        - Studien starter, og du vil gjennomgå alle tester som nevnt og starte og spise fisk/kjøtt i 16 uker. For noen pasienter vil det bli tatt blodprøve og kostholdsintervju etter 4 uker. For alle vil det bli gjort nye tester etter 16 uker.
- Mulige fordeler
    - Du vil få gratis fisk eller kjøtt til middag 2 ganger og pålegg til to måltider pr uke i 16 uker
- Mulige ubehag/ulemper
    - Du må ta ekstra blodprøver i tillegg til de du tar når du er innlagt

    - Du må tilbedre middag av råvarene du får hjem til deg 2 ganger pr uke
- Pasientens ansvar
    - At du spiser maten som avtalt ved studiestart
- Pasienten vil bli orientert så raskt som mulig dersom ny informasjon blir tilgjengelig som kan påvirke pasientens villighet til å delta i studien
- Pasienten skal opplyses om mulige beslutninger/situasjoner som gjør at deres deltagelse i studien kan bli avsluttet tidligere enn planlagt

Personvern, biobank, økonomi og forsikring

Personvern

Opplysninger som registreres om deg er helseopplysninger fra din journal på Haukeland Universitetetssykehus eller Haraldsplass Diakonale sykehus. I tillegg vil vi innhente informasjon om følgende: vekt, høyde, blodtrykk, blodprøver, urinprøver, fysisk funksjon, kosthold, kroppssammensetning.

Universitetet i Bergen ved administrerende direktør er databehandlingsansvarlig.

Utlevering av materiale og opplysninger til andre

Hvis du sier ja til å delta i studien, gir du også ditt samtykke til at prøver og avidentifiserte opplysninger utleveres til samarbeidende universiteter i EU og USA**.** Dette kan være land med lover som ikke tilfredsstiller europeisk personvernlovgivning.

Biobank

Blod- og urinprøvene vil med din tillatelse bli lagret i en forskningsbiobank ved Hormonlaboratoriet, Haukeland Universitetssykehuset. Hvis du ikke vil delta i denne studien kan du allikevel samtykke til at vi lagrer det biologiske materialet i en biobanken. Informasjon om forskningsprosjekter det biologiske materialet en gang kan benyttes i vil du finne på følgende internettside: http://www.helse-

bergen.no/omoss/avdelinger/hormonlaboratoriet/Sider/forskning-og-utvikling.aspx. Du kan også få utdelt skriftlig informasjon om biobanken. **Overlege/professor Gunnar Mellgren** er ansvarshavende for forskningsbiobanken. Det biologiske materialet kan bare brukes etter godkjenning fra Regional komité for medisinsk og helsefaglig forskningsetikk (REK).

Rett til innsyn og sletting av opplysninger om deg og sletting av prøver
Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra studien, kan du kreve å få slettet innsamlede prøver og opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Økonomi
Studien og biobanken er finansiert gjennom forskningsmidler fra **Fiskeri- og havbruksnæringens forskningsfond (FHF)**. FHF har ingen innflytelse på det vitenskapelige oppsettet, tolking eller publisering av resultatene fra studien.

Forsikring
Ved deltagelse i studien eller hvis du bidrar til biobanken, har du rettigheter i forhold til Pasientskadeerstatningsloven.

Informasjon om utfallet av studien
Som deltager i studien har du rett til å få informasjon om resultatet av studien.

Samtykke til deltakelse i studien og/eller biobank

- ☐ Jeg er villig til å delta i studien
- ☐ Jeg er villig til at biologisk materiell lagres i en biobank
- ☐ Jeg er villig til å delta i studien og at det lagres biologisk materiell og datamateriell i en biobank

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(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)

Appendix 2

Time	Type of meal	Quantity/ number of servings	Foods	Drinks

24 h recall interview-guide, based on Gibsons: **Principles of nutritional assessment**

STEPS:
1. An overview list of all foods and beverages consumed the preceding day

2. A more detailed description of each food and beverage consumed, including cooking methods and brand names if possible. Detailed question of e.g. what kind of milk, type of bread…

3. Estimate the amount of food and beverage consumed, household measurements are OK. If food is made, gather information on the ingredients.

4. Review the recall to ensure that all items, including use of vitamin and mineral supplements. Ask control questions about foods that normally are forgotten: crisps, fruit, cookies, chocolate, nuts etc.

Appendix 3

God ernæringspraksis

Retningslinjer for
ernæringsbehandling
i Helse Bergen HF

Forord

Mat og helse henger nøye sammen. I Helse Bergen har vi utviklet en ernæringsstrategi som vi mener vil være en viktig del av behandlingen.

Når pasientene er innlagt hos oss, er det derfor viktig at de screenes / vurderes med hensyn til ernæringsstatus. På den måten kan vi identifisere de pasientene som er i en ernæringsmessig risiko slik at de kan få den ernæring og behandling de trenger.

Det er derfor utviklet retningslinjer for screening av pasienter og vi har et screeningverktøy som vil være et godt hjelpemiddel.
Det er ønskelig at screeningen skjer når pasientene legges inn, slik at en eventuell ernæringsbehandling kommer i gang så tidlig som mulig og kan integreres i den helhetlige behandlingen.

Det forventes at de faglige retningslinjene følges. Ved å gjøre det, oppfylles kravet om faglig forsvarlighet i lovverket.
Dersom noen av en eller annen grunn velger løsninger som i vesentlig grad avviker fra retningslinjene, må dette dokumenteres og det må gis en begrunnelse for det valget som er tatt.

Ledelsen i Helse Bergen legger stor vekt på ernæringsstrategien og de positive virkningene den har for pasientene våre. Jeg håper og tror at alle ansatte vil følge opp strategien og de føringene som legges i de retningslinjene som er utarbeidet.

Stener Kvinnsland
Administrerende direktør

”God ernæringspraksis. Retningslinjer for ernæringsbehandling i Helse Bergen HF” er utarbeidet på oppdrag fra Ernæringsrådet i Helse Bergen av:

Leder: Anne Berit Guttormsen, overlege, dr. philos Intensivavd
Berit Falk Dracup, klinisk ernæringsfysiolog, sjef for Avdeling for klinisk ernæring
Lene Botnen Huus, sykepleier, Kir Avd
Borghild Ljøkjell, lege, ØNH
Rune Svensen, overlege, Kir Avd
Randi J Tangvik, klinisk ernæringsfysiolog/ernæringskoordinator FoU-Avd (sekretær)

Høringsinstans:
Nivå-2-lederne for kliniske avdelinger i Helse Bergen HF
Ernæringsfaglederne i Helse Bergen
Avdeling for klinisk ernæring Helse Bergen
Avdeling for klinisk ernæring Helse Stavanger
Seksjonsoverlege Hans Flaatten, Helse Bergen

Retningslinjene ble vedtatt av Foretaksledelsen 24.april 2007.

Bakgrunn

Forskning viser med stor tyngde at en forbedret ernæringsbehandling

1. Kan forbedre og hindre reduksjon i mental og fysisk helse.
2. Kan redusere antall komplikasjoner som følge av sykdom og behandling.
3. Kan redusere rekonvalesenstiden.
4. Kan forkorte liggetiden på sykehuset og redusere behovet for primærhelsetjenester.

Det er mange årsaker til sykdomsrelatert underernæring, men redusert matinntak synes å være en klar hovedårsak.

Alle pasienter som innlegges i Helse Bergen skal screenes i forhold til ernæringsmessig risiko. Som screeningverktøy anbefales NRS 2002 (Nutritional Risk Screening), i norsk oversettelse "God ernæringspraksis – vurdering av ernæringsmessig risiko". Dette er enkelt i bruk, det innbefatter høyde, vekt og tar hensyn både til ernæring og stressmetabolisme.

Primærscreeningen består av fire spørsmål som stilles opp ved innkomst til sykehuset, fortrinnsvis av sykepleier i innkomstsamtalen. Svarene avgjør om den grundigere hovedscreeningen skal utføres. Tiltak hos pasienter i ernæringsmessig risiko gjennomføres i et samarbeid mellom leger, sykepleiere og kliniske ernæringsfysiologer. Fokuser på måltidene, server tilstrekkelig antall måltider i et stimulerende spisemiljø. Berik maten til småspiste pasienter. Skjerm måltidet. Næringsdrikker brukes for å øke energitilførselen, men skal ikke erstatte måltidene.

Enteral ernæring tilføres via nasogastrisk sonde, PEG eller jejunumkateter i tilfeller hvor pasienten ikke ved egen hjelp kan ta til seg tilstrekkelig ernæring. Ved for liten energitilførsel enteralt suppleres med parenteral ernæring i de tilfeller hvor pasientens leveutsikter eller livskvalitet signifikant kan bedres av slik behandling.

Ernæringsbehandlingen skal sees i sammenheng med de fire etiske grunnprinsippene:

1. Beneficiens: Å gjøre godt, balansere nytte mot risiko
2. Non maleficiens: Å avstå fra å gjøre skade
3. Autonomi: Pasienten har rett til medbestemmelse og informert samtykke
4. Justis: Rettferdig fordeling av ressurser i forhold til nytte og risiko

Det grunnleggende mål for all behandling og omsorg, herunder oral, enteral eller parenteral ernæring må være at tiltakene alltid iverksettes i pasientens beste interesse, og at fordelene ved tiltakene oppveier både ulemper og risiko. Det vil oppstå situasjoner hvor det enten er etisk riktig å unnlate å starte en ernæringsbehandling, eller avslutte en allerede påbegynt behandling.

ICD10-koden E46-Protein- og energiunderernæring gis til pasienter i ernæringsmessig risiko (score ≥3) som har fått ernæringsbehandling under sykehusoppholdet.

1. Innledende screening

Innledende screening skal gjennomføres på alle pasienter.

		JA	NEI
1	Er BMI < 20,5?		
2	Har pasienten tapt vekt i løpet av de siste ukene?		
3	Har pasienten hatt redusert næringsinntak de siste ukene?		
4	Er pasienten alvorlig syk?		
JA: Dersom svaret er "JA" på ett eller flere av disse spørsmål, gjennomføres hovedscreening NEI: Dersom svaret er "NEI" på alle spørsmål, gjennomføres ny risikoscreening om én uke. NB! Resultatet av all screening skal dokumenteres i "God ernæringspraksis-journalark"			

Opplysningene innhentes på alle voksne pasienter ved innkomst i avdelingen. De skal føres i journalarket "God ernæringspraksis" av sykepleier eller lege og oppbevares tilgjengelig under hele innleggelsen i kurvebok. Ved utskriving skannes og lagres journalarket i Doculive kapittel F2.

Spørsmål 1 ("nå-situasjonen")

BMI (= Body mass index = KMI = kroppsmasseindeks) gir en rask vurdering av protein- og energistatus basert på individets høyde og vekt. Bestem høyde (mål høyde, se i journalen eller spør pasienten) og vei pasienten for å kalkulere BMI (kg/m^2), eller bruk BMI-tabell.

BMI < 18,5:	Lav protein/energistatus er sannsynlig
BMI 18,5 – 20,5:	Lav protein/energistatus er mulig
BMI > 20,5:	Lav protein/energistatus lite sannsynlig

Spørsmål 2 (stabil/ustabil tilstand?)

Vekttap: JA/NEI. Ufrivillig vekttap over en periode på 3-6 mnd er en mer akutt risikofaktor for underernæring enn BMI. Hvis vekten ikke er journalført, spør pasienten hva han/hun veide før de ble syke, eller for 3-6 mnd siden. Sammenlign dette med aktuell vekt.

Spørsmål 3. (vil situasjonen forverres?)

Spist lite: JA/NEI. Har pasienten spist mindre enn normalt de siste dagene/ukene før sykehusinnleggelsen? Har pasienten kostrestriksjoner som medfører et ensidig kosthold? Har pasienten svelgproblemer? Har pasienten redusert appetitt?

Spørsmål 4. (vil sykdomsprosessen akselerere situasjonen?)

Alvorlig syk: JA/NEI Har pasienten en kronisk sykdom eller en sykdom som sannsynligvis vil påvirke matinntaket? Skal pasienten gjennom et større kirurgisk inngrep eller få annen behandling som vil medføre redusert næringsinntak og økte behov?

Resultat av innledende screening:

Dersom svaret er JA på ett eller flere spørsmål, gå videre til hovedscreening
Dersom svaret er NEI på alle spørsmål, screeningen er ferdig, men skal repeteres om en uke, dersom pasienten fremdeles er inneliggende.

2. Hovedscreening

Gjennomføres hos pasienter som fyller minst ett av kriteriene i innledende screening.

1. Gi score:

Score	Ernæringstilstand	Score	Sykdommens alvorlighetsgrad
0	Normal ernæringstilstand	0	Ikke syk
1	Vekttap > 5 % siste 3 mnd eller Matinntak 50-75% av behov siste uke	1	Kronisk sykdom eller gjennomgått mindre kirurgisk inngrep
2	Vekttap > 5 % siste 2 mnd eller BMI = 18,5 – 20,5 + redusert allmenn-tilstand eller Matinntak 25-50% av behov siste uke	2	Tydelig redusert allmenntilstand pga sykdom
3	Vekttap > 5 % siste måned (> 15 % siste 3 mnd) eller BMI < 18,5 + redusert allmenntilstand eller Matinntak 0-25 % av behov siste uke	3	Alvorlig syk. Intensivpasient

Vekttap
Sammenlign aktuell vekt med tidligere vekt. Kalkuler sykdomsrelatert vekttap:

Prosent vekttap = vekttap i kg x 100/ opprinnelig vekt i kg

Vekttap < 5 % siste 3 mnd: Innenfor normalvariasjon
Vekttap > 5 % siste 3 mnd: Tidlig indikator på risiko for underernæring
Vekttap > 5 % siste 2 måneder: Klinisk signifikant vekttap

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2. Summér score:

Score for ernæringstilstand:	**0-3**
+ Score 1 for alder > 70 år:	**0-1**
+ Score for sykdommens alvorlighetsgrad:	**0-3**
= Risikoscore	**0-7**

Score 0-2: Pasienten er ikke i ernæringsmessig risiko. Dokumenter at screening er utført. Angi resultatet på journalarket for senere skanning til journal. **Gjenta** innledende screening etter 1 uke.

Score ≥ 3: Pasienten er i ernæringsmessig risiko. **Lag ernæringsplan**.

Hvis tvil om pasientens score, ernæringstilstand eller ernæringsbehov: **Henvis til klinisk ernæringsfysiolog.**

3. Ernæringsplan

1. Beregn kaloribehov: 30 kcal/kg/døgn

Modifikasjoner: Sengeliggende 29, oppegående 33, i oppbyggingsfase 40 (kcal/kg/døgn) (21).
Tilpass individuelt:

- Mager pasient: Øk med 10 %
- Alder 18-30 år: Øk med 10 %
- Alder > 70 år: Reduser med 10 %
- Overvektig: Reduser med 10 %
- Febril: Øk med 10 % for hver grad temperaturøkning

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2. Beregn væskebehov: 30 -(40) ml/kg/døgn

Ved feber, svette, diaré, oppkast, fistel/stomi/sårtap osv. må tapt væske erstattes.

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3. Sett mål

Målrettet ernæringsbehandling skal ha en start og en slutt.
Forsiktig oppstart: De fleste pasienter, og spesielt de som har spist lite den siste tiden, kan trenge gradvis opptrapping av næringsinntaket.
Stabil vekt eller vektøkning: Ved behov for vektøkning, sett også mål for når ønsket og realistisk vektøkning skal nås. Observer toleranse/komplikasjoner og vektutvikling for å avgjøre om planen kan følges eller må justeres.
"Energikick": Det kan være et mål at pasienten får i seg så mye næring som mulig under sykehusoppholdet, og at ernæringen seponeres ved utskrivning. Et høyt energiinntak noen dager gir bedre appetitt etter seponering, og kan bedre pasientens forutsetning for å klare seg selv etter utskrivning.
Hjemmeernæring: Vurder behovet for å videreføre ernæringsbehandlingen i hjemmet og forbered dette.

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4. Kartlegg og, om mulig, korriger faktorer som innvirker på matinntaket

Liten appetitt, kvalme, fort mett, smerter, svelgvansker, munnsårhet, fordøyelsesproblemer (diare, obstipasjon, gass, annet), maten smaker ikke/smaker annerledes, liker/liker ikke, dyspnoe osv.

Hva skal gis? Kosttilskudd, beriking eller kunstig ernæring?
Hvordan skal det gis? Peroralt, enteralt, parenteralt eller en kombinasjon?
Vurder behov for **opptrappingsplan.**

Vurder behov for **klinisk ernæringsfysiolog, logoped** (utredning av svelgevansker) **ergoterapeut** (tilrettelegging) eller en **egnet lege** for vurdering mtp parenteral ernæring.

5. Gi ICD10 diagnosekode: E46 Protein- og energiunderernæring

Kriterier: Ernæringsscore ≥3 og gjennomført ernæringsbehandling under sykehusoppholdet (beriket eller på annen måte tilpasset kosthold, systematisk bruk av næringsdrikker, sondeernæring, parenteral ernæringstilførsel, kombinasjoner, konsultasjon med klinisk ernæringsfysiolog).

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6. Henvis til klinisk ernæringsfysiolog og evt medisinsk spesialist

- Hvis sykdom eller symptomer tilsier behandling med terapeutisk diett
- Hvis pasienten har intoleranse/allergier som gjør det vanskelig å tilpasse sykehuskosten
- Hvis metabolske eller funksjonelle problemer hindrer bruk av standard ernæringsplan

4. Peroral ernæring

1. Spisemiljø

Sørg for frisk luft og ryddig spiseplass. La pasienten vaske hender og gjerne ansikt og hals før måltidet. Ivareta munnstell før og etter måltidet. Legg vekt på at maten skal se frisk og appetittlig ut. Legg på litt farge, f. eks appelsinskive, tomat, druer eller lignende. Ved dårlig appetitt tilbys små porsjoner, med mulighet for påfyll. Del opp store biter og hele skiver. Bestikk, glass og servise skal se pent ut, uten skjolder og høy slitasje.

2. Matomsorg

Vis omtanke og server maten på en hyggelig måte. Sørg for at maten ser innbydende ut. Tilby smaksforsterker (salt, krydder), alternativ mat eller spisehjelp hvis pasienten ikke vil/kan spise, og påfyll til de som har spist opp. Pasienter som ikke klarer å spise tilstrekkelig, kan trenge hjelp til å spise eller trenger annen tilrettelegging for å greie dette selv.

3. Normalkost

Gi pasienten rett type kost. Ta utgangspunkt i sykehusets normalkost og tilpass denne til pasientens ønsker og behov eller bestill **spesialkost**. Ved dysfagi/svelgproblemer, velg **konsistenstilpasset** kost (moset, flytende eller geleringskost), og vurder henvisning til logoped for utredning. Velg energi- og næringstett (EN-kost) kost til småspiste pasienter. Ved ulike former for kostrestriksjoner, bestill spesialdiett og vurder henvisning til klinisk ernæringsfysiolog.

Server tilstrekkelig antall måltider. Hvis pasienten spiser lite, er mellommåltider desto viktigere. Unngå nattlig faste over 11 timer. Vurder behov for tilskudd og beriking i form av energi, protein, mikronæringsstoffer eller annet. Ved tvil om inntaket er tilstrekkelig, gjennomføres kostregistrering.

4. Næringsdrikker

Når det er behov for næringsdrikk, skal den helst komme i tillegg til vanlig mat. Tilby først det vanlige måltidet og avslutt med næringsdrikk. Næringsdrikk gir et viktig tilskudd av energi og næringsstoffer. Se til at den blir drukket. Det er bedre å gi *litt* næringsdrikk i et glass framfor å sette fram hele pakningen dersom den likevel ikke drikkes opp. Velg en med høyt energiinnhold per ml. Velg en smak pasienten liker. Tilby evt flere smaker. Serveres godt avkjølt.

5. Kostregistrering

Hvis det er tvil om pasienten trenger støttebehandling i form av enteral eller parenteral ernæringsbehandling, gjennomføres kostregistrering for å skaffe dokumentasjon. Kostregistrering er en detaljert nedtegnelse av hva og hvor mye pasienten har spist i løpet av en dag. Dette må utføres nøyaktig og fullstendig for at det skal ha noen verdi. Bruk en lyntabell (fås hos Avdeling for klinisk ernæring) til å beregne energiinnholdet i maten. Vær oppmerksom på at både pasienten selv og ansatte ved avdelingen har en stor tendens til å overestimere pasientens inntak. Vurder derfor registreringen kritisk.

6. Henvis til klinisk ernæringsfysiolog

- Hvis det er tvil om hvilken mat pasienten skal tilbys
- Hvis det oppstår problemer med å få bestilt/levert riktig mat til pasienten
- Hvis det er behov for kostveiledning.

5. Enteral ernæring

Enteral ernæring forutsetter intakt mage-tarmkanal og brukes der peroralt inntak av en eller annen grunn ikke er mulig eller tilstrekkelig.

1. Administrasjonsveier

Nasogastrisk sonde ved behov for enteral ernæring i inntil 2-4 uker.

Nasojejunal sonde ved risiko for aspirasjon, f. eks ved gastroparese/ventrikkelretensjon, hyperemesis, etter abdominal kirurgi, kritisk syke.

Gastro- eller enterostomi ved behov for ernæring > 2-4 uker. Velg fortrinnsvis PEG (perkutan endoskopisk gastrostomi). Ved risiko for aspirasjon eller oppkast, velg PEJ (perkutan endoskopisk jejunostomi) eller JET-PEG (jejunaltube-PEG). Gi forebyggende råd om hudstell for å unngå infeksjon ved gastrostomiporten og behandling av granulasjonsvev (”villkjøtt”). Vurder henvisning til stomisykepleier.

Jejunumkateter (JK) legges inn peroperativt på pasienter i ernæringsmessig risiko som gjennomgår laparotomi.

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2. Valg av sondeløsning

Fullverdige ernæringsløsninger	**Innhold per 100 ml**	**Bruk**
Standard, med og uten fiber	100 kcal, 4 g protein	Kan brukes til de fleste. Fiber bedrer fordøyelsen og forebygger obstipasjon.
Energirik, med og uten fiber	150 (120-200) kcal, 6 (5,6 – 7,5) g protein	Væskerestriksjon eller forhøyet energibehov. Fiber bedrer fordøyelsen og forebygger obstipasjon.
Lavenergiløsninger	75 og 80 kcal	Redusert energibehov. NB: noen av løsningene har tilsvarende redusert nivå av mikronæringsstoffer
Komprimert	120 kcal, 5,5 g protein Forhøyet nivå av mikronæringsstoffer	Væskerestriksjon og redusert energibehov
Lavt elektrolyttnivå	25-100 mg Na, 50-180 mg K, 25-80 mg Cl,35-75 mg P	Aktuelt ved nyre-, lever-, hjertesvikt
Proteinrik	6-7,5 g protein	Forhøyet proteinbehov ved metabolsk stress, sårtilheling etc.
Peptidbasert med MCT	Proteinet er hydrolysert til peptider. Det finnes også en ren aminosyreløsning.	Malabsorpsjon, f.eks Mb Crohn eller korttarmsyndrom.
Andre spesialløsninger	Tilpasset ulike sykdommer	Intensiv: Tilsatt ekstra glutamin og n-3-fettsyrer Melkeintoleranse: Soyabasert Diabetes: Vanligvis velges standard sondeløsning med fiber, men det finnes spesialing som er energiredusert, fiberholdig og med langkjedede karbohydrater

		Liggesår: Det finnes sondeløssning beriket med protein, vit C og E, sink, selen, karotenoid og arginin for bedre sårtilheling Diaré/fettmalabsorpsjon: Sondeløsninger med MCT-fett for bedre absorpsjon.

3. Oppstart med sondeernæring

For effektiv ernæringsbehandling er det best å komme i gang så tidlig som mulig, og å komme opp i beregnet behov så rask som mulig. Gradvis tilvenning er likevel nødvendig, og toleranse må oppnås før opptrappingen fortsetter. Ernæringstilførsel v.hj av ernæringspumpe er å foretrekke.

Metode	Tid	Kommentar
Kontinuerlig	20-24 timer	Gir færre komplikasjoner, sjeldnere refluks, mindre magesmerter og diaré. Foretrekkes til de svært syke og de som har vært lenge uten mat i tarmen. En nattlig pause på 4 timer kan fremme bedre fordøyelse ettersom pH i magesekken normaliseres ila av denne tiden.
Periodisk	8-20 timer	Mer fleksibelt for pasienten,
Bolus	100-400 ml ila 10-30 min gjentatte ganger ila dagen	Til stabile pasienter. Ligner mest på ordinært måltidsmønster og kan være fysiologisk best. Hvis maten gis for fort eller i for store mengder kan det medføre diaré, magekrampe, kvalme, oppblåsthet og magesmerter.

Hvis sonden ligger i jejunum, kan kontinuerlig tilførsel med pumpe redusere grad av diare og aspirasjon.

Ved å heve sengens hodeende til 30-45 grader under sondetilførselen kan risikoen for aspirasjon reduseres.

Maten bør ikke fortynnes ved oppstart. Dette kan forsinke begynnelsen på en positiv nitrogenbalanse og kan se ut til å øke forekomsten av diare, krampe og ubehag.

Infusjonshastigheten kan økes raskt til ønsket hastighet. Begynn med infusjonshastighet 25 ml/time de første 8 timer. Dersom pasienten tåler, dette øk med 25 ml/time hver 8. time til maksimalt 150 ml/time. Husk å skylle sonden med 30 ml vann før oppstart og ca hver 8 time.

4. Komplikasjoner

Feilplassert sonde: Er man usikker på riktig plassering av sonde, bør dette kontrolleres med røntgen.
Sår: Bruk tynne, myke sonder i vevsvennlig materiale for å unngå mekaniske sår.
Okklusjon av sonde: Ved kontinuerlig tilførsel kan det også være nødvendig å ta en pause for å skylle sonden etter 6-8 timer. Unngå bruk mandreng til å åpne tett sonde pga av faren for perforasjon.
Refeeding syndrome med hypofosfatemi, hypomagnesemi, hypokalemi, tiaminmangel og væskeretensjon. Ernæringsterapi trappes opp langsomt hos pasienter som ikke har hatt adekvat ernæringstilførsel over lengre tid. Korriger elektrolyttene og gi tiamintilskudd: 250 mg intramuskulært pr dag i 2 dager, deretter 100 mg tablett per os under sykehusoppholdet.
Overfeeding syndrom med CO2-retensjon og feber skyldes for høy kaloritilførsel.
Aspirasjon kan unngås ved å legge sonden ned i tynntarmen og gi kontinuerlig næringstilførsel. Pasientens overkropp heves til 30-45 grader under og i en time etter infusjonen.

Oppkast: Reduser eller stans næringstilførselen. Undersøk grunn til oppkast, og gjenoppta når den er behandlet.
Diare ved for rask infusjonshastighet og næring gitt i bolus. Vurder Loperamid. Noen har god effekt av Biola 100 ml x2/dag etter antibiotikabehandling.
Kontaminasjon. Sondeløsninger kan henge i opptil 24 timer. Sonden gjennomskylles med vann etter avsluttet tilførsel. Tilførselssettet skiftes en gang i døgnet.
Intoleranse: Alle sondeløsninger er gluten- og klinisk laktosefrie. Spor av laktose kan forekomme i løsninger med melkeprotein, men det er svært sjelden at noen reagerer på så små mengder. Sondeløsninger tilsatt glutamin kan inneholde spor av gluten, men i så små mengder at cøliakere som tåler vanlig glutenfri kost kan få disse.
Oppblåsthet og følelse av metthet forekommer når pasienten får for mye sondeløsning, når sondeløsningen gis i for høyt tempo eller det gis for mye fiber. Reduser volum, øk tiden det gis på og introduser fiberløsninger gradvis.

6. Parenteral ernæring

Parenteral ernæring er, med få unntak (17-20), indisert der næringsinntaket per os eller enteralt er utilstrekkelig eller der det foreligger ikke-fungerende mage-tarmkanal.

1. Administrasjonsveier

Perifer venekanyle ved forventet parenteral ernæring < 1 uke med gode perifere vener. Tynn kanyle (rosa 1,0 -1,1 mm) legges i en stor vene. Innstikksstedet inspiseres x 1-2/dag, veneflonen skiftes minimum hvert 2. døgn og ved tegn til tromboflebitt. Unngå løsninger med osmolalitet > 1000 mOsmol/kg. Eksempel: Oliclinomel N4 550 E.
Sentralvenøst kateter brukes ved forventet parenteral ernæring > 1 uke og der man ønsker å gi mer konsentrerte løsninger enn f eks Oliclinomel N4 550 E.

2. Parenterale løsninger

Parenteral ernæring gis oftest som storposer hvor glukose, fett og aminosyrer blandes umiddelbart før bruk. På det norske markedet er det tilgjengelig storposer fra ulike firma; Baxter, Braun og Fresenius Kabi. **Storposer skal alltid tilsettes vitaminer og sporstoffer**.

3. Tilsetninger

Fettløselige vitaminer: Vitalipid, normalt døgnbehov: 1 hetteglass.
Vannløselige vitaminer: Soluvit, normalt døgnbehov: 1 hetteglass
Blanding med både fett- og vannløselige vitaminer: Cernevit, normalt døgnbehov 1 hetteglass.
NB: Cernevit inneholder ikke vitamin K.
Vitamin K (Konakion): Vurdér ukentlig tilførsel.
Sporstoffer: Tracel, normalt døgnbehov: 1 hetteglass.

4. Spesielle behov

Til pasienter med spesielle behov finnes forskjellige løsninger med glukose, aminosyrer og fett. Disse benyttes i Sykehusapotekets produksjon av egne "storposer" tilpasset den enkelte pasient. Kfr Metodebok for Intensivmedisinsk seksjon: http://innsiden.helse-bergen.no/enhet/ksk/metode/
Eksempler: Ved respirasjonssvikt med CO2 retensjon reduseres mengden karbohydrat. Ved nyresvikt gis redusert protein- og elektrolyttmengde, men energirik. Til intensivpasienter: Glutamin gir bedre resultat**.** Ved leversvikt er forgrenede aminosyrer aktuelt.

5. Praktisk gjennomføring

Parenteral ernæring startes når pasienten er stabil. Løsninger bestilles fra Sykehusapoteket på eget skjema. **Den parenterale ernæringsløsningen skal alltid tilsettes vitaminer og sporstoffer.**
I noen tilfeller vil det være aktuelt å tilsette ekstra elektrolytter. Vær spesielt oppmerksom på økt behov for fosfat, kalium og magnesium.

6. Komplikasjoner

Mangeltilstander på grunn av mangelfull tilførsel av vann- og fettløslige vitaminer og sporstoffer. Endring i leverfunksjon med forhøyede transaminaser og bilirubin (stasemønster). Hyperosmolaritet. Forhøyede triglyserider. Forhøyet blodsukker. Refeeding syndrom. Overfeedingsyndrom. Komplikasjoner til venekateter og kanyle (22).

7. Monitorering

Ernæringsbehandlingen monitoreres kontinuerlig ut fra:

1: Mengden som er gitt
2: Effekt av behandlingen
3: Toleranse

Vurderingen dokumenteres i journalen.

Vekt: Pasienter innlagt i sykehus bør veies ukentlig, og noen to ganger/uke.

Følg blodprøver. Dette er spesielt viktig når hovedmengden av ernæringen gis intravenøst.

Forslag til blodprøveovervåking:

Parameter	X 2/dag	X 1/dag	X 2/uke	X 1/uke	X1/md
Glu, K, fosfat, laktat	akutt	stabil	langtid		
Na, Cl, Ca, Mg, TG, Kreatinin, karbamid		akutt	stabil	langtid	
INR, ASAT, ALAT, ALP, bilirubin, ammoniakk, amylase			akutt	langtid	
Total protein, transferrin, prealbumin			akutt	stabil	langtid
Sporstoffer					langtid
Vitaminer					langtid
Urinanalyse (obs glukose!)		akutt	stabil		langtid

8. Hjemmeernæring

Ernæringsbehandling kan foregå i hjemmet etter at pasient er utskrevet fra sykehuset. Rikstrygdeverket dekker ernæringsløsningene etter søknad, og Helse Bergen dekker nødvendig forbruksmateriell.

- Lege fyller ut "Nasjonalt skjema for behandlingshjelpemidler 2004" som lastes ned fra www.behandlingshjelpemidler.no Husk å føre opp diagnose og om det er behov for tilleggsutstyr som pumpe, ryggsekk eller stativ. Sykehuset har avtale med Fresenius Kabi på Applix Smart ernæringspumpe. Hver pumpe har et registreringsnummer og skal regelmessig kontrolleres og valideres av Medisinsk teknisk avdeling (MTA). Pumpene oppbevares hos MTA.
- Fyll ut skjemaet " Bestilling av forbruksmateriell til hjemmeernæring" som fås fra Seksjon for behandlingshjelpemidler, tlf 7-3896.
- Begge skjemaene sendes til Seksjon for behandlingshjelpemidler via internposten. Seksjon for behandlingshjelpemidler holder til i Møllendalsveien 1.
- Pasienter får med skjemaet "Anskaffelse av utstyr til hjemmeernæring", og ringer selv når han/hun trenger påfyll av forbruksmateriell.
- Lege må skrive resept på sondeløsning eller Oliclinomel, klorhexidin og NaCl.
  - Rtv-blankett 2.16 E må sendes Bergen trygdekontor (denne finnes i Doculive: somatisk dokument-lege-j1).

9. Referanser

Retningslinjene er utarbeidet med bakgrunn i følgende retningslinjer:

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Lov om helsepersonell §4. Forsvarlighet og §5. Øyeblikkelig hjelp §39 journalføring.

Lov om spesialisthelsetjeneste §1-1. Lovens formål, § 2-3 Plikt til forsvarlighet.

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Statens ernæringsråds retningslinjer for kostholdet i helseinstitusjoner: Universitetsforlaget; 1995.

Stratton R GC, Elia M. Disease related malnutrition: an evidence-based approach to treatment. Wallingford, Oxon, UK: CAB international publishing; 2003.

Waitzberg DL, Saito H, Plank LD, Jamieson GG, Jagannath P, Hwang TL, et al. Postsurgical infections are reduced with specialized nutrition support. World J Surg 2006; 30: 1592-604.

Appendix 4

Pasient: Dato:

Kjønn:	Kvinne:		Mann:	
KMI (vekt/høyde^2):	Vekt:	Høyde:		
	Hvis ikke høyde kan måles:			
	Knehøyde:	Armspenn:		
	Kommentarer/avvik ved måling:			
Midjemål (cm):				
Ernæringsscreening:	Er KMI > 20,5 Ja^0/nei^1 Har pasienten tapt vekt i løpet av siste ukene? Ja^0/nei^1 Har pasienten hatt redusert næringsinntak de siste ukene? Ja^0/nei^1 Er pasienten alvorlig syk? Ja^0/nei^1			
Normal ernæringsstatus (0 poeng)	Normal ernæringsstatus:		Frisk:	
1 poeng	Vekttap 5-10% siste 3 mnd. Matinntak 50-75% av behovet i mer enn en uke:		Kronisk sykdom eller mindre kirurgisk inngrep (hoftebrudd, KOLS Leverchirrose, kreft)	
2 poeng	Vekttap 10-15% siste 3 mnd. KMI 18.5-20.5 Matinntak 25-50% av behov i mer enn en uke:		Større operasjoner i magen, alvorlig lungebetennelse, akutt nyresvikt og gjentatte operasjoner:	
3 poeng	Vekttap > 15% siste 3 mnd. KMI < 18.5 Matinntak 0-25 % av behov i mer enn en uke:		Intensivpasienter, alvorlig blodforgiftning store hodeskader:	
Over 70 år (1 ekstrapoeng)	Ja/nei			
Sum hovedscreening	Under 3 poeng:		Over 3 poeng:	
Bioimpedansemåling:	Resistans Hø.s. Ve.s	Reactans Hø.s Ve.s.	Phase angle Hø.s Ve.s	Impedance Hø.s V.s

Pasient: Dato:

Gripestyrke (kg)	Venstre hånd Høyre hånd: 1. 2. 3. 1. 2. 3.
Kneekstensjon (N) på siden uten brudd	1. 2. 3.
MUAMC (Muskler i høyre overarm)	Omkrets av høyre overarm, målt midt mellom skulder og albue: cm Underhudsfett over tricepsmuskel: 1. 2. Beregnet muskelmasse i armen: 1. 2. Underhudsfett over biceps: 1. 2.
Blodtrykk (mmHg)	1. 2. 3.
Kosttilskudd	1. 2. 3. 4.
Medikamenter	1. 4. 2. 5. 3. 6. Annet:
Alkohol (enheter pr uke)	Daglig: 1-2 x pr uke: < 1x pr uke: < 1x pr mnd aldri: Hva drikker du (antall enheter): Øl (33 cl): Vin (15 cl): Brennevin (4 cl):
Røyking	Ja/Nei Hvis ja, antall pr dag Hvis nei, har du røykt tidligere: når?
Tannstatus og svelgfunksjon	Vansker med å tygge: Sjelden: Av og til: Aldri: Svelgevansker: Sjelden: Av og til: Aldri:

Pasient: Dato:

Kommentarer:

Pasient: Dato:

New Mobility Score (NMS)

Mobilitet	Uten besvær	Med ganghjelpemiddel	Med hjelp fra en annen	Klarer det ikke
I stand til å gå innendørs	3	2	1	0
I stand til å gå utendørs	3	2	1	0
I stand til å gjøre innkjøp	3	2	1	0

Veiledning til bruk av New Mobility Score

- Ved måling av NMS er det viktig å spørre hvordan det konkret gikk i perioden før innleggelsen, fordi en del pasienter beskriver sitt nivå lengre tilbake, da de ofte fungerte på et høyere nivå. For eksempel er det viktig å spørre når de sist var ute, og om de har gått ned trappene hvis de svarer ja til utendørs gange.
- For pasienter, som grunnet kognitivt nivå, ikke selv er i stand til å redegjøre for tidligere funksjonsnivå, innhentes nødvendig opplysninger fra pårørende, hjemmesykepleie eller institusjon.

Ganghjelpemiddel

Innendørs:	Utendørs:
Innkjøp:	

Resultat NMS

Inne (0-3):	Ute (0-3):	Innkjøp (0-3):	**Total (0-9):**

Hvilke dag i uken er kostanamnesen fra?

Man: Tirs: Ons: Tors: Fre: Lør: Søn:

Appendix 5

Table A. Map of correlations in the present study.

	NMS	Quadriceps	Hangrip	BMI C - BMI A	BMI B - BMI A	Phase Angle	FM %	FFM kg	LOS	BMI C	BMI B	BMI A	Protein C	protein B	Protein A	EI C	EI B	EI A	Age
Age	**r = -0.544** **p = 0.020**	r = -0.288 p = 0.364	**r = -0.720** **p = 0.008**	r = 0.039 p = 0.905	r = 0.025 p = 0.940	r = -0.275 p = 0.442	r = 0.055 p = 0.880	r = -0.598 p = 0.068	**r = 0.618** **p = 0.008**	r = -0.129 p = 0.647	r = 0.041 p = 0.893	r = -0.286 p = 0.265	r = 0.215 p = 0.442	r = -0.418 p = 0.107	**r = -0.805** **p = 0.000**	r = 0.140 p = 0.620	r = -0.334 p = 0.206	**r = -0.621** **p = 0.008**	r = 0.000 p = 1.000
EI A, kcal	r = 0.111 p = 0.718	r = 0.286 p = 0.535	r = 0.450 p = 0.310	r = 0.381 p = 0.352	r = 0.133 p = 0.681	r = 0.086 p = 0.872	r = -0.657 p = 0.156	r = 0.143 p = 0.787	r = 0.209 p = 0.515	r = -0.224 p = 0.533	r = -0.209 p = 0.494	r = 0.214 p = 0.482	r = -0.067 p = 0.855	r = 0.409 p = 0.116	**r = 0.795** **p = 0.000**	r = -0.115 p = 0.751	**r = 0.585** **p = 0.017**	r = 0.000 p = 1.000	
EI B, kcal	r = 0.222 p = 0.488	r = -0.086 p = 0.872	r = -0.116 p = 0.827	r = 0.262 p = 0.531	r = -0.049 p = 0.880	r = -0.500 p = 0.391	r = 0.000 p = 1.000	r = -0.400 p = 0.505	r = 0.094 p = 0.784	r = -0.517 p = 0.154	r = -0.500 p = 0.082	r = -0.104 p = 0.734	r = -0.333 p = 0.381	**r = 0.785** **p = 0.000**	r = 0.274 p = 0.305	r = -0.200 p = 0.606	r = 0.000 p = 1.000		
EI C, kcal	r = 0.178 p = 0.525	**r = 0.699** **p = 0.011**	r = 0.365 p = 0.243	r =-0.385 p = 0.217	r = -0.643 p = 0.086	r = 0.389 p = 0.266	r = -0.515 p = 0.128	r = 0.624 p = 0.054	r = 0.298 p = 0.347	r = 0.007 p = 0.980	r = -0.017 p = 0.966	r = -0.028 p = 0.931	**r = 0.900** **p = 0.000**	r = -0.150 p = 0.700	r = 0.067 p = 0.854	r = 0.000 p = 1.000			
Protein A, g	r = 0.391 p = 0.187	r = 0.703 p = 0.078	**r = 0.818** **p = 0.024**	r = 0.323 p = 0.435	r = 0.021 p = 0.948	r = 0.290 p = 0.577	r = -0.551 p = 0.257	r = 0.638 p = 0.173	r = -0.187 p = 0.560	r = 0.030 p = 0.934	r = -0.052 p = 0.865	r = 0.187 p = 0.541	r = 0.116 p = 0.751	r = 0.283 p = 0.289	r = 0.000 p = 1.000				
Protein B, g	r = 0.109 p = 0.736	r = 0.314 p = 0.544	r = 0.174 p = 0.742	r = 0.214 p = 0.610	r = 0.105 p = 0.746	r = -0.800 p = 0.104	r = 0.400 p = 0.505	r = 0.100 p = 0.873	r = 0.192 p = 0.571	r = -0.267 p = 0.488	r = -0.236 p = 0.437	r = 0.038 p = 0.901	r = -0.283 p = 0.460	r = 0.000 p = 1.000					
Protein C, g	r = 0.145 p = 0.607	**r = 0.720** **p = 0.008**	r = 0.288 p = 0.364	r = 0.028 p = 0.931	r = -0.405 p = 0.320	r = 0.419 p = 0.228	r = -0.442 p = 0.200	r = 0.455 p = 0.187	r = 0.298 p = 0.347	r = 0.018 p = 0.950	r = 0.083 p = 0.831	r = -0.238 p = 0.457	r = 0.000 p = 1.000						
BMI A	r = 0.317 p = 0.249	r = 0.250 p = 0.516	r = 0.317 p = 0.406	r = -0.175 p = 0.587	r = -0.203 p = 0.527	r = 0.679 p = 0.094	r = -0.214 p = 0.645	r = 0.679 p = 0.094	r = -0.156 p = 0.628	**r = 0.811** **p = 0.001**	**r = 0.853** **p = 0.000**	r = 0.000 p = 1.000							
BMI B	r = 0.040 p = 0.902	r = 0.257 p = 0.623	r = 0.232 p = 0.658	r = 0.429 p = 0.289	r = 0.161 p = 0.618	r = 0.600 p = 0.285	r = -0.300 p = 0.624	r = 0.700 p = 0.188	r = -0.280 p = 0.466	**r = 0.967** **p = 0.000**	r = 0.000 p = 1.000								
BMI C	r = 0.219 p = 0.433	r = 0.301 p = 0.342	r = 0.368 p = 0.239	r = 0.266 p = 0.404	r = -0.024 p = 0.955	r = 0.255 p = 0.476	r = 0.103 p = 0.777	**r = 0.709** **p = 0.022**	r = 0.029 p = 0.929	r = 0.000 p = 1.000									
LOS	r = -0.337 p = 0.238	r = 0.047 p = 0.891	r = -0.359 p = 0.278	r = -0.094 p = 0.811	r = -0.304 p = 0.464	r = -0.321 p = 0.400	r = -0.179 p = 0.645	r = -0.179 p = 0.645	r = 0.000 p = 1.000										
FFM kg	r = 0.533 p = 0.112	**r = 0.770** **p = 0.009**	**r = 0.973** **p = 0.000**	r = -0.393 p = 0.383	r = -0.400 p = 0.600	r = 0.395 p = 0.258	r = -0.358 p = 0.310	r = 0.000 p = 1.000											
FM %	r = 0.345 p = 0.329	r = -0.152 p = 0.676	r = -0.365 p = 0.300	r = -0.071 p = 0.879	r = 0.200 p = 0.800	r = -0.365 p = 0.300	r = 0.000 p = 1.000												
Phase Angle	r = 0.230 p = 0.523	r = 0.468 p = 0.172	r = 0.424 p = 0.222	r = -0.714 p = 0.071	r = -0.800 p = 0.200	r = 0.000 p = 1.000													
BMI B - BMI A	r = -0.103 p = 0.763	r = 0.300 p = 0.624	r = 0.400 p = 0.505	**r = 0.857** **p = 0.007**	r = 0.000 p = 1.000														
BMI C - BMI A	r = 0.284 p = 0.371	r = -0.050 p = 0.898	r = -0.033 p = 0.932	r = 0.000 p = 1.000															
Handgrip, kg	r = 0.542 p = 0.069	**r = 0.611** **p = 0.035**	r = 0.000 p = 1.000																
Quadriceps, kg	**r = 0.633** **p = 0.027**	r = 0.000 p = 1.000																	
NMS	r = 0.000 p = 1.000																		

EI = energy intake
BMI = body mass index
LOS = Length of (hospital) stay
FFM = Fat free mass
FM= fat mass
NMS = new mobility score
NRS = nutritional risk screening
All the correlation tests are performed by Spearmans Rho.
Any correlation is considered statistically significant if $p < 0.05$.
Statistically significant correlations are presented in bold.