Nutritional risk in a university hospital

Challenges and consequences in clinical practice

Randi Julie Tangvik

View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by NORA - Norwe

Dissertation for the degree philosophiae doctor (PhD)

at the University of Bergen

2015

Dissertation date: 25.03.2015

The material in this publication is protected by copyright law.

Year: 2014

Title: Nutritional risk in a university hospital:

Challenges and consequences in clinical practice

Author: Randi Julie Tangvik

Print: AIT OSLO AS / University of Bergen

Scientific environment

This research project was performed at the Department of Research and Development at Haukeland University Hospital. The work was funded by the Western Norway Regional Health Authority and Kavli Research Centre for Geriatric and Dementia. I was granted admission to the Department of Clinical Science 2, the Faculty of Medicine, University of Bergen.

I participated in the Graduate School of Clinical Medicine Program at the University of Bergen, Bergen, Norway; the Strategic Healthcare Research Program at the Centre of Clinical Research, Helse Bergen; Doctoral training and Ph.D. courses at the University of Bergen and the Kavli Research Centre for Geriatric and Dementia.

‘Anyone who has gone without food for one or two days will know the discomfort it gives. In European hospitals it is common that patients go without food for several days. It has been amply demonstrated that this starvation has human, functional, clinical and financial implications. The money spent treating nutritional-related complications is enormous as is the monetary value of hospital food wasted.’

Council of Europe 2002 (1)

Acknowledgements

First of all, I want to thank the management of Haukeland University Hospital. When I started as a clinical dietician in 1991, it was unthinkable that a hospital's Chief Executive Officer (CEO) would be interested in nutrition, and it was equally unbelievable that nutrition would be explicitly put on the hospital's agenda. I am grateful to Stener Kvinnsland, CEO; Grethe S. Tell, Director of the Department of Research and Development; Anita Lyssand, Department Manager and Anne Berit Guttormsen, Senior Consultant in Anaesthesiology for introducing a nutritional strategy and for giving me the opportunity to lead this novel initiative.

It was not obvious that the initial effort in developing this strategy could eventually become a Ph.D. I am very grateful that Professor Anette Hylen Ranhoff saw opportunities and solutions.

I would like to extend my deep thanks to my three supervisors, Professor Anette Hylen Ranhoff, Professor Grethe S. Tell, and Professor Anne Berit Guttormsen for their important contributions, for sharing their experience, and for introducing me to a national and international research fellowship.

My special thanks also go to statisticians Andreas Henriksen, Roy Miodini Nilsen and Tore Wentzel-Larsen for their important contributions, thoroughness, and patience. I am grateful for your expertise. It has been great to work with you.

I also extend many thanks to my co-authors, Professor John A. Eisman and Dr. Jannike Øyen, for their important and constructive contribution to the papers and for an inspiring stay at the Garvan Institute for Medical Science in Sydney.

Further, I am grateful for the opportunity to use the nutrition registrations, unique to the international field of clinical nutrition. Based on the well-organised infection registrations, this nutritional database has many contributors. Most of all, thanks to

Elizabeth Nordeide and Kari Sygnestveit for performing the surveys together with me. It is a great pleasure to collaborate with you.

I am also grateful to Alf Henrik Andreassen, Alfred Halstensen, Kjersti Berge, Håkon Ersland, Alf M. Aksland, Leah Mc Fault, Mette Holst, Jens Kondrup, and Guro Berge Smedshaug for important contributions they made to the project.

I am very grateful for the exceptional Ph.D. fellowship and friendship I experienced: Many thanks to Frøydis, Ida, Marit, Bård, Ole Martin, and Ragnhild at Kavli Research Centre, and to Kjersti, Tina, Anette, Arvid, Bente, Hedda, Leslie, Gro Beate, Jannice, Nathalie, Kari Britt, Ranveig, Anne Britt, and finally Tone and all the staff at the Section for Scientific Research, Haukeland University Hospital.

Also I extend warm thanks to my colleagues in the Department of Research and Development and to all the clinical dieticians. I appreciate being one of your colleagues.

Finally, I would like to thank my dear family and friends for filling my life with joy and adventures. My deepest thanks go to Hans. Your extraordinary enthusiasm for skiing, skating, biking and kayaking fills my life with happiness and great experiences.

Bergen, December 2014

Randi Julie Tangvik

Abstract

Introduction

Malnutrition is present in 20-50% of hospitalised patients, leading to increased risk for adverse clinical outcomes and even mortality. Nutritional status is often ignored during hospitalisation. The Bergen Nutritional Strategy was a multi-pronged effort introduced to increase focus on improving patients' food and mealtime routines, and the routines used by staff to evaluate nutritional risk. Another element of this strategy was to ensure proper nutritional care during patients' hospitalisation. Guidelines were implemented and hospital staff was educated. Repeated point-prevalence surveys were introduced in 2008 to increase awareness about patients' nutritional status and to improve nutritional care.

Aims

The main objective of this dissertation research was to objectively evaluate the Bergen Nutritional Strategy. This was accomplished by conducting three studies, each addressing different aspects of the strategy.

The aim of the first study was to evaluate whether the Bergen Nutritional Strategy had positive effect overall on nutritional care of patients at Haukeland University Hospital (Paper I).

The aim of the second study comprised two aspects. The first was to study in detail the components of the Nutritional Risk Screening (NRS 2002) tool to determine the minimum number of components necessary to clearly classify a patient as being 'at nutritional risk'. The intention was to simplify the screening procedure, if possible. The second aspect was to assess whether being 'at nutritional risk' is associated with increased morbidity, mortality, and health-care costs. This was assessed during a one-year follow-up (Paper II).

The aim of the third study was to determine the prevalence of nutritional risk as a function of patients' age, disease category, and the hospital department in which they were treated in order to better understand in which departments and patients groups nutritional care is most crucial to monitor (Paper III).

Methods

Nutritional registrations performed as point-prevalence surveys were conducted every three months during 2008 and 2009. Any changes in clinical practice at hospital units were assessed by repeated surveys. The first survey was conducted at 14 hospital units and the next seven at 51 units. NRS 2002 was used to classify patients as 'at nutritional risk' or 'not at risk', according to their nutritional status and severity of illness (See Appendix 2, section 11.2). Data on length of hospital stay, new hospital admissions, and mortality were obtained from the patient administrative system.

Patients

For the eight point-prevalence surveys in 2008 and 2009, 5849 adult hospitalised patients were subject for inclusion; 3604 patients were included in study I, and 3279 patients were included in studies II and III.

Results

In study I, 1230 (34%) of 3604 patients were at nutritional risk. Among these, 53% received nutritional treatment, and dieticians were involved in the treatment of only 5%. The proportion of patients who were screened increased significantly from the first to the last survey ($p=0.012$). However, the proportion of patients who received nutrition treatment did not increase during the study period ($p=0.66$).

In study II, 3279 patients were followed for one year. Of these, 29% were at nutritional risk, as assessed by NRS 2002. Being at nutritional risk was strongly associated with increased morbidity and mortality. Even the initial screening robustly identified adverse outcomes. Every single item of the screening tool was found to be a significant independent risk predictor. A positive response to one or more of the

initial four questions in NRS 2002 was associated with increased risk of morbidity and mortality, and positive answers to all four questions were associated with a 13 times greater risk of dying during the following year (OR 13.0, 95% CI 4.52 to 37.6).

In study III, compared to well-nourished patients, those at nutritional risk were more often female (53% vs.50%); underweight (mean Body Mass Index [BMI] 21.4 vs. 25.3 kg/m^2); and older (mean age: 67.8 vs. 63.0 years). The prevalence of nutritional risk increased with age, being 40% for patients ≥80 years and 21% for those <40 years old. It is important to note, that even the younger patients (18-39 years), overweight and obese patients (BMI>25 kg/m^2), and patients with fewer than four diagnoses were frequently found to be at nutritional risk.

A high prevalence of nutritional risk was found in nearly all patient groups and hospital units. However, it was most common among patients with infections, cancer, or pulmonary diseases. The greatest numbers of patients at nutritional risk were in the departments of general medicine or surgery. Nearly half (40%) of the patients who were discharged from hospital to nursing homes, and 25% of the patients who were discharged to their own home were at nutritional risk.

Conclusions

This comprehensive study of a university hospital patient population revealed that a high proportion of the patients in this university hospital were at nutritional risk during the study period. Far from being simply an academic finding, this risk was strongly associated with adverse outcomes, sometimes even death. Nutritional depletion is a significant risk factor for morbidity, increased use of hospital services, and premature death.

Our findings support the elevated need for nutritional screening in hospitals. Patients at nutritional risk were identified in all disease categories and all ages. A screening tool is immensely valuable for categorising patients at nutritional risk, and NRS 2002 was found to be suitable for identifying high-risk patients. The initial four questions

of NRS 2002 were strong predictors of hospitalisation, morbidity, and most importantly, mortality, among hospitalised patients. Thus the combined use of just these four questions would be appropriate and effective to use as an initial screening of hospitalised patients.

Implementation of the Bergen Nutritional Strategy improved the screening performance among the hospital staff, but did not improve the patients' nutritional treatment. Therefore, more intense efforts are necessary to improve nutritional practice and staff knowledge in hospitals.

List of publications

I. Tangvik RJ, Guttormsen AB, Tell GS, Ranhoff AH. Implementation of nutritional guidelines in a university hospital monitored by repeated point prevalence surveys. European Journal of Clinical Nutrition 2012 Mar;66(3):388-93. doi: 10.1038/ejcn.2011.149.

II. Tangvik RJ, Tell GS, Eisman JA, Guttormsen AB, Henriksen A, Nilsen RM, Oyen J, Ranhoff AH. The nutritional strategy: Four questions predict morbidity, mortality and health care costs. Clinical Nutrition 2014 Aug;33(4):634-41. doi:10.1016/j.clnu.2013.09.008.

III. Tangvik RJ, Tell GS, Guttormsen AB, Eisman JA, Henriksen A, Nilsen RM, Ranhoff AH. Nutritional risk profile in a Norwegian hospital population. Clinical Nutrition 2014 Aug:12. pii: S0261-5614(14)00205-2. doi: 10.1016/j.clnu.2014.08.001.

Reprints were made with the permission from the Nature Publishing Group (paper I) and Elsevier Ltd. (papers II and III). All rights reserved.

Abbreviations

ASPEN: American Society for Parenteral and Enteral Nutrition

BMI: Body Mass Index (BMI= kg/m^2)

DIPS: Distribuert informasjons og pasientdatasystem i sykehus (The Hospitals Distributed Information and Patients Data System)

DRG: Diagnosis Related Group, version 10

ESPEN: European Society for Clinical Nutrition and Metabolism

ICD-10: The International Classification of Disease 10th revision

MNA: Mini Nutritional Assessment

MNA-SF: MNA-Short Form

MUST: Mini Undernutrition Screening Tool

NRS 2002: Nutritional Risk Screening 2002

NSKE: Norsk selskap for klinisk ernæring (Norwegian Society of Clinical Nutrition)

RCT: Randomised Controlled Trials

SGA: Subjective Global Assessment

WHO: World Health Organization

Contents

1. Introduction

The increasing global growth of the elderly population represents a triumph of medical, social, and economic developments. Medical advancements, however, have also led to a situation in which patients now live longer with incurable diseases. Among this population are those who are disabled and those with chronic disease. Both are especially vulnerable to nutritional depletion, and this represents a challenge linked to diseases, disability, and malnutrition.

Norwegian hospitals are highly specialised. Nonetheless, clinical nutrition is still under- recognised as part of medical treatment, and adequate routines to monitor nutritional status and ensure that patients' nutritional needs are met are often absent (2).

Nutritional risk in hospitals and the challenges and consequences in clinical practice are the subjects of this dissertation.

1.2 Malnutrition

The association between poor nutritional status during illnesses and impaired quality of life and increased risk of mortality was first described 2400 years ago, by the Greek physician and founder of western medicine, Hippocrates (460 - c. 370 BC) (3).

When the body does not get the right amount of energy, protein, and/or nutrients to maintain normal organ function, malnutrition develops. This might be caused by a wide variety of underlying conditions. Hence, a reduction in nutritional status during illness can produce a range of different symptoms in the body. Malnutrition is both a cause and a consequence of ill health.

Malnutrition is a state in which a deficiency of nutrients or excess of energy, protein and other nutrients causes measurable adverse effects on tissue/body form and function, and clinical outcome (4). The scope of malnutrition considered in this

dissertation does not include the situations in which excess nutrients are provided or there is a lack of a single micronutrient. Rather it considers only the situation in which there is a deficiency, as stated at the outset.

To address the different aspects of malnutrition in hospitalised patients, an International Guideline Committee composed of members from both the American Society for Parenteral and Enteral Nutrition (ASPEN) and the European Society for Clinical Nutrition and Metabolism (ESPEN), was established to develop a consensus approach to defining nutrition depletion syndromes for adults in the clinical setting (5, 6). They made the following proposal for three malnutrition classifications:

Starvation-related malnutrition is a consequence of pure starvation (6). Energy intake is lower than energy expenditure.

Chronic disease-related malnutrition is due to a mild or moderate degree of inflammation caused by underlying disease such as organ failure, cancer, rheumatoid arthritis or sarcopenic obesity (6). Despite achieving energy balance, the patient loses muscle mass.

Acute disease or injury-related malnutrition is a consequence of reduced intake and utilisation of nutrients and/or a marked inflammatory response to major infections, burns, trauma or closed head injury (6). Despite achieving energy balance, the patient loses body weight and muscle mass.

Classification is an important step for increasing awareness of malnutrition and for improving care of patients at nutritional risk. However, there are important challenges in achieving this. First, consensus is lacking regarding clinical identification criteria to use for the three classifications. Second, the existing International Classification of Disease (10^{th} revision) (ICD-10) criteria for malnutrition were developed for kwashiorkor and marasmus arising from natural disaster-related food shortages and rather than for malnutrition arising from illness or severe injury. Finally, different classes of malnutrition might co-exist or might also co-occur with symptoms

stemming from disease, ageing, or compromised lifestyle, making it difficult to identify the root cause(s) of the malnutrition and, thus, a clinical solution.

1.2.1 **Causes**

Jeejeebhoy discussed five physiological mechanisms that are involved in the kind of nutritional depletion seen in hospitalised patients (7).

1. Insufficient food intake results in wasting. Several diseases and trauma increase nutritional needs due to increased loss of nutrients from wounds, malabsorption, or catabolism. Despite this, most patients eat less during hospitalisation (8).
2. Increased cytokine activity results in reduced protein synthesis and loss of muscle mass. This is seen in patients with inflammation, obese patients, and the elderly.
3. Inactivity and bed rest reduces muscle loading and re-synthesis. Exercise is necessary to stimulate protein synthesis.
4. Hormonal changes due to illness or ageing influence body composition. Anabolic hormones are insulin and testosterone; catabolic hormones are catecholamine and corticosteroids.
5. Inflammation and disease increase the neuromuscular atrophy of type II muscle fibres.

These mechanisms are present to varying degrees in hospitals, and according to the underlying disease, treatment and several other risk factors. Hence, malnutrition might be present in different forms, as starvation-related malnutrition, acute disease- or injury-related malnutrition, or in conditions such as cachexia and sarcopenia. Cachexia and sarcopenia are defined in Appendix 1, Section 11.1.

1.2.2 **Risk factors**

The risk of developing malnutrition during illness most often depends on a multifactorial combination of physical, physiological, and psychological factors. Persons with predisposing factors are more vulnerable to nutritional depletion when they become sick (Figure 1).

Predisposing factors are increased age; chronic illness; and socioeconomic factors, including poverty, social isolation, and substance abuse (9, 10). Patients with dementia, frailty, substance abuse, psychiatric disorders and patients with chronic diseases such as cancer, rheumatoid arthritis, osteoporosis, heart disease, and lung disease belong to high-risk groups (10, 11).

Medication side effects (i.e., anorexia, taste disturbances, nausea, vomiting, constipation, swallowing difficulties) can affect appetite and food intake. Dysphagia is a common reason for malnutrition among patients, especially those with neurological diseases (12-14). Even *mild* dysphagia is a common problem among older patients and overlooked, as it is sometimes thought to be normal in elderly (12).

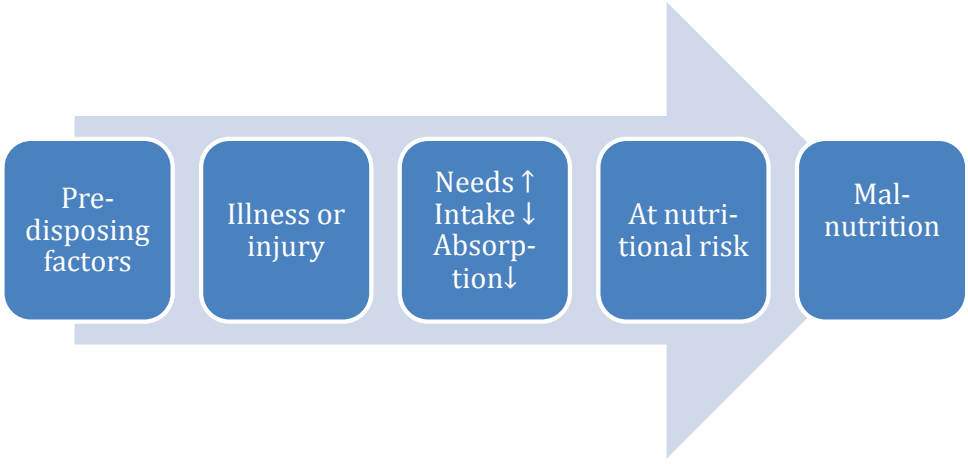


Figure 1: Causal model for malnutrition.

1.2.3 **Food intake during hospitalisation**

Insufficient food intake during hospitalisation is common (8, 15). The Australian Nutrition Care Day Survey identified poor food intake in 2-in-3 hospitalised patients (8). In this survey, 1-in-3 malnourished patients and 1-in-5 well-nourished patients consumed less than 25% of the food offered (8). Only 25% of patients that eat nothing at lunch receive artificial nutrition support (15). A Danish study found that patients have only 60% of their energy needs covered (16).

There might be several different causes of low food intake during hospitalisation. The catering provision, patient-specific factors, illness, treatment, and an unfamiliar hospital setting might lead to depressed mood, poor appetite, or gastrointestinal symptoms. The ability to chew and swallow is often affected by diseases and medications (17). Catabolic conditions such as injury or inflammation might increase nutritional needs and thus, increase the gap between sufficient food intake and nutritional needs (18).

Poor food intake is an independent risk factor for hospital mortality prolonged hospital stay, and frequent readmissions (15, 19). The great wastage of food represents also a waste of resources (20).

In order to meet nutritional needs for optimal recovery, hospital food should be appealing to a degree that it encourages patients to eat well. The food also needs to be nourishing. The menus need to be flexible, -providing patients with a greater choice of meals. Protected mealtime policy is introduced in some hospitals to ensure un-disturbed meals. Between normal daytime meals and during the night, light meals should be available. Facilitation and assistance during mealtime increase food intake and improve clinical outcome (20).

1.2.4 **Prevalence**

The prevalence of malnutrition among hospitalized patients varies between 20 and 50%, depending on the patient population, definitions and tools used to identify the condition (21-26). In Switzerland, for example, of 32,837 medical patients assessed with the Nutritional Risk Screening (NRS 2002), 18% were identified to be at nutritional risk (27). In a European multi-centre study of 5051 hospitalised patients, 32% were identified as being at nutritional risk (28).

Kaiser et al. investigated 4507 elderly with a mean age of 82 years and found that the overall prevalence of malnutrition was 23%. They also observed large differences in prevalence among different settings: rehabilitation, 51%; hospital, 39%; nursing home, 14%; community, 6%. It was notable that the prevalence of well-nourished patients in the same study population was, 9%, 14 %, 33%, and 62%, respectively. Among these well-nourished patients, 41%, 47%, 53%, and 32%, respectively, had already experienced the beginning of nutritional depletion and were categorised to be at risk for developing malnutrition (29).

For patients who are malnourished at admission to hospitals, the situation often becomes even worse during the hospital stay because the condition is not identified, prevented, or treated (4).

1.2.5 **Consequences**

Malnutrition negatively affects all organs of the body; thus the consequences might be severe. Muscle wasting increases the risk for falls and disability (30). Compared to well-nourished patients, complications such as delirium, pressure ulcers and reduced wound healing are more common among malnourished patients (4, 9, 21, 31-33). Malnourished patients have increased risk for infections compared to well-nourished patients (34-36).

The consequences of malnutrition and suboptimal nutritional status are great and can have cascading effects. Moreover, they can be both an individual burden and an economic burden for the health-care system, resulting in prolonged hospitalisation and more readmissions (37, 38). The consequences and interacting effects of malnutrition are briefly summarised in Figure 2. How patients are treated will obviously influence all elements of this scheme of consequences.

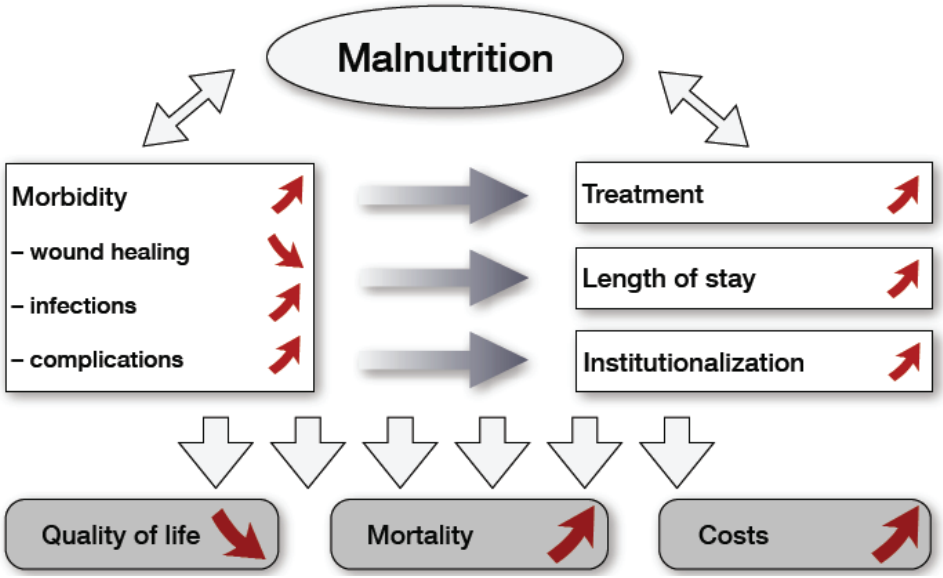


Figure 2: Consequences of malnutrition (based on Stratton and Tappenden (4, 17)).

1.3 Nutritional evaluation of hospitalised patients

1.3.1 **Nutritional assessment**

The aim of nutritional assessment is to define nutritional status, to describe any clinically relevant malnutrition, and to monitor any changes in nutritional status during nutritional support (39) .

Which indices are used to describe a clinically relevant malnutrition situation often depends on the underlying condition. In the past, clinical judgement was primarily used to determine body composition and strength. Clinical judgement still contributes importantly to dietary, anthropometric, biochemical and functional methods currently used to estimate nutritional status for tailored dietary treatment (40).

Dietary assessment includes registration of food intake, interview, and observation in order to identify nutritional deficiency. Dietary intake of nutrients may be inadequate. For example, condition factors such as drugs or disease state might reduce utilisation or increase loss of nutrients. Dietary data derived from this assessment provides a sound basis for developing and implementing nutritional care plans.

Anthropometric measurements are used to quantify a patient's energy store; these include weight, height, middle upper-arm circumference, triceps skinfold thickness, and hip and waist measurements. Body Mass Index (BMI; kg/m^2) is often used to identify malnutrition (41). However, this singular approach can lead to misclassifications. For example, using low BMI (<20 kg/m^2) as the sole criterion could lead to low-weight, well-nourished patients being erroneously categorised as malnourished or normal or overweight malnourished patients being erroneously categorised as adequately nourished. Waist circumference is used to determine whether a young or middle aged person is overweight; large waist circumference is also an independent risk factor for metabolic syndrome (42, 43).

Bioelectric impedance analysis (BIA) and Dual X-ray Absorptiometry are appropriate methods to investigate body compositions (DEXA) (39). However, these methods are still mostly used in clinical research projects, rather than in daily clinical practice.

Biochemical parameters include albumin; prealbumin; transferrin; retinol-binding protein; single nutrients such as ferritin, calcium, B vitamins (e.g. thiamine), vitamin D; electrolytes; and immunological parameters such as white blood cell count. These parameters are often confounded by the underlying disease state, making their isolated use to identify protein and energy malnutrition less useful. Biochemical measures provide important information needed to detect the lack of single nutrients (39).

Functional status is assessed by measuring the loss of muscle strength and function. These are relevant outcome parameters in the treatment of malnutrition. However, functional status assessments are still not used routinely in clinical practice. Physical function and strength are most often measured by walking speed, the Timed Up and Go (TUG) method and hand-grip strength. These are independent predictors of reduced nutritional status (44-48).

The methods most preferred to determine nutritional status depend on a patient's nutritional risk as a function of health and disease. The most common nutritional assessment tools used with adult patients in European hospitals are presented in Table 1.

Nutrition assessment tools	Anthropometry and/or diet related	Severity of illness	Other assessment measures	Reference
Mini Nutritional Assessment (MNA)	Weight data, height, mid-arm circumference, calf circumference, diet history, appetite, feeding mode.	Albumin, prealbumin, cholesterol, lymphocyte count.	Self-perception of nutrition and health status	(49)
Subjective Global Assessment (SGA)	Weight history, diet history	Primary diagnosis, stress level	Physical symptoms (subcutaneous fat, muscle wasting, ankle oedema, sacral oedema, ascites); functional capacity; gastrointestinal symptoms	(50)

Table 1: Parameters used in the most common nutritional assessment tools in European hospitals: Mini Nutritional Assessment and Subjective Global Assessment. (51)

Clinical assessment can be time-consuming and therefore may not be readily accepted as being cost-effective for routine use on all hospitalised patients. Therefore, a quick and easy nutritional screening method that can be performed on all patients within 24 hours of hospital admission is recommended (1, 51, 52).

1.3.2 **Nutritional screening**

In contrast to nutritional assessment which aims to define nutritional status and to monitor changes in status, nutritional screening aims to predict clinical outcome related to current nutritional factors and to determine whether nutritional therapy is likely to influence outcome.

Screening is defined as a method to identify a disease or condition not initially recognised in order to prevent development of disease and improve outcome (53). A screening tool is an instrument used to determine whether additional information from an assessment or clinical investigations is required to warrant an intervention. The intention of nutritional screening is to identify patients at nutritional risk and to achieve health benefits for those patients by applying an intervention guided by the result of screening (52, 54).

The ideal screening method should be easy, quick, non-invasive, and valid. Moreover, it should be able to be reliably performed by different health personnel (55). An ongoing goal is to identify simpler and more pragmatic methods to identify at-risk individuals who might benefit from targeted prevention. Screening tools with several items are typically developed, often with a scoring system. The screening tools most frequently used in European hospitals are presented in Table 2.

The Council of Europe recommends that nutritional screening and nutritional intervention should be a part of medical treatment in order to improve or maintain nutritional status and to improve recovery (1).

Screening tools	Anthropometry and/or diet related	Severity of illness	Reference
Birmingham Nutrition Risk Score	Weight loss, body mass index, appetite, ability to eat	Stress factor (severity of diagnosis)	(56)
Malnutrition Screening Tool	Appetite, unintentional weight loss		(57)
Malnutrition Universal Screening Tool	BMI, change in body weight	Presence of acute disease	(37)
Maastricht Index	Percentage ideal body weight	Albumin, prealbumin, lymphocyte count	(58)
Nutrition Risk Classification	Weight loss, percentage ideal body weight, dietary intake	Gastrointestinal function	(59)
Nutritional Risk Index	Present and usual body weight	Albumin	(60)
Nutritional Risk Screening 2002	Weight loss, body mass index, food intake	Diagnoses (severity)	(52)
Prognostic Inflammatory and Nutritional Index		Albumin, prealbumin, C-reactive protein, α1-acid glycoprotein	(61)
Prognostic Nutritional Index	Triceps skin fold	Albumin, transferrin, skin sensitivity	(62)
Simple Screening Tool	Body mass index, percentage weight loss	Albumin	(63)
Short Nutrition Assessment Questionnaire	Recent weight history, appetite, use of oral supplements or tube feeding		(64)

Table 2. Parameters used in different nutrition screening tools, most commonly in European hospitals (51)

1.3.3 **NRS 2002**

NRS 2002 was developed and validated by Kondrup and co-workers (52) and translated to Norwegian by an expert committee established by the Norwegian Society in Clinical Nutrition (NSKE) in 2006. NRS 2002 is recommended for use in hospitals by ESPEN, NSKE, and the Norwegian Directorate of Health (65). NRS 2002 (Norwegian version) was implemented at Haukeland University Hospital during 2007 and is now the most common screening tool used in Norwegian hospitals. NRS 2002 (English version) is reproduced in Appendix 2 (Section 11.2), and is described in detail in the Methods section (4.4) and in paper I.

The purpose of NRS 2002 is not to summarise nutritional status, but to identify patients who will benefit from appropriate nutritional care by detecting protein and energy undernutrition, and/or to predict whether undernutrition is likely to develop/worsen . NRS 2002 interrogates the four items listed in Table 3:

Question	Initial screening	Final screening
1. What is the condition now?	Is BMI <20.5?	Is BMI <20.5 or <18.5? Is general condition impaired?
2. Is the condition stable?	Has the patient lost weight within the last 3 months?	Is weight loss >5% in 1, 2, and 3 months?
3. Will the condition get worse?	Has the patient's dietary intake been reduced in the last week?	Is food intake <75%, <50% or <25% of normal requirement in the preceding week?
4. Will the disease process accelerate nutritional deterioration?	Is the patient severely ill?	Is the severity of disease mild, moderate, or severe?

Table 3. Summary of NRS 2002 (52).

NRS 2002 was developed to identify patients who have a measurable effect of nutritional support and was validated with 128 randomised clinical trials investigating the effect of nutritional treatment according to disease (52).

In this dissertation, patients ‘at nutritional risk’ were identified using NRS 2002 and as a group might include patients from all categories of malnutrition and patients at risk for developing these conditions.

1.4 Nutritional treatment of hospitalised patients

Nutritional treatment is individually tailored nutritional support based on the patient’s needs and includes:

1. Assessment of current nutritional status.
2. Estimation of nutritional requirement.
3. Prescription and delivery of appropriate amount of nutrition; energy, protein, nutrients, electrolytes, and fluids.
4. Monitoring of clinical status and ensuring that the most optimal feeding route is used at all times.
5. Documentation of nutritional status, nutritional plan, goal for nutritional treatment and results for monitoring.

Malnutrition in most cases is treatable. If detected early enough, severe malnutrition can be prevented with nutritional care. Nutritional treatment of patients with incurable diseases might delay severe malnutrition and improve quality of life (51).

1.4.1 **Effect of treatment**

Dietary counselling improves clinical outcomes for hospitalised patients (66, 67). The comprehensive meta-analyses of Stratton included 287 studies and approximately 12 000 patients. She concluded from these analyses that individually tailored nutritional treatment improved patients' mental and physical health and function, reduced the use of antibiotics, reduced the number and length of hospitalisations, and reduced mortality (4).

A meta-analyses of 55 studies, which included 9187 patients, confirmed the results of Stratton: Nutritional treatment given to malnourished patients reduced the complication rate of additional medical problems by 50% (68).

A good example of the practical application of these findings is the employment of a dietetic assistant, a health-care worker who is given the responsibility for individually tailoring food intake and assisting patients during mealtime. Aid from dietetic assistants reduced the mortality by 6% in hospitalised patients and by 10% after a four-month follow-up in a clinical randomised intervention study of elderly women with hip fracture (20).

Despite this, research sometimes demonstrates conflicting results. The presence of inflammation might limit the measurable effectiveness of nutritional interventions. The effect of nutritional treatment might be helpful but provided too late, and sometimes beneficial effects are lacking. Beneficial effects of clinical nutrition might be absent when used indiscriminately or too aggressively (69-73).

1.5 Cost-benefit

Malnutrition is costly for health-care planning and delivery (74-77). Malnourished patients are vulnerable to complications and need more attention, which leads to more frequent and longer hospital stays compared to well-nourished patients within the

same Diagnosis Related Group (DRG) category (78, 79). Hospital cost is three times higher for malnourished patients compared to well-nourished patients (80).

In the Netherlands, the additional cost of managing malnourished patients was estimated in 2011 to be approximately 2 billion Euros, which is 5% of the health-care sector budget and 2% of the total expenditure on all health-related costs (64).

Malnutrition in patients is often overlooked (2, 81); therefore, the potential cost savings for hospitals aiming to improve in this area are pronounced (82). The National Institute for Health and Care Excellence (NICE) identified nutritional care and treatment for malnutrition as the fourth largest source of cost savings in the health-care sector. A strategy for early identification and timely management of malnutrition should improve patient care and outcomes. Their resource impact analyses suggest that a change from the current to the proposed pathway of nutritional care results in an overall net cost saving, mainly due to reduced hospitalisation (83, 84).

In the Netherlands, hospital costs decreased by a mean of 400 Euros per patient per hospitalisation due to individually tailored nutritional treatment for malnourished patients (64). In Denmark improved nutritional practice should reduce health-care costs by one billion DKR per year due to reduced hospital infections, medication, reduced waste of food, reduced number of reoperations and shorter hospital stays.

Juul extrapolated these estimates to Norwegian health-care services and suggested it would be possible to achieve a yearly 1% reduction of hospital costs by implementing a strategy for early identification and timely management of malnutrition compared to treatment as usual (85).

2. Nutritional Strategy at Haukeland University Hospital

During 2003, to improve hospitalisation, the Patients' Board (Brukerutvalget) at Haukeland University Hospital sent a request to hospital management asking for increased focus on nutrition during hospitalisation. Their aim was to have nutritional assessment and treatment to be an integrated part of patient care and they wanted better hospital food for patients.

The CEO responded to the request by introducing a quality improvement project. Based on recommendations from The Council of Europe to integrate nutrition into patient treatment and care (1), and the ESPEN guidelines for nutritional screening (86), a new nutritional strategy was developed and carried out. Later, the nutritional strategy became part of the main Haukeland University hospital strategy document for 2008-2012 (Table 4).

The overall aim of the nutritional strategy was to support evidence-based patient care, provide education of hospital staff, and conduct research in the fields of nutritional risk in health-care settings. Four items were given priority:

- Improve hospital food
- Educate hospital staff
- Implement guidelines
- Document results

In order to fight malnutrition effectively in busy hospitals, it is crucial to make it easy for staff to do what is right. Tools and procedures were developed to simplify and improve clinical practice. These four nutritional strategy items are discussed in detail in Section 2.1.

Helse Bergen Strategy Document 2008-2012:

The policy 'good nutritional practice' will be introduced to the entire hospital. The hospital shall carry out routines to integrate nutrition into all aspects of the patients' care and treatment. The hospital shall ensure that good and nourishing food is provided to the patients.

The hospital's quality improvement items are:

1. Improve nutritional knowledge
2. Perform a patient centred nutritional care and treatment
3. Monitor results

Nutritional treatment should be based on guidelines.

Table 4. Helse Bergen Strategy Document 2008-2012

2.1 Nutritional strategy items

2.1.1 **Improve hospital food**

To fight malnutrition in hospitals, it is essential to provide tailored nutrition, and to develop adequate mealtime routines. In order to make better and more flexible meals, the services, food delivery system, communication between the kitchen and the clinical units were improved. Intranet web pages were created and posted to improve the presentation of food services.

The kitchen was given more responsibility for handling mealtimes, and chefs engaged with some units to secure better food quality, from the point of preparation to the time it is delivered to the patient.

Nutritional supplements such as seep drinks and enriched food became more available. Dieticians shared responsibility for ensuring that the food met national recommendations for meals in Norwegian hospitals and nursing homes.

2.1.2 **Educate hospital staff**

Physicians, nurses and kitchen staff were invited to seminars, courses, and mini screening schools. Importantly, patients and their relatives were also invited to nutritional seminars. Physicians, nurses, and dieticians were involved in educating their colleagues. Electronic courses in clinical nutrition were developed to make information about nutritional screening, treatment, and monitoring available for the staff 24/7. These e-learning programs became important supplements to classroom courses and qualified as an organised part (15 hours) of specialist education for physicians and nurses by the Norwegian Medical Association and the Norwegian Society of Nurses, respectively.

2.1.3 **Implement guidelines.**

Guidelines were developed to optimise patient food intake and to promote tailored nutritional support to patients with such needs. These guidelines included methods to determine how nutritional risk should be identified, treated, monitored, and documented. A screening program was carried out to identify all hospitalised patients at nutritional risk in order to initiate a nutritional therapy. Preferred nutritional support consisted of enriched and individually tailored meals, seep drinks, and assistance at mealtime. Guidelines and other relevant information were presented on dedicated intranet websites.

Several pieces of equipment were given priority so that it would be easier to carry out the guidelines correctly: height measurement devices and scales were placed in each patient room, scales for patients in wheelchairs and bedridden patients were provided, an interactive e-course in clinical nutrition was created and made available, and a dedicated e-form in the patient journal system was created.

Responsibilities were updated and re-assigned:

- Food and mealtimes: Kitchen staff received more responsibility for maintaining food quality from preparation to delivery to the patients
- Nutritional screening: Nurses
- Individually tailored nutritional treatment: Nurses and physicians
- Documentation and diagnosis: Nurses and physicians

2.1.4 **Document results**

All health personnel are responsible for properly documenting all types of investigations, treatment and diagnoses (ICD-10 code) of all patients. In cases where appropriate systems for documentation of nutritional parameters were lacking, documentation was inadequate or incomplete. Appropriate forms in the patients' electronic journal system (DIPS) were developed in order to make it 'easy to do what is right'. The e-form is interactive and gives an overview of the screening results, automatically calculates energy and protein requirements, and creates a draft of an individually tailored nutrition plan. It also facilitates the monitoring of nutritional treatment and suggests diagnoses and resources.

Repeated nutritional registrations were introduced and made every third month.

2.2 The nutritional network

A nutritional network composed of health-care professionals, kitchen staff, patient representatives, and hospital management was established to develop and implement

the guidelines and to facilitate implementation. This network included 130 physicians, nurses, and nurse assistants organised at three levels (Figure 3).

The members of the second and third level of the nutritional network received education in clinical nutrition for 2 days. They participated in workshops and were invited to monthly meetings. After attending the course in clinical nutrition, participants were responsible for implementing the guidelines in their respective units. Incentives for taking the course included counting the course as paid work and received credit for it as part of specialisation education for nurses and physicians.

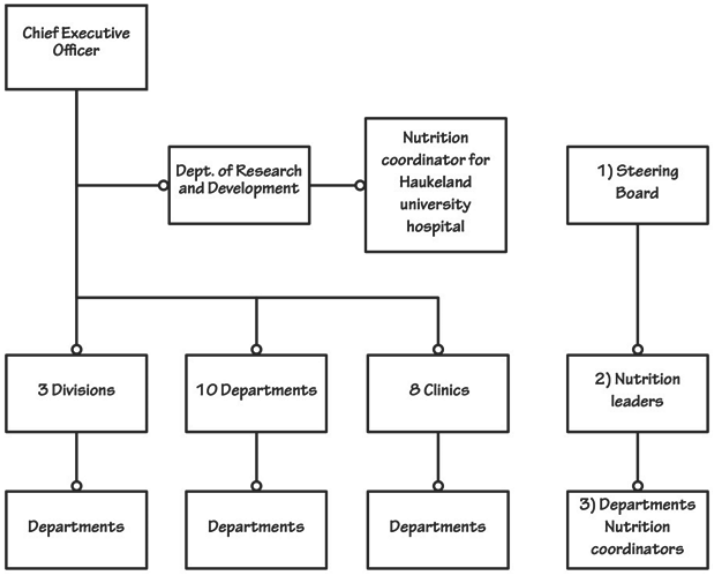


Figure 3: Nutritional network, organisation of the Helse Bergen Nutritional Strategy.

The first level -the steering board- consisted of the management of the entire hospital and leaders from the department of dietetics, kitchen, medicine, and surgery. Also representatives from the patients, nurses and physicians participated.

The second level –the nutrition leaders- consisted of one physician and one nurse from each hospital department.

The third level –nutrition coordinators- consisted of a nurse or nurse assistant from each hospital unit.

3. **Aims of the study**

The overall purpose of this dissertation research was to objectively evaluate and improve the Bergen Nutritional Strategy.

The specific aims were:

To determine whether the Bergen Nutritional Strategy has an overall positive effect on nutritional care at Haukeland University Hospital.

To determine whether all components of NRS 2002 are necessary to adequately classify patients as being ‘at nutritional risk’ or whether a subset is sufficient.

To determine whether being at nutritional risk is associated with increased morbidity, mortality, and health-care costs during a one-year follow-up, compared to patients not at risk.

To determine the prevalence of nutritional risk as a function of age, disease category, and hospital departments.

4. Methods

4.1 Clinical setting

The study setting was Haukeland University Hospital, which is the second largest hospital in Norway with 975 beds. Voss Hospital (a general hospital), Hagavik Orthopaedic Hospital (orthopaedic elective surgery) and Nordås Rehabilitation Centre are organised under Haukeland University Hospital and thus were included in the study. A total of 100,000 somatic patients are treated at Haukeland University Hospital each year.

4.2 Study design

Study 1

The first study (paper I) was an observational study conducted to investigate the effect of a nutritional strategy on clinical practice. Repeated surveys were used to improve screening performance and to monitor adherence to routines. This study was part of a larger quality improvement project and participation was integrated as part of regular hospital routines.

Clinical practice was objectively evaluated by counting the number of patients screened and treated. A change in practice was assessed by comparing the number and proportions of patients screened and treated across the eight surveys.

Study 2

The second study (paper II) was a longitudinal cohort study conducted to investigate the association between being at nutritional risk and clinical outcomes such as morbidity, hospitalisation, risk for new admissions, and premature death during a one-year follow-up.

Study 3

The third study (paper III) used a cross-sectional design to determine the prevalence of nutritional risk in different wards and different patient groups at the hospital.

4.3 Repeated prevalence surveys

The computer application 'Good Nutritional Practice – Nutritional Registration' (GNPNR) was developed in cooperation with Webport AS (Grimstad, Norway) and adapted from the National Registration of Prevalence of Hospital Infections (NRPHI) (87). Questions in the NRPHI about infections were replaced with questions listed in NRS 2002 and additional questions about nutritional treatment (Appendix 4, Section 11.4). Also, the nutritional prevalence surveys were modelled after the routines of well-implemented infection prevalence registrations (87). The product of this adaption was our repeated prevalence survey.

The survey proceeds as follows. At 08:00 on the day of registration, each patient's data (name, date of birth, sex, and hospital ward) were transferred from the hospital's patient administrative system to a dedicated database created for this project. A dedicated nurse at each unit was responsible for organising nutritional screening, collecting the screening results, and entering this information into the database for each patient. The questionnaire (see Appendix 4, Section 11.4) begins with an exclusion question, which has to be answered 'no' if screening is to continue according to NRS 2002. The questionnaire ends with a question regarding nutritional support if the total score is at least 3. This survey was conducted on each patient at the ward on the day of registration between 8:00 and 16:00.

GNPNR tabulated: (1) how many patients of the total patient population were screened, (2) how many patients of the total patient population were at nutritional risk, (3) how many patients received nutritional supplements, and (4) how many patients were seen by a clinical dietician.

4.4 NRS 2002

To evaluate nutritional risk, we used NRS 2002. The patients were characterised by giving 0-3 points for both nutritional status and illness severity and 0-1 points for age (paper I). A patient was defined to be at nutritional risk if he or she had ≥3 points. This score is gained if a patient is severely ill, severely malnourished, or is moderately ill and malnourished. Denoting one score for patients aged 70 years or older allowed us to identify patients with milder degrees of malnutrition and illness, as at nutritional risk.

4.5 Data collection

The data automatically copied from the hospital's patient administrative system into the dedicated database were age, gender, and hospital unit.

Data collected by the nurses and registered into the Webport program were current weight, weight three month ago, height, food intake and severity of disease. For the patients identified to be at nutritional risk, information about nutritional treatment was also collected.

The data retrieved from the hospital's patient administrative system by employees at the Department for Research and Development were information about diagnoses according to ICD-10, length of hospital stay, number of hospital stays, discharge address, and mortality.

Hospital statisticians merged the files. The resulting file represented the data on which statistics were performed.

4.6 Outcome

Paper I

Clinical practice was objectively assessed by calculating the proportion of patients screened and proportion of patients at nutritional risk who actually received nutritional treatment. Change in clinical practice was assessed by comparing these proportions at eight different times across two years. We assumed that the patients received nutritional treatment if they were receiving nutritional support, if nutritional support was planned, or if a dietician was involved.

Furthermore, it was assumed that if the patients were coded with the diagnoses of malnutrition according to the ICD-10 E44 or E46 (Appendix 5, Section 11.5), then their doctors were aware of the condition, and thus, participated in the nutritional treatment. This information was retrieved from the hospital's patient administrative system. Prevalence of nutritional risk was a secondary outcome in this study.

Paper II

The population was followed for one year. Clinical outcomes were the number of days in hospital (the recent hospital stay and at one-year follow-up), number of ICD-10 diagnoses, one-year mortality, and number of admissions (four-year follow-up). Morbidity was dichotomised, and increased morbidity was defined as having more than four ICD-10 diagnoses at discharge.

Clinical outcomes were compared for patients at nutritional risk and not at risk. Clinical outcomes were also compared for patients with a positive answer on at least one out of four initial screening questions with patients with 'no' on all these questions and all four questions were simultaneously entered into the regression model, i.e. mutually adjusted for each other.

Finally, patients who answered 'yes' on *one, or more questions* were compared to those who answered 'no' on all four questions.

Hospital costs were calculated based on a mean daily cost of 6000 NOK (88).

Paper III

Clinical outcomes were prevalence values of nutritional risk determined for the different wards, ages, genders, co-morbidities, BMIs, diagnoses, and types of admission. The prevalence values were adjusted for relevant confounders (Section 4.7 Statistics).

4.7 Statistics

Several different statistical software packages were used for analyses. We used version 9 of SAS (SAS Institute, Inc., Cary, North Carolina, USA); version 17 and 18 of SPSS (SPSS Inc., Chicago, IL, USA); and version 2.15.1 of R (The R Foundation for Statistical Computing, www.r-project.org).

Paper I

Statistical evaluation included descriptive analyses of demographic variables, estimations of prevalence of nutritional risk and of the proportion of patients who underwent nutritional treatment for each survey. Results were presented as numbers and percentages. To estimate changes in clinical practice, linear regression was used. All statistical tests were two-sided. P-values less than 0.05 were considered to be statistically significant.

Paper II

Continuous variables were reported as means ± SEM and categorical variables as prevalence (%) ± SEM. The chi-square test was used to evaluate whether differences in prevalence of the categorical variables were statistically different, while the Mann-Whitney U test was used to test for differences in medians of continuous variables. One-way analysis of variance was used to test for reliable differences in means of continuous variables.

We were aware of a possible sampling bias and sought to account for this. Length-bias sampling is defined as oversampling of long-term stayers (89), in our case, hospitalisation duration. In hospital-based, cross-sectional studies, patients with longer duration hospital stays are more often likely to be sampled than patients with shorter duration stays. This oversampling may influence the true population means and prevalence values of exposures and outcomes, as well as the effect estimates of exposure-outcome associations (90). In order to account for the possibility of a length bias, individual sampling weights were incorporated into the analyses by giving more weight to patients with shorter hospital stays, analogous to that described by Nowell et al. (91). Patients with the longest hospital stay (250 days) were given a weight of 1, while those with the shortest stay (1 day) were given a weight of 250. The generalised forms of weights were calculated in terms of length of stay (LOS) as follows: weight = 250/length of stay (LOS).

The associations of nutritional risk and the four introductory questions of NRS 2002 with mortality (1 year) and morbidity were assessed statistically using logistic regression models. The estimated odds ratios (OR) with the corresponding 95% confidence intervals (CI) were reported in their raw form and adjusted for relevant confounders. After accounting for the individual length sampling weights described above, we used the SAS procedure. Analyses of mortality were further adjusted for the possible confounding variables of age (continuous); gender (male, female); height (continuous); emergency admission (yes, no); month of inclusion (quarter); number of days from admission to inclusion (continuous); and number of diagnoses (continuous). Analyses of morbidity were adjusted for the same variables except for the number of diagnoses variable.

Associations of nutritional risk and the four introductory questions of NRS 2002 with LOS, hospital stay (one- year follow-up) and admissions (four-year follow-up) were assessed statistically using linear regression models. Since the dependent variables were positively skewed, a log transformation was performed on these to better meet

the assumption of normally distributed residuals in the regression models. After model fitting, the estimated slope coefficient B was interpreted on an anti-log scale, i.e., exp (B), rather than on a linear scale. The result of doing this means that for a one-unit increase in the independent variable the expected value of the dependent variable changed by a factor of exp (B). The estimated exp (B) with the corresponding 95% CI was reported raw, and after accounting for the above-mentioned sampling weights, we used the SAS procedure PROC SURVEYREG. As with the analysis of nutritional risk associations and NRS 2002 introductory questions described above, in analyses of LOS and hospital stay (one year), we statistically controlled for age (continuous); gender (male, female); height (continuous); emergency admissions (yes, no); time of year at inclusion (quarter); and number of diagnoses (continuous).

The same variables were similarly controlled in analyses of admission (four years), as was the number of days from admission to inclusion (continuous) variable.

The 6000 NOK estimate of hospital costs was based on a mean daily cost for patients ready to leave the hospital (88) and the mean number of days in hospital over one year.

The method of list-wise deletion was used to account for missing values in multiple regression models. All tests were two-sided, and p values less than 0.05 were considered statistically significant.

Paper III

Continuous variables were categorised and reported as percentages ± SEM. The prevalence of nutritional risk was estimated overall, as well as according to disease categories and hospital departments. To compare between disease categories, prevalence estimates and the corresponding 95% CI were adjusted for age and gender using a direct standardisation method (89). For this adjustment, first, the total population (n = 3279) was considered to be a standard and was then divided into six

different groups based on age (18-59, 60-79, 80+ years) and gender. For each combination, we estimated the relative frequency, or weight (w), from the total population. If one or more cells of the combination variables were empty (n = 0), we excluded gender and only standardised the variable for age. Second, the raw prevalence (p) of nutritional risk was estimated for each combination of age, gender, and disease categories (or hospital departments). Finally, the adjusted prevalence of nutritional risk within disease categories was defined as the weighted average of the respective prevalence p, weighted by w (92, 93). The same adjustment procedure was done separately for the analyses of prevalence related to hospital departments in which the patients were treated.

4.8 Ethics and data integrity

This study was part of a larger quality improvement project. It was therefore exempted from review by the Regional Committee for Medical and Health Research Ethics. The study was approved by the Norwegian Data Inspectorate and the hospital research board. The patients were not subject to any experimental interventions and were not asked to give informed consent.

Prevalence surveys are performed routinely in the hospital. It is mandatory for patients to be screened for nutritional risk, without their written consent. Collected data were saved on the hospital's server for quality projects and protected by industry-standard security and data-integrity routines, including by password. The research data were retrieved from the quality server to the hospital's research server by a statistician and saved on a dedicated site, protected by password.

5. Study population

5.1 Inclusion and exclusion criteria

All adult patients (18+ years) who were registered in Haukeland University hospital's patient administrative system at 08:00 during the registration days were included. This means that all adult patients in any somatic ward who spent at least one night in hospital were included in the study.

Departments participating in the first survey were 17 units in the cardiac unit; intensive care unit (ICU); surgery; oncology; medical; and ear, nose, and throat (ENT) departments. In the second to eighth surveys, all medical and surgical hospital departments at Haukeland University Hospital and the three satellite hospitals of Voss, Hagavik, and Nordås were included (See Appendix 6, Section 11.6: Participating hospital units).

Obstetrics, paediatrics, and psychiatric wards were excluded because appropriate screening tools for patients in those wards are lacking. Patients were excluded if they were admitted for bariatric surgery, were younger than 18 years old, or received terminal care.

Paper II and III

Information was retrieved from the hospital's patient administrative system. This information was not available for foreign patients without a Norwegian personal identification number. Therefore, foreigners were excluded.

5.2 Study population

Paper I

A total of 5849 patients were registered during the eight days of registration in 2008 and 2009. Of these patients, 666 were excluded because they did not satisfy the

criteria or because they were discharged. According to the hospital's routines, patients discharged from the hospital after 16:00 are registered as discharged in the hospital's patient administrative system the following day. For unknown reasons, the screening was not performed or was incomplete for 1579 patients. Thus, 3604 patients were included in the first study. See Appendix 3, Section 11.3 Flow chart for study I.

Paper II and III

Duplicate patients and foreign patients were excluded; otherwise, the database subjected to analyses was identical with the one used in study I. See Appendix 3, Section 11.3 Flow charts for study II and study III.

5.3 Missing data

Screening was incomplete for 683 included patients. Therefore, they could not be classified as being, or not being, at nutritional risk. Other data from these patients were determined to have intermediate values between the two above groups; mean age: 64.9 years; mean BMI: 25.3 kg/m^2; mean number of diagnosis: 4.8; one-year mortality rate: 28%; LOS: 17.8 days and 49.5% women.

5.4 Data collection

Patient age, gender, and hospital units in which they were treated were automatically extracted from the hospital's patient administrative system.

Nurses collected the following patient data and registered them into the Webport program: current weight, weight 3 months ago, height, food intake, and severity of disease. For the patients identified to be at nutritional risk, information about nutritional treatment was also collected and registered.

Data retrieved from the hospital's patient administrative system by the Department for Research and Development staff comprised diagnoses that fit the ICD-10, and also the patients' length of hospital stay, number of hospital stays, discharge address, and mortality.

The hospital statisticians merged the files.

6. Results

6.1 Paper I

In this study we determined whether introducing nutritional guidelines and repeated prevalence surveys would improve nutrition practice in a university hospital during a two-year follow-up.

Of 5183 hospitalised patients, 3604 (70%) were fully screened, and 1230 (34%) were identified to be at nutritional risk. About half (53%) of the patients at nutritional risk received nutritional treatment or nutritional treatment was planned. Only 5% of the patients at nutritional risk were under the care of a dietician.

Screening skills improved during the two years, and the proportion of patients screened increased from the first to the eight point prevalence survey (P=0.012). However, the proportion of patients receiving nutritional support did not improve (P=0.66).

6.2 Paper II

In this study we determined the association between nutritional status and clinical outcomes.

Of the 3279 patients who were followed for one year, 952 patients (29%) were classified as being at nutritional risk by NRS 2002. Patients at nutritional risk had significantly higher morbidity and mortality, longer hospitalisations, and more new admissions than patients not at risk. Compared to patients who answered ‘no’ on the four initial questions of NRS 2002, patients who answered ‘yes’ on at least one of the questions had significantly stronger associations with mortality, morbidity, hospitalisation, and new admissions the following year. This association increased progressively with increasing numbers of ‘yes’ responses to these four questions.

A ‘yes’ response to the initial question about reduced dietary intake in previous week most robustly predicted adverse outcomes, with those patients being 2.4 (95% CI 1.8 to 3.2) times more likely to die the following year, and 1.9 (95% CI 1.5 to 2.4) times more likely to experience increased morbidity compared to patients not at nutritional risk.

6.3 Paper III

In this study we determined the prevalence of clinical nutrition as a function of basic patient demographic characteristics. The highest prevalence of nutritional risk was found among the oldest patients, patients with BMI <20.5 kg/m^2, patients with multi-morbidity, and those with emergency admissions. However, the largest number of patients at nutritional risk had a BMI >20.5 kg/m2, four to seven diagnoses, or were 60-80 years old.

The prevalence of nutritional risk was at least 9% in all main categories of the ICD-10 system and was highest among patients with infections (51%), cancer (44%), and pulmonary diseases (42%).

With regard to medical departments, nutritional risk was most common in patients admitted to oncology (49%), pulmonology (43%), and general medicine (40%) units. However, most (72%) of the 587 patients at nutritional risk in medical departments were in three units: general medicine (n=195), oncology (n=120), and cardiology (n=109).

In surgical departments, the prevalence of nutritional risk was highest in intensive care units (74%), otolaryngology (40%), and general surgery (40%).

Nearly half (41%) of the patients discharged from hospital to nursing homes were at nutritional risk.

7. Discussion

The overall aim of this dissertation was to improve the Bergen Nutritional Strategy and to objectively evaluate the initiative. During eight nutritional prevalence surveys conducted over two years, nutritional screening performance improved, but nutritional care did not. We conclude that NRS 2002 is appropriate and effective for identifying patients at nutritional risk. Novel information is that for screening purposes, the first four questions of NRS 2002 strongly predicts prolonged hospitalisation, morbidity, and mortality. Furthermore, we have shown that nutritional risk is common among nearly all hospital units and patient groups.

7.1 Methodological issues

7.1.1 Definition of nutritional risk

The results of this study are affected of the definition of nutritional risk. The term 'nutritional risk' includes both malnourished patients and patients at risk of developing malnutrition. Other criteria and a more precise definition would likely have resulted in different prevalence estimates, and thus risk estimates. However, NRS 2002 is widely used in Norwegian and European hospitals, and thus its criteria are highly relevant and appropriate.

7.1.2 Study design

Study I

The first study (paper I) was an observational study conducted to evaluate the effect of an overall nutritional strategy on clinical practice over a two year period. The effect parameters were number of patients screened and treated. Several elements could have influenced practice during the two years. Observational studies are not appropriate for assessing separate individual factors or intervention (89). A prospectively designed study with intervention and control groups would have been

more appropriate. However at this time, it was not feasible to do an intervention study. Instead, we deemed it would be more appropriate as the first step to perform an observational survey to assess the effect of such a program.

Study II

The second study (paper II) was a longitudinal cohort study showing that being at nutritional risk was associated with adverse clinical outcomes such as morbidity, increased hospitalisation, and mortality during a one-year follow-up. Because of the design and data collected, we cannot conclude whether the strong association found between being at nutritional risk and adverse clinical outcomes is caused by lack of nutrients or by underlying disease. Adjusting for several confounding variables (e.g., illness severity and co-morbidity), however, strengthened the finding that adverse outcomes are related to nutrition-related condition(s) identified with NRS 2002. This is briefly discussed in Section 7.1.3. Despite this weakness, the design was considered appropriate for assessing the associations between nutritional risk and adverse outcomes.

Study III

The third study (paper III) was a cross-sectional study that determined the prevalence of nutritional risk in different hospital units and patient groups. The prevalence of a clinical condition is affected by incidence, duration, and time of investigation: The greater the incidence and the longer the duration of nutritional risk, the higher the prevalence. Also, the results would have been influenced differently if data collection had occurred at hospital admission (91).

However we believe that point prevalence surveys are appropriate for investigating the daily burden of nutritional risk in a hospital (89).

7.1.3 **Internal validity**

Internal validity refers to the extent to which scientific inference can be drawn for the population under study (89). The main types of errors affecting epidemiologic studies

are random and systematic errors. The chance for random errors is reduced with larger sample sizes. Thus, random errors should be relatively low in our studies, as there were a large number of participants: Study I had 3604 participants, studies II and III had 3279 participants. A single measurement is more likely to be affected by random failure. This is the case with the prevalence estimates. Prevalence values were calculated from an average of 7-8 repeated measurements, and therefore are likely robust. Therefore, we claim that it was not necessary to address the issue that random errors might have unduly influenced the results.

Systematic errors, -*selection bias, information bias,* and *confounding factors,* are not affected by sample size (89). In our study*, selection bias* cannot be totally excluded since 17% of the patients were not fully screened, even though the screening procedure was part of regular routine and should include all adult patients hospitalised in somatic wards. To assess the possibility that selection bias was present, we collected administrative data on patients who were not screened. We found that these patients had scores between the patient group identified to be "at nutritional risk" and the patient group "not at risk" according to mean values of gender, age, number of diagnoses and hospital stay. We hypothesized that the sickest and the healthiest patients might have been more likely to be missed in the routine screening.

Information bias may lead to classification of patients in an incorrect category. For example, NRS 2002 screening questions are simple questions about potentially complicated issues. In some cases, it might be difficult to obtain a categorical 'yes' or 'no' answer on some of the first four questions of NRS 2002. It might also be difficult to obtain reliable information for some of the questions of the remaining screening items of NRS 2002. Examples are the questions about weight 3 months prior to screening and food intake related to normal intake. The patients' patterns of eating may vary widely due to several factors that were not investigated. Ideally, food intake should be registered in order to evaluate to what extent nutritional needs are

met. In these three studies, misclassifying patients into categories could have occurred because several different staff collected the data.

Because of the included parameters, a weakness of NRS 2002 is that patients who ate a poor, unbalanced diet but without weight loss, or patients who had high fat mass might be identified as 'not at risk' despite their poor nutritional status. Patients with a compromised lifestyle, taking certain medications (e.g., prednisolone or comparable medication with a similar effect), or experiencing edema might be more likely to be miscategorised as being not at risk, even though they are at risk.

Study I

According to the guidelines, a nutritional plan should be prepared for patients at nutritional risk. The extent of compliance was not assessed. In paper I we assumed that patients receiving nutritional supplements also had a nutritional plan. We cannot exclude the possibility that some information bias may have been present in Study I.

Study II

Collecting data on a particular day, as we did for the point prevalence surveys, is more likely to result in the sampling of patients with prolonged hospitalisation (selection bias). How we handled length-sample bias is described in the Methods (Section 4.7).

In Study II, the association between nutritional risk and adverse outcomes could have been affected by other variables that were not studied directly (i.e., *confounders*). Chronological age of patients is one of the most prominent confounding variables that may influence the association of nutritional risk with morbidity and mortality. The estimate of the adjusted odds ratio for morbidity included the possible confounding variables.

Study III

To compare estimated prevalences between different hospital wards, prevalence data were controlled for age and sex by a direct standardized method. This is described in

the data collection section of the Methods (Section 4.6). Standardisation is a method commonly used to deal with confounding factors in order to facilitate comparisons of different groups (94).

7.1.4 External validity

External validity (or generalisability) refers to the ability to generalize results and conclusions from the study population to other populations (89).

The study population consisted of all adult patients in somatic wards at Haukeland University Hospital and at three satellite hospitals (Voss, Hagavik, and Nordås) Haukeland University Hospital is a local and regional hospital, with one national hospital specialty (burns). The screening tool is not suitable for use on children, patients admitted for bariatric surgery, psychiatric patients, pregnant women, or terminally ill patients. These patients were excluded.

Based on this, our results have high external validity.

7.1.5 Screening

Screening is the systematic collection of simple parameters that are used to detect more complex conditions that are easy to overlook, in order to prevent a disease or provide treatment at an early stage of disease (55). In the best cases lives are saved.

The dilemma of screening is the risk of misclassification of healthy persons as being sick, or at risk of being sick (false positive), or failing to identify truly sick persons that should be treated (false negative). Another concern arises when the screening method itself may be unsafe (53, 95). A related concern is when a screening program reliably identifies a large number of sick patients, or at-risk persons, but who will not be offered treatment.

Validity

It is essential that NRS 2002 has a robust ability to correctly identify patients truly at nutritional risk (sensitivity) and also to correctly reject those patients not at risk (specificity) (39). Such validation requires a 'gold standard' for comparison. Although no consensus exists on which 'gold standard' to use for nutritional screening tools, the SGA is one standard widely used.

Several studies have shown that sensitivity and specificity of NRS 2002 has acceptable limits. The malnutrition advisory group validated NRS 2002 against SGA and found sensitivity and specificity to be 74% and 87%, respectively (96). In a review of 43 studies validating 28 screening tools, compared to the MNA and SGA, NRS 2002 satisfactorily predicted clinical outcomes, such as increased hospitalisation, mortality, and complications (97). In another study, Raslan and co-workers compared NRS 2002, MUST, and MNA-SF with the SGA and found NRS 2002 to be a good predictor of unfavorable clinical outcomes, even though it identified only 28% of at-nutritional risk patients (98). This may be because NRS 2002 takes into account the effect a disease may have on nutritional status (98).

Ideally, validation of NRS 2002 should take into account the fact that it is designed to identify patients who will benefit from nutritional treatment. It is not intended to determine the nutritional status of patients. This type of validation is yet to be performed.

Treatment

Weight loss due to loss of appetite during illness contributes significantly to adverse outcome (69). The rationale for nutritional risk screening is that early nutritional treatment together with exercise is the treatment of choice for preserving muscle mass and thus improving clinical outcome (99). Pharmacological intervention to improve appetite has little effect and possibly may have adverse side effects (69). Thus, nutritional therapy appears to be the logical way to combat inadequate nutrition. However, a Cochrane review concluded that positive evidence for nutritional

screening aimed at improving patient outcome is lacking (55). In order to strengthen such evidence, screening must be evaluated as part of the pathway that leads to tailored nutritional treatment. Further, outcome of *earlier* nutritional treatment must be compared to treatment onset at the time nutritional depletion would have been identified without screening. Finally, proper guidelines and resources to educate and treat must be developed and presented ahead of a screening program in order to take care of the large number of at risk patients.

7.1.6 **Prevalence surveys**

Repeated prevalence surveys are shown to improve clinical practice in hospitals (100, 101). The nutrition registrations were organised in the same way as the infection registrations and were introduced to improve nutritional skills, remind the staff to give nutritional needs a priority, and to highlight important knowledge about nutritional depletion in hospitalised patients. These are important factors for improving nutritional care. Finally, repeated prevalence surveys allow trend analyses.

Conducting the surveys is time-consuming for hospital staff. Introducing the screening tool into the electronic patient journal system would simplify data collection, and important data will then be available 24/7.

We still suggest prevalence surveys to be appropriate to assess the ‘burden’ of nutritional risk in hospitalised patients, and to give a signal that nutrition is an important part of patient care.

7.2 Discussion of the results

In this section, I discuss the importance and magnitude of nutritional risk in hospitals, as shown in papers II and III, and then I discuss whether this should affect clinical practice (paper I).

7.2.1 **Paper II: Prediction of adverse outcomes**

In study II, all adult patients at Haukeland University Hospital were investigated regarding nutritional risk. Twenty-nine percent of the patients were identified as being in nutritional risk. We found that being at nutritional risk was associated with increased morbidity, hospitalisation, and mortality during one-year follow-up, even after adjusting for relevant confounding variables. Also, each of the first four NRS 2002 questions was effective in predicting morbidity and mortality.

The results, were affected by the time of data collection. Performing the screening at admission, rather than by point-prevalence surveys, would have included more patients with shorter hospital stays. How length-sample bias was handled is described in the Section 4.5.

The prevalence of nutritional risk varies ranging from 15 to 60% depending on which criteria are used to identify its occurrence and which patient population is investigated (51). The prevalence of nutritional risk identified by NRS 2002 and its four initial questions are both within the range of what has been reported during the last 15 years from studies of hospital populations (27, 28, 33, 74, 102-104).

Even after adjusting for relevant confounders, the association between being at nutritional risk and adverse outcomes, such as increased morbidity, hospitalisation and even mortality, was strong. Also, each of the four questions was independent and effective in predicting adverse outcomes, and thus are important parts of the screening tool. This is in line with other studies. In a multinational multicentre study, Sorensen et al. found NRS 2002, and elements of it, to predict increased

hospitalisation, morbidity, and mortality (28). Kyle et al. screened nearly 1000 patients with NRS 2002 and found nutritional risk to be associated with increased hospitalisation (105). According to other studies, NRS 2002 also predicts postoperative complications (106, 107).

Ideally, nutritional assessment should become part of patient care in order to perform tailored nutritional treatment (108). Because assessment is time-consuming, simpler screening methods such as NRS 2002 should be mandatory. Quick and easy methods could have consequences for patients falsely recognised as being not at risk (false negative) (109). On the other hand, patients identified as false positive might overburden the health care system. Compared to the more complex scoring questions of the complete NRS 2002, the four initial questions identified correctly all the patients at nutritional risk and 91% of the patients not at risk. Thus, these initial questions incorrectly 'over-identified' 9% of the patients to be at nutritional risk compared to the full screening program. Using the full survey did not result in any material improvement in the prediction of subsequent adverse outcomes. Misclassifications or mistakes most commonly occur during the scoring of NRS 2002 which is also the most time-consuming part of the survey (110).

Costs

In this study, the estimation of hospital costs was based on length of hospitalisation and a calculated price per day at Norwegian hospitals (88). More thorough investigations are needed in order to perform cost-efficient analyses more precisely, and in order to describe the extent to which different parts of the health services costs will increase. Such analyses were performed in Croatia and Portugal (111, 112). They found that 3.4% of the total national health-care budget was used to treat malnourished patients. The money was spent on more medication (43%), prolonged hospitalisations (34%), more community health nursing (13%), parenteral nutrition (6%), and enteral nutrition (1%) ((112).

7.2.2 **Paper III: Risk groups in a university hospital**

Study III revealed that the proportion of patients at nutritional risk was high in almost all patient groups at Haukeland University Hospital. As expected, the prevalence of nutritional risk was highest among the elderly; the slimmest patients; patients with multi-morbidity; and among patients with infections, cancer, and pulmonary diseases. However, at this hospital, most of the at-nutritional-risk patients were *not* underweight, had four to seven diagnoses, and were 60-80 years old. Even younger patients, obese patients, and patients with few diagnoses were frequently found to be at nutritional risk.

The prevalence of nutritional risk was greatest among patients in the intensive care unit and in oncology and pulmonology units. Patients in these units might have wasting due to severe and sometimes terminal diseases (99). Also in patients with myocardial infarction, where being overweight may be a risk factor, one out of four patients were at nutritional risk. Nearly half of the patients discharged from hospital to nursing homes were at nutritional risk.

The prevalence of nutritional risk in patients aged 80 and older was 40%. This result was influenced by adding one extra score to the overall NRS 2002 score for patients aged 70 years and older. Without the additional score for age, the prevalence of nutritional risk would have been 29% for patients 80 years and older and 25% for patients 60 to 79 years old. Old age is a well-known risk factor for malnutrition (4, 27, 97, 99, 105). Older people have lower tolerance for reduced nutritional status due to reduced muscle mass (sarcopenia), and more co-morbidity and polypharmacy, which affect appetite, food intake and absorption of nutrients (4, 9, 31, 32, 99, 113). It might be difficult to identify nutritional depletion in the elderly when loss of muscle mass is hidden by increased fat mass and when a reduction in height results in a false ‘normal’ BMI values (99, 114). Therefore, adding one extra point for age is a good solution for addressing this challenge.

Furthermore, the prevalence of nutritional risk was inversely proportional to body weight. This was because in NRS 2002, low BMI and large weight loss can be given up to three points. Even though patients might be categorised as having a lower BMI because of wasting, the prevalence of nutritional risk was still high among overweight and obese patients. This was also observed in previous studies (10, 115). Hence awareness of nutrition is relevant for patients regardless of their BMI.

We found that patients at nutritional risk were a heterogeneous group. They were admitted to almost all hospital units; comprised many disease categories; had great variability of age and BMI; and had a single, few, or several diagnoses. The heterogeneity of the patients indicates that it might be difficult to identify patients at nutritional risk without nutritional risk screening or assessment. Hence, routine screening on admission according to guidelines appears essential.

Up to 25% of patients discharged to their own home, and 40% of patients discharged to nursing homes, were at nutritional risk. Adequate transmission of information about nutritional status and intervention from the hospital to the GPs, home care services and nursing homes is therefore important. According to a Dutch study, such systematic transfer of relevant nutritional information from the hospital to the primary health carrier is fragmentary and even lacking (116). This may also be the case in our hospital. Proper reporting of nutritional status, nutritional plan, and goals is an important part of health care. In countries like Norway that lack dieticians to follow up patients after hospital discharge, and the quality of discharge letters is even more essential (117, 118).

7.2.3 **Paper I: Change in clinical practice**

In this study we investigated how clinical practice changed during eight surveys over two years. Although screening performance improved over of the eight surveys and

although as much as every third patient was identified as being at nutritional risk, the proportion of patients treated was very low and did not improve over time. An important reason might be that the nutritional strategy and education of the staff was performed before the first prevalence survey. Change in clinical practice might have occurred before the first survey. Furthermore, the last prevalence survey was performed during the high-level mobilisation against the swine flu epidemic, which might have influenced the results.

When the nutritional strategy was carried out, we took into account five factors suggested by the Council of Europe as being major barriers to implementing nutritional guidelines in hospitals (1). The barriers were:

1. Lack of sufficient education with regard to nutrition among all staff groups.
2. Lack of cooperation between different staff groups.
3. Lack of clearly defined responsibilities in planning and managing nutritional care.
4. Lack of involvement from the hospital managers.
5. Lack of influence and knowledge of the patients.

Barriers against improving nutritional care in hospitals are under discussion. In Norway, lack of knowledge and interest among physicians and nurses are important barriers. Nutrition has low-priority in the education of medical students and nurses (117). Norwegian physicians and nurses reported that they have less knowledge and interest in clinical nutrition than their Danish and Swedish counterparts (2, 119). In a Norwegian study by Eide, nurses reported ‘loneliness’ in nutritional care (120). The physicians were not involved and dieticians were not available; thus, nutritional care was easily neglected during busy days (120). The number of dieticians/clinical nutritionists in Norwegian hospitals is among the lowest in Western countries (117), implying that physicians and nurses are those responsible for nutritional care. The interest in nutritional matters is poor in wards not regularly visited by dieticians (121).

Our studies and recent publications (2, 117, 119, 120), suggest that there is scarcity of nutritional knowledge and available dieticians.

We propose that a more intense focus on nutritional education of physicians; economic incentives, such as reimbursement for diagnosing malnutrition; and audits by health authorities may improve clinical practice (108, 122). Indeed, we believe that it is critical to increase the number of clinical dieticians that in colaboratorian with doctors, nurses and kitchen personnell can develop systems to ensure implementation of guidelines, improve food quality, number of dishes and flexibility in food service practices.

To make it simpler, we propose that the four initial guestions of NRS 2002 are used instead of the full screening tool (123). This is safe as all patients at nutritional risk is identified by the first four questions of NRS 2002 (no false negatives). However, further consensus regarding assessment of patients at nutritional risk must be attained.

7.3 Implications for clinical practice

There is an increased attention in many countries on improving quality and efficiency of health-care management and delivery (124). We suggest that this focus should also include disease-related malnutrition as this has a huge impact on patient outcome.

Bridging the 'know-do' gap

The 'know-do' gap is the disparity between what is known and what is done in practice (119). Failure to bridge this gap often has grave consequences.

Repeated prevalence surveys regularly performed at Haukeland University Hospital revealed that a large proportion of patients in most hospital units were at nutritional risk. Moreover, this risk was strongly associated with increased morbidity, hospitalisation, and mortality. Even though screening performance improved and prevalence data were regularly presented to hospital staff, delivery of tailored

nutritional treatment was insufficient. This ‘know-do’ gap between patients identified and patients actually treated could undermine overall treatment quality.

Improvement of nutritional care represents a unique opportunity for hospitals to improve patient care and to reduce costs (30).

8. Conclusions

Our studies in a university hospital patient population revealed that being at nutritional risk is associated with morbidity, increased use of hospital services and premature death. NRS 2002 was suitable to identify high risk patients. One third of the patients were at nutritional risk. They were identified in all hospital units, disease categories, categories of BMI and ages. The novelty of this thesis is that the first four questions of NRS 2002 strongly predict prolonged hospitalisation, morbidity, and mortality, and can replace the full NRS 2002 to identify patients who would benefit from focussed nutritional intervention. This simplification is suggested to be cost-effective and easier to implement in clinical practice.

Implementation of the nutritional strategy improved the screening performance among the hospital staff. However, nutritional treatment was not implemented. Efforts to highlight nutritional knowledge and practice are required to improve patient care.

9. Suggestions for future research

- NRS2002 is designed to identify patients who will profit from nutritional support. To prove that early tailored nutrition cause a better outcome in these patients, still remains.
- Barriers against improving clinical practice according to guidelines should be investigated in a survey (questionnaire) among nurses, dieticians, and physicians.
- To investigate if a simpler screening method, such as the four initial questions of NRS 2002, could result in a higher proportion of patients screened and a higher number of patients treated.
- To examine if focusing on long- stayers (>3 days hospitalization) can increase the numbers screened and the numbers treated.
- To investigate whether change in responsibility (nurse vs dieticians) can alter number screened and number receiving nutritional treatment (clinical performance).
- A systematic literature review failed, due to lack of high quality studies, to show that nutritional screening improves clinical outcome. This represents a lack in existing knowledge that needs to be filled.

10. References

1. Council of Europe. Food and nutritional care in hospitals: How to prevent undernutrition.: Council of Europe; 2002. Available from: http://lis.tees.ac.uk/campus/food_and_nutritional_care_in_hospitals.pdf.
2. Mowe M, Bosaeus I, Rasmussen HH, Kondrup J, Unosson M, Rothenberg E, et al. Insufficient nutritional knowledge among health care workers? Clinical nutrition. 2008;27(2):196-202.
3. Doehner W, Anker SD. Cardiac cachexia in early literature: a review of research prior to Medline. International journal of cardiology. 2002;85(1):7-14.
4. Stratton RG, C.J.; Elia, M. Disease-related malnutrition: An Evidence-Based Approach To Treatment CABI publishing; 2003.
5. Jensen GL, Mirtallo J, Compher C, Dhaliwal R, Forbes A, Grijalba RF, et al. Adult starvation and disease-related malnutrition: a proposal for etiology-based diagnosis in the clinical practice setting from the International Consensus Guideline Committee. Clinical nutrition. 2010;29(2):151-3.
6. White JV, Guenter P, Jensen G, Malone A, Schofield M, Academy Malnutrition Work G, et al. Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). JPEN Journal of parenteral and enteral nutrition. 2012;36(3):275-83.
7. Jeejeebhoy KN. Malnutrition, fatigue, frailty, vulnerability, sarcopenia and cachexia: overlap of clinical features. Current opinion in clinical nutrition and metabolic care. 2012;15(3):213-9.
8. Agarwal E, Ferguson M, Banks M, Bauer J, Capra S, Isenring E. Nutritional status and dietary intake of acute care patients: results from the Nutrition Care Day Survey 2010. Clinical nutrition. 2012;31(1):41-7.
9. Stratton RJ. Malnutrition: another health inequality? The Proceedings of the Nutrition Society. 2007;66(4):522-9.
10. Pirlich M, Schutz T, Norman K, Gastell S, Lubke HJ, Bischoff SC, et al. The German hospital malnutrition study. Clinical nutrition. 2006;25(4):563-72.
11. Orsitto G, Fulvio F, Tria D, Turi V, Venezia A, Manca C. Nutritional status in hospitalized elderly patients with mild cognitive impairment. Clinical nutrition. 2009;28(1):100-2.
12. Mann T, Heuberger R, Wong H. The association between chewing and swallowing difficulties and nutritional status in older adults. Australian dental journal. 2013;58(2):200-6.
13. Sura L, Madhavan A, Carnaby G, Crary MA. Dysphagia in the elderly: management and nutritional considerations. Clinical interventions in aging. 2012;7:287-98.

14. Carrion S, Cabre M, Monteis R, Roca M, Palomera E, Serra-Prat M, et al. Oropharyngeal dysphagia is a prevalent risk factor for malnutrition in a cohort of older patients admitted with an acute disease to a general hospital. Clinical nutrition. 2014.
15. Hiesmayr M, Schindler K, Pernicka E, Schuh C, Schoeniger-Hekele A, Bauer P, et al. Decreased food intake is a risk factor for mortality in hospitalised patients: the NutritionDay survey 2006. Clinical nutrition. 2009;28(5):484-91.
16. Almdal T, Viggers L, Beck AM, Jensen K. Food production and wastage in relation to nutritional intake in a general district hospital--wastage is not reduced by training the staff. Clinical nutrition. 2003;22(1):47-51.
17. Tappenden KA, Quatrara B, Parkhurst ML, Malone AM, Fanjiang G, Ziegler TR. Critical role of nutrition in improving quality of care: an interdisciplinary call to action to address adult hospital malnutrition. Journal of the Academy of Nutrition and Dietetics. 2013;113(9):1219-37.
18. Weekes CE, Spiro A, Baldwin C, Whelan K, Thomas JE, Parkin D, et al. A review of the evidence for the impact of improving nutritional care on nutritional and clinical outcomes and cost. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association. 2009;22(4):324-35.
19. Agarwal E, Ferguson M, Banks M, Batterham M, Bauer J, Capra S, et al. Malnutrition and poor food intake are associated with prolonged hospital stay, frequent readmissions, and greater in-hospital mortality: results from the Nutrition Care Day Survey 2010. Clinical nutrition. 2013;32(5):737-45.
20. Duncan DG, Beck SJ, Hood K, Johansen A. Using dietetic assistants to improve the outcome of hip fracture: a randomised controlled trial of nutritional support in an acute trauma ward. Age and ageing. 2006;35(2):148-53.
21. McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. Bmj. 1994;308(6934):945-8.
22. Martins CP, Correia JR, do Amaral TF. Undernutrition risk screening and length of stay of hospitalized elderly. Journal of nutrition for the elderly. 2005;25(2):5-21.
23. Bauer JD, Isenring E, Torma J, Horsley P, Martineau J. Nutritional status of patients who have fallen in an acute care setting. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association. 2007;20(6):558-64.
24. Naber TH, Schermer T, de Bree A, Nusteling K, Eggink L, Kruimel JW, et al. Prevalence of malnutrition in nonsurgical hospitalized patients and its association with disease complications. The American journal of clinical nutrition. 1997;66(5):1232-9.
25. Thomas DR. Starving in the hospital. Nutrition. 2003;19(10):907-8.
26. Singh H, Watt K, Veitch R, Cantor M, Duerksen DR. Malnutrition is prevalent in hospitalized medical patients: are housestaff identifying the malnourished patient? Nutrition. 2006;22(4):350-4.

27. Imoberdorf R, Meier R, Krebs P, Hangartner PJ, Hess B, Staubli M, et al. Prevalence of undernutrition on admission to Swiss hospitals. Clinical nutrition. 2010;29(1):38-41.
28. Sorensen J, Kondrup J, Prokopowicz J, Schiesser M, Krahenbuhl L, Meier R, et al. EuroOOPS: an international, multicentre study to implement nutritional risk screening and evaluate clinical outcome. Clinical nutrition. 2008;27(3):340-9.
29. Kaiser MJ, Bauer JM, Ramsch C, Uter W, Guigoz Y, Cederholm T, et al. Frequency of malnutrition in older adults: a multinational perspective using the mini nutritional assessment. Journal of the American Geriatrics Society. 2010;58(9):1734-8.
30. Barker LA, Gout BS, Crowe TC. Hospital malnutrition: prevalence, identification and impact on patients and the healthcare system. International journal of environmental research and public health. 2011;8(2):514-27.
31. Juliebo V, Bjoro K, Krogseth M, Skovlund E, Ranhoff AH, Wyller TB. Risk factors for preoperative and postoperative delirium in elderly patients with hip fracture. Journal of the American Geriatrics Society. 2009;57(8):1354-61.
32. Mowe M, Diep L, Bohmer T. Greater seven-year survival in very aged patients with body mass index between 24 and 26 kg/m2. Journal of the American Geriatrics Society. 2008;56(2):359-60.
33. Kondrup J, Johansen N, Plum LM, Bak L, Larsen IH, Martinsen A, et al. Incidence of nutritional risk and causes of inadequate nutritional care in hospitals. Clinical nutrition. 2002;21(6):461-8.
34. Krell RW, Kaul DR, Martin AR, Englesbe MJ, Sonnenday CJ, Cai S, et al. Association between sarcopenia and the risk of serious infection among adults undergoing liver transplantation. Liver transplantation : official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society. 2013;19(12):1396-402.
35. Lieffers JR, Bathe OF, Fassbender K, Winget M, Baracos VE. Sarcopenia is associated with postoperative infection and delayed recovery from colorectal cancer resection surgery. British journal of cancer. 2012;107(6):931-6.
36. Cosqueric G, Sebag A, Ducolombier C, Thomas C, Piette F, Weill-Engerer S. Sarcopenia is predictive of nosocomial infection in care of the elderly. The British journal of nutrition. 2006;96(5):895-901.
37. Elia M. The "MUST" report. Nutritional screening of adults: multidisciplinary responsibility. Development and use of the "Malnutrition Universal Screening Tool" (MUST) for adults. 2003.
38. Mowe M, Bohmer T. Reduced appetite. A predictor for undernutrition in aged people. The journal of nutrition, health & aging. 2002;6(1):81-3.
39. Gibson R. Principles of Nutritional Assessment: Oxford University Press; 2005.
40. Dwyer J. Dietary Assessment. In: Maurice E Shils, James A Olson, Moshe Shike, A Catharine Ross, editors. Modern Nutrition in Health and Disease. 9th ed. Baltimore, USA: Lippincott Williams & Wilkins; 1999. p. 1941.

41. WHO. BMI classification 2014. 26/11/2014:[Available from: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html.
42. Klein S, Allison DB, Heymsfield SB, Kelley DE, Leibel RL, Nonas C, et al. Waist circumference and cardiometabolic risk: a consensus statement from Shaping America's Health: Association for Weight Management and Obesity Prevention; NAASO, The Obesity Society; the American Society for Nutrition; and the American Diabetes Association. The American journal of clinical nutrition. 2007;85(5):1197-202.
43. Directorate of Health. Overvekt og fedme. http://helsedirektoratet.no/folkehelse/ernering/klinisk-ernering/diagnoser/Sider/overvekt.aspx: Helsedirektoratet; 2014 [cited 2014 13.02].
44. Falsarella GR, Coimbra IB, Barcelos CC, Iartelli I, Montedori KT, Santos MN, et al. Influence of muscle mass and bone mass on the mobility of elderly women: an observational study. BMC geriatrics. 2014;14:13.
45. Flood A, Chung A, Parker H, Kearns V, O'Sullivan TA. The use of hand grip strength as a predictor of nutrition status in hospital patients. Clinical nutrition. 2014;33(1):106-14.
46. Norman K, Stobaus N, Gonzalez MC, Schulzke JD, Pirlich M. Hand grip strength: outcome predictor and marker of nutritional status. Clinical nutrition. 2011;30(2):135-42.
47. Hillman TE, Nunes QM, Hornby ST, Stanga Z, Neal KR, Rowlands BJ, et al. A practical posture for hand grip dynamometry in the clinical setting. Clinical nutrition. 2005;24(2):224-8.
48. Hornby ST, Nunes QM, Hillman TE, Stanga Z, Neal KR, Rowlands BJ, et al. Relationships between structural and functional measures of nutritional status in a normally nourished population. Clinical nutrition. 2005;24(3):421-6.
49. Guigoz Y. The Mini Nutritional Assessment (MNA) review of the literature--What does it tell us? The journal of nutrition, health & aging. 2006;10(6):466-85; discussion 85-7.
50. Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, et al. What is subjective global assessment of nutritional status? JPEN Journal of parenteral and enteral nutrition. 1987;11(1):8-13.
51. Mueller C, Compher C, Ellen D.M., ASPEN. A.S.P.E.N. Clinical Guidelines. Nutrition Screening, Assessment, and Intervention in Adults. Journal of Parenteral and Enteral Nutrition. 2011;35(1):16-24.
52. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z, Ad Hoc EWG. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. Clinical nutrition. 2003;22(3):321-36.
53. Mæland JG. Forebyggende helsearbeid. Folkehelsearbeid i teori og praksis. Oslo: Universitetsforlaget; 2010.
54. Elia M, Zellipour L, Stratton RJ. To screen or not to screen for adult malnutrition? Clinical nutrition. 2005;24(6):867-84.

55. Omidvari AH, Vali Y, Murray SM, Wonderling D, Rashidian A. Nutritional screening for improving professional practice for patient outcomes in hospital and primary care settings. The Cochrane database of systematic reviews. 2013;6:CD005539.
56. Reilly HM, Martineau JK, Moran A, Kennedy H. Nutritional screening--evaluation and implementation of a simple Nutrition Risk Score. Clinical nutrition. 1995;14(5):269-73.
57. Ferguson M, Capra S, Bauer J, Banks M. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. Nutrition. 1999;15(6):458-64.
58. Kuzu MA, Terzioglu H, Genc V, Erkek AB, Ozban M, Sonyurek P, et al. Preoperative nutritional risk assessment in predicting postoperative outcome in patients undergoing major surgery. World journal of surgery. 2006;30(3):378-90.
59. Kovacevich DS, Boney AR, Braunschweig CL, Perez A, Stevens M. Nutrition risk classification: a reproducible and valid tool for nurses. Nutrition in clinical practice : official publication of the American Society for Parenteral and Enteral Nutrition. 1997;12(1):20-5.
60. The Veterans AffairsTotal Parenteral Nutrition Cooperative Study Group. Perioperative total parenteral nutrition in surgical patients. The new England journal of medicine 1991;325(8):525-32.
61. Ingenbleek Y, Carpentier YA. A prognostic inflammatory and nutritional index scoring critically ill patients. International journal for vitamin and nutrition research Internationale Zeitschrift fur Vitamin- und Ernahrungsforschung Journal international de vitaminologie et de nutrition. 1985;55(1):91-101.
62. Buzby GP, Mullen JL, Matthews DC, Hobbs CL, Rosato EF. Prognostic nutritional index in gastrointestinal surgery. American journal of surgery. 1980;139(1):160-7.
63. Laporte M, Villalon L, Thibodeau J, Payette H. Validity and reliability of simple nutrition screening tools adapted to the elderly population in healthcare facilities. The journal of nutrition, health & aging. 2001;5(4):292-4.
64. Kruizenga HM, Van Tulder MW, Seidell JC, Thijs A, Ader HJ, Van Bokhorst-de van der Schueren MA. Effectiveness and cost-effectiveness of early screening and treatment of malnourished patients. The American journal of clinical nutrition. 2005;82(5):1082-9.
65. Guttormsen A, Irtun Ø, Mowe M, Sørbye L, Thoresen L, Øien H, et al. National guidelines on preventing and treatment of malnutrition. Oslo: Directorate of Health, 2009 IS-1580.
66. Jie B, Jiang ZM, Nolan MT, Efron DT, Zhu SN, Yu K, et al. Impact of nutritional support on clinical outcome in patients at nutritional risk: a multicenter, prospective cohort study in Baltimore and Beijing teaching hospitals. Nutrition. 2010;26(11-12):1088-93.

67. Stratton RJ, Elia M. A review of reviews: A new look at the evidence for oral nutritional supplements in clinical practice. Clinical Nutrition Supplements. 2007;2007(2):5-23.
68. Milne AC, Avenell A, Potter J. Meta-analysis: protein and energy supplementation in older people. Annals of internal medicine. 2006;144(1):37-48.
69. Schutz P, Bally M, Stanga Z, Keller U. Loss of appetite in acutely ill medical inpatients: physiological response or therapeutic target? Swiss medical weekly. 2014;144:w13957.
70. Doig GS, Simpson F, Sweetman EA, Finfer SR, Cooper DJ, Heighes PT, et al. Early parenteral nutrition in critically ill patients with short-term relative contraindications to early enteral nutrition: a randomized controlled trial. JAMA : the journal of the American Medical Association. 2013;309(20):2130-8.
71. Casaer MP, Mesotten D, Hermans G, Wouters PJ, Schetz M, Meyfroidt G, et al. Early versus late parenteral nutrition in critically ill adults. N Engl J Med. 2011;365(6):506-17.
72. Heyland D, Muscedere J, Wischmeyer PE, Cook D, Jones G, Albert M, et al. A randomized trial of glutamine and antioxidants in critically ill patients. N Engl J Med. 2013;368(16):1489-97.
73. Jensen GL, Wheeler D. A new approach to defining and diagnosing malnutrition in adult critical illness. Current opinion in critical care. 2012;18(2):206-11.
74. Lim SL, Ong KC, Chan YH, Loke WC, Ferguson M, Daniels L. Malnutrition and its impact on cost of hospitalization, length of stay, readmission and 3-year mortality. Clinical nutrition. 2012;31(3):345-50.
75. Alvarez-Hernandez J, Planas Vila M, Leon-Sanz M, Garcia de Lorenzo A, Celaya-Perez S, Garcia-Lorda P, et al. Prevalence and costs of malnutrition in hospitalized patients; the PREDyCES Study. Nutricion hospitalaria. 2012;27(4):1049-59.
76. Ljungqvist O, Man F. Under nutrition: a major health problem in Europe. Nutricion hospitalaria. 2009;24(3):369-70.
77. Ljungqvist O, van Gossum A, Sanz ML, de Man F. The European fight against malnutrition. Clinical nutrition. 2010;29(2):149-50.
78. Robinson G, Goldstein M, Levine GM. Impact of nutritional status on DRG length of stay. JPEN Journal of parenteral and enteral nutrition. 1987;11(1):49-51.
79. Elia M, Stratton RJ, Russell C, Green C, Pan F. The cost of disease-related malnutrition in the UK and economic considerations for the use of oral nutritional supplements (ONS) in adults. http://www.bapen.org.uk/pdfs/health_econ_exec_sum.pdf: BAPEN; 2012 [cited 2012].

80. Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clinical nutrition. 2003;22(3):235-9.
81. Lyder CH, Preston J, Grady JN, Scinto J, Allman R, Bergstrom N, et al. Quality of care for hospitalized medicare patients at risk for pressure ulcers. Archives of internal medicine. 2001;161(12):1549-54.
82. Freijer K, Tan SS, Koopmanschap MA, Meijers JM, Halfens RJ, Nuijten MJ. The economic costs of disease related malnutrition. Clinical nutrition. 2013;32(1):136-41.
83. National Institute for Health and Care Excellence. Implementing a policy for identifying and managing malnutrition in Care Homes https://www.nice.org.uk/savingsAndProductivityAndLocalPracticeResource?ci=http%3a%2f%2fsearch.nice.org.uk%2fusingguidance%2fsharedlearningimplementingniceguidance%2fexamplesofimplementation%2feximpresults.jsp%3fo%3d342: NICE; [updated 09.09.2014; cited 2013].
84. Nidirect. Promoting good nutrition. Strategy for good nutritionl care for adults in all care settings in Nothern Irland 2011-2016. In: Ireland G, editor. http://www.dhsspsni.gov.uk/index/index-good-nutrition/gn-context/gn-disease-malnutrition: nidirect; 2014.
85. Juul H. Forebygging og behandling av underernæring. Potensial for kostnadsbesparelser? 2010.
86. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M, Educational, et al. ESPEN guidelines for nutrition screening 2002. Clinical nutrition. 2003;22(4):415-21.
87. Herud T, Nilsen RM, Svendheim K, Harthug S. Association between use of hand hygiene products and rates of health care-associated infections in a large university hospital in Norway. American journal of infection control. 2009;37(4):311-7.
88. Ministry of Health Care services. Stortingsmelding nr 47. 2008-2009. Samhandlingsreformen. Oslo: Ministry of Health Care services.
89. Rothman KLT. Moden epidemiology. Third edition. : William & Wilkins; 2008.
90. Fluss R, Mandel M, Freedman LS, Weiss IS, Zohar AE, Haklai Z, et al. Correction of sampling bias in a cross-sectional study of post-surgical complications. Statistics in medicine. 2013;32(14):2467-78.
91. Nowell C, Stanley LL. Length-biased sampling in mall intercept surveys. Journal of Marketing Research. 1991;28(4):475-9.
92. Nilsen RM, Vollset SE, Gjessing HK, Magnus P, Meltzer HM, Haugen M, et al. Patterns and predictors of folic acid supplement use among pregnant women: the Norwegian Mother and Child Cohort Study. The American journal of clinical nutrition. 2006;84(5):1134-41.
93. Naing NN. Easy way to learn standardization : direct and indirect methods. The Malaysian journal of medical sciences : MJMS. 2000;7(1):10-5.
94. Altman DG. Practical statistics for medical research. London: Chapman 6 Hall/CRC; 1991.

95. Pace LE, Keating NL. A systematic assessment of benefits and risks to guide breast cancer screening decisions. JAMA : the journal of the American Medical Association. 2014;311(13):1327-35.
96. Young AM, Kidston S, Banks MD, Mudge AM, Isenring EA. Malnutrition screening tools: comparison against two validated nutrition assessment methods in older medical inpatients. Nutrition. 2013;29(1):101-6.
97. van Bokhorst-de van der Schueren MA, Klinkenberg M, Thijs A. Profile of the malnourished patient. European journal of clinical nutrition. 2005;59(10):1129-35.
98. Raslan M, Gonzalez MC, Dias MC, Nascimento M, Castro M, Marques P, et al. Comparison of nutritional risk screening tools for predicting clinical outcomes in hospitalized patients. Nutrition. 2010;26(7-8):721-6.
99. Gupta D, Vashi PG, Lammersfeld CA, Braun DP. Role of nutritional status in predicting the length of stay in cancer: a systematic review of the epidemiological literature. Annals of nutrition & metabolism. 2011;59(2-4):96-106.
100. Scheel O, Stormark M. National prevalence survey on hospital infections in Norway. The Journal of hospital infection. 1999;41(4):331-5.
101. Sartor C, Delchambre A, Pascal L, Drancourt M, De Micco P, Sambuc R. Assessment of the value of repeated point-prevalence surveys for analyzing the trend in nosocomial infections. Infection control and hospital epidemiology : the official journal of the Society of Hospital Epidemiologists of America. 2005;26(4):369-73.
102. Sacks GS, Dearman K, Replogle WH, Cora VL, Meeks M, Canada T. Use of subjective global assessment to identify nutrition-associated complications and death in geriatric long-term care facility residents. Journal of the American College of Nutrition. 2000;19(5):570-7.
103. Persson C, Sjoden PO, Glimelius B. The Swedish version of the patient-generated subjective global assessment of nutritional status: gastrointestinal vs urological cancers. Clinical nutrition. 1999;18(2):71-7.
104. Rasmussen HH, Kondrup J, Staun M, Ladefoged K, Kristensen H, Wengler A. Prevalence of patients at nutritional risk in Danish hospitals. Clinical nutrition. 2004;23(5):1009-15.
105. Kyle UG, Kossovsky MP, Karsegard VL, Pichard C. Comparison of tools for nutritional assessment and screening at hospital admission: a population study. Clinical nutrition. 2006;25(3):409-17.
106. Schiesser M, Kirchhoff P, Muller MK, Schafer M, Clavien PA. The correlation of nutrition risk index, nutrition risk score, and bioimpedance analysis with postoperative complications in patients undergoing gastrointestinal surgery. Surgery. 2009;145(5):519-26.
107. Ozkalkanli MY, Ozkalkanli DT, Katircioglu K, Savaci S. Comparison of tools for nutrition assessment and screening for predicting the development of complications in orthopedic surgery. Nutrition in clinical practice : official

publication of the American Society for Parenteral and Enteral Nutrition. 2009;24(2):274-80.
108. Garcia RS, Tavares LR, Pastore CA. Nutritional screening in surgical patients of a teaching hospital from Southern Brazil: the impact of nutritional risk in clinical outcomes. Einstein. 2013;11(2):147-52.
109. Bell JJ, Bauer JD, Capra S, Pulle RC. Quick and easy is not without cost: implications of poorly performing nutrition screening tools in hip fracture. Journal of the American Geriatrics Society. 2014;62(2):237-43.
110. Geiker NR, Horup Larsen SM, Stender S, Astrup A. Poor performance of mandatory nutritional screening of in-hospital patients. Clinical nutrition. 2012;31(6):862-7.
111. Amaral TF, Matos LC, Tavares MM, Subtil A, Martins R, Nazare M, et al. The economic impact of disease-related malnutrition at hospital admission. Clinical nutrition. 2007;26(6):778-84.
112. Benkovic V, Kolcic I, Ivicevic Uhernik A, Vranesic Bender D, Oreb I, Stevanovic R, et al. The economic burden of disease-related undernutrition in selected chronic diseases. Clinical nutrition. 2014;33(4):689-93.
113. Pisciottano MV, Pinto SS, Szejnfeld VL, Castro CH. The relationship between lean mass, muscle strength and physical ability in independent healthy elderly women from the community. The journal of nutrition, health & aging. 2014;18(5):554-8.
114. Addison O, Drummond MJ, LaStayo PC, Dibble LE, Wende AR, McClain DA, et al. Intramuscular fat and inflammation differ in older adults: the impact of frailty and inactivity. The journal of nutrition, health & aging. 2014;18(5):532-8.
115. Planas M, Audivert S, Perez-Portabella C, Burgos R, Puiggros C, Casanelles JM, et al. Nutritional status among adult patients admitted to an university-affiliated hospital in Spain at the time of genoma. Clinical nutrition. 2004;23(5):1016-24.
116. Holst M, Rasmussen H. Nutritional Therapy in the Transition between Hospital and Home: An investigation og Barriers. Journal of Nutrition and Metabolism. 2013;2013:8.
117. Directorate of Health. Ernæring i helsetjenesten. 2007 Contract No.: IS-1424.
118. Directorate of Health. Ernæringskompetanse i helse- og omsorgstjenesten. Oslo: Helsedirektoratet; 2012. p. 35.
119. Mowe M, Bosaeus I, Rasmussen HH, Kondrup J, Unosson M, Irtun O. Nutritional routines and attitudes among doctors and nurses in Scandinavia: a questionnaire based survey. Clinical nutrition. 2006;25(3):524-32.
120. Eide HD, Halvorsen K, Almendingen K. Barriers to nutritional care for the undernourished hospitalised elderly: perspectives of nurses. Journal of clinical nursing. 2014.
121. Thoresen L, Rothenberg E, Beck AM, Irtun O, Scandinavian Nutrition G. Doctors and nurses on wards with greater access to clinical dietitians have

better focus on clinical nutrition. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association. 2008;21(3):239-47.
122. Devries S, Dalen JE, Eisenberg DM, Maizes V, Ornish D, Prasad A, et al. A deficiency of nutrition education in medical training. The American journal of medicine. 2014;127(9):804-6.
123. Leistra E, van Bokhorst-de van der Schueren MA, Visser M, van der Hout A, Langius JA, Kruizenga HM. Systematic screening for undernutrition in hospitals: predictive factors for success. Clinical nutrition. 2014;33(3):495-501.
124. Det kongelige helse- og omsorgsdepartement. Oppdragsdokument 2014 Helse Vest RHF. Oslo2014. p. 13.
125. Evans WJ, Morley JE, Argiles J, Bales C, Baracos V, Guttridge D, et al. Cachexia: a new definition. Clinical nutrition. 2008;27(6):793-9.
126. Rodriguez-Manas L, Feart C, Mann G, Vina J, Chatterji S, Chodzko-Zajko W, et al. Searching for an operational definition of frailty: a Delphi method based consensus statement: the frailty operative definition-consensus conference project. The journals of gerontology Series A, Biological sciences and medical sciences. 2013;68(1):62-7.
127. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381(9868):752-62.
128. Mosby. Mosby's Medical Dictionary. 8. ed2009. 2056 p.
129. Atkins M, Basualdo-Hammond C, Hotson B, Dietitians of C. Canadian perspectives on the nutrition care process and international dietetics and nutrition terminology. Canadian journal of dietetic practice and research : a publication of Dietitians of Canada = Revue canadienne de la pratique et de la recherche en dietetique : une publication des Dietetistes du Canada. 2010;71(2):e18-20.
130. Tchekmedyian NS, Zahyna D, Halpert C, Heber D. Clinical aspects of nutrition in advanced cancer. Oncology. 1992;49 Suppl 2:3-7.
131. Cruz-Jentoft AJ. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age and ageing. 2010;39(4):412-23.
132. KITH Kompetansetjenesten for IT i helsesektoren. 2014 [cited 2014]. Norwegian criteria for diagnoses ICD-10]. Available from: http://finnkode.kith.no/#|icd10|ICD10SysDel|2596277|flow.
133. WHO. ICD-10 criteria: World Health Organization; 2014 [updated 2014; cited 2014]. Available from: http://apps.who.int/classifications/icd10/browse/2015/en#/E40-E46.

11. Appendices

11.1 Appendix 1: Definitions

Cachexia is a complex metabolic syndrome associated with underlying illness and characterised by loss of muscle with or without loss of fat mass (125).

Frailty is the term used to indicate a geriatric syndrome characterised by reduced homeostatic reserves, exposing individuals at increased risk for negative health-related events (including falls, hospitalisations, worsening disability, institutionalisation, and mortality) (126, 127).

Malnutrition is a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein, and other nutrients causes measurable adverse effects on tissue/body form (body shape, size, and composition); function; and clinical outcome (37).

Malnutrition is also a state of insufficient intake, utilisation, or absorption of energy and nutrients, which results in recent or rapid weight loss and change in organ function. It is likely to be associated with a worse outcome related to the disease or treatment. Malnourished patients can be overweight or obese, as assessed by BMI (1).

Nutrition assessment is a comprehensive approach to diagnosing nutrition problems that uses a combination of the following aspects to characterise it: medical, nutrition, and medication histories; physical examination, anthropometric measurements; and laboratory data. The goal of nutrition assessment is to identify any specific nutrition risk(s) or clear presence of malnutrition that then provides the basis for nutrition intervention. Nutritional assessment may lead to recommendations for improving nutrition status, such as a change in diet, enteral or parenteral nutrition, or further medical assessment. (51)

Nutritional care is the substances, procedures, and setting involved in ensuring the proper intake and assimilation of nutriments, especially for the hospitalized patient. (128)

Nutritional risk is the risk for nutrition-related complications resulting from a disease or treatment (1). Patients found to be at nutritional risk need nutritional support. The evaluation of patients for nutritional risk is based on nutritional status, illness, and age (Nutritional Risk Screening) (52).

Nutritional risk screening is the process of identifying characteristics known to be associated with nutrition-related complications. Its purpose is to detect patients at risk who may experience an improved clinical outcome when given nutritional support (1).

Nutritional interventions are purposefully planned actions designed with the intent of changing nutrition-related behavior, risk factors, environmental conditions, or aspects of health status. Nutrition interventions are typically directed towards resolving nutrition diagnoses. They may also be targeted at reducing the signs or symptoms of the nutrition diagnoses. Ideally, nutrition support should involve a team approach that includes clinical dieticians, nurses, and physicians (129, 130).

Nutritional support includes the assessment of current nutritional status; estimation of nutritional requirements; prescription and delivery of appropriate energy, macro- and micronutrients, electrolytes, and fluids (in the form of ordinary hospital food [first choice], sip feedings, and/or artificial nutrition); monitoring the former in the context of clinical status; and ensuring that the most optimal feeding route is used at all times. Nutritional support is part of medical treatment, and its purpose is to improve or maintain a patient's nutritional status and hasten and improve recovery (1).

Sarcopenia is a age-related syndrome characterised by progressive and generalised loss of skeletal muscle mass and strength. It is associated with a risk of adverse outcomes such as physical disability, poor quality of life, and death. Diagnosis is

based on documentation of meagre muscle mass and either meagre muscle strength or diminished physical performance (131)

Undernutrition is a state resulting from lack of uptake or intake of nutrition and occurs when lack of energy, protein, and/or other nutrients has resulted in a measureable adverse effect on body composition, function, and clinical outcome (65).

11.2 Appendix 2: Nutritional Risk Screening (NRS 2002)

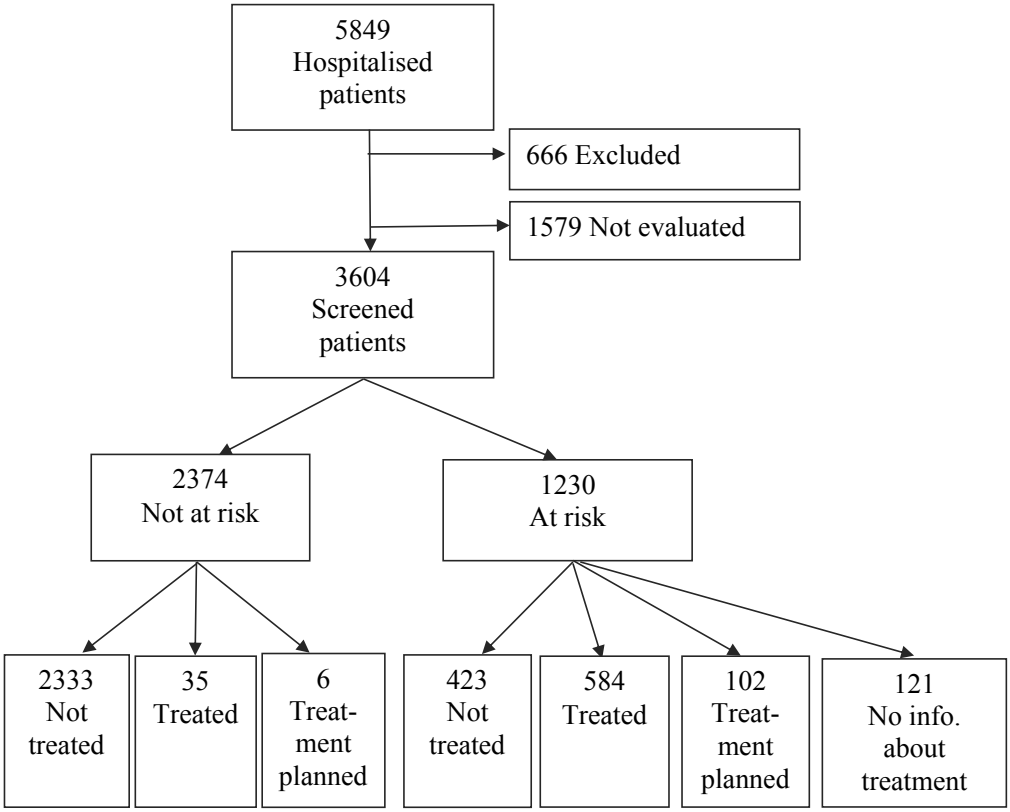
Table 1 Initial screening			
1	Is BMI <20.5?	Yes	No
2	Has the patient lost weight within the last 3 months?		
3	Has the patient had a reduced dietary intake in the last week?		
4	Is the patient severely ill? (e.g. in intensive therapy)		
Yes: If the answer is "Yes" to any question, the screening in Table 2 is performed. **No**: If the answer is "No" to all questions, the patient is –re-screened at weekly intervals. If the patient e.g. is scheduled for a major operation, a preventive nutritional care plan is considered to avoid the associated risk status			

Table 2 Final screening			
	Impaired nutritional status	**Severity of disease (=increase in requirements)**	
Absent **Score 0**	Normal nutrition status	Absent **Score 0**	Normal nutrition requirements
Mild **Score 1**	Weight loss >5% in 3 months or food intake below 50-75% of normal requirement in preceding week.	Mild **Score 1**	Hip fracture, chronic patients, in particular with acute complications, cirrhosis, COPD, chronic hemodialysis, diabetes, oncology
Moderate **Score 2**	Weight loss >5% in 2 months or BMI 18.5-20.5 +impaired general condition or food intake below 25-60% of normal requirement in preceding week.	Moderate **Score 2**	Major abdominal surgery, stroke, severe pneumonia, hematologic malignancy.
Severe **Score 3**	Weight loss >5% in 1 months or BMI <18.5 + impaired general condition or food intake below 0-25% of normal requirement in preceding week.	Severe **Score 3**	Head injury, bone marrow transplantation, intensive care patients (APACHE>10)
score:	+ score:	= total score:	
Age: If ≥ 70 years add 1 to total score above. This is the 'age-adjusted total score'			
Score ≥ 3: The patient is nutritionally at-risk and a nutritional care plan is initiated. Score < 3: The patient undergoes weekly rescreening. If the patient is scheduled, for example, for a major operation, a preventive nutritional care plan is considered to avoid the associated risk status Abbreviations: COPD, chronic obstructive pulmonary disease; APACHE, Acute Physiology And Chronic Health Evaluation.			

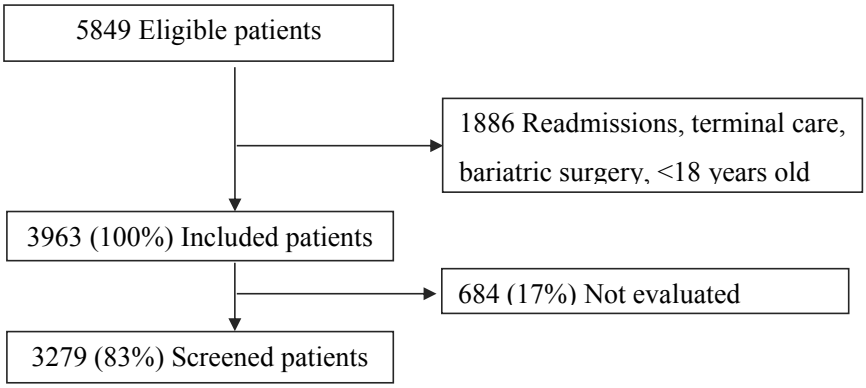
(52)

11.3 Appendix 3: Flow charts for selection of studied patient populations

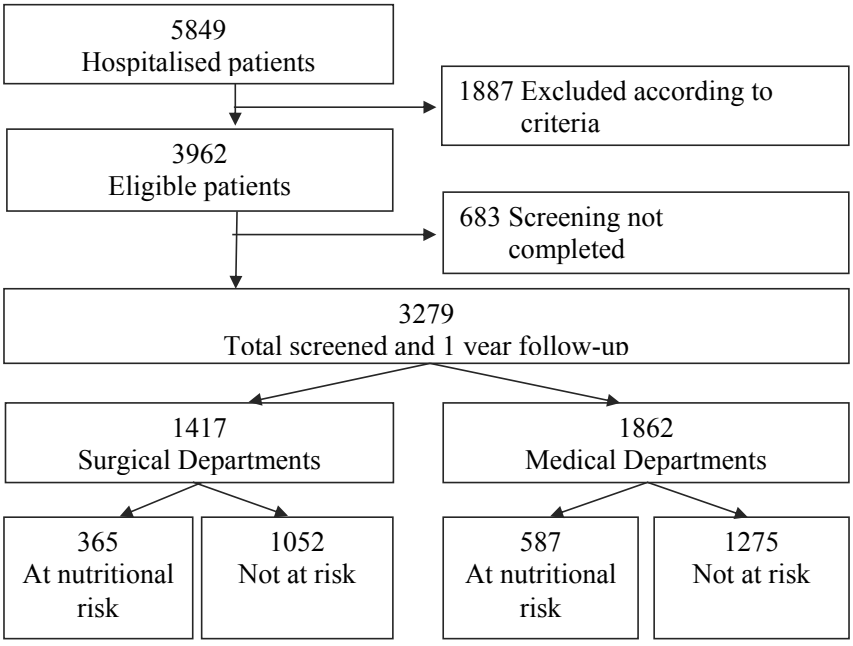
Paper I



Paper II



Paper III



11.4 Appendix 4: Nutrition prevalence survey (Webport program)

Sheet 1		**Response options**
No screening *per se*, the patient is	Not selected	*Not available/Terminally ill*

Sheet 2		**Response options**
Weight (kg)	65	
Height (cm)	180	
BMI	20	*Automatically calculated*
Factors affecting weight	Not selected	*Edema/cast/pregnancy/ amputation*
Initial screening		
Is BMI <20.5?	Yes	*Automatic*
Has the patient lost weight in recent weeks?	Yes	*Yes/No*
Has the patient been eating less in recent weeks?	Yes	*Yes/No*
Is the patient seriously ill?	No	*Yes/No*

Sheet 3		**Response options**
Disease-related weight loss	7	
Screening for nutritional risk		
Weight (kg) 3 months ago	70	
Food intake (% of normal) requirement for preceding week	25-50	
Score for impaired nutritional status	2	*Automatically calculated*
Severity of disease (metabolic stress)	1	
Age ≥70 years	0	
Total score for nutritional risk	3	*Automatically calculated*
Nutritional support		
Is nutritional support given?	Yes	*Yes/Not yet/No*
Has a dietician been consulted?	Yes	*Yes/No*

11.5 Appendix 5: Diagnoses criteria of the ICD-10

The Norwegian criteria

E44.0 Moderate protein-/energy malnutrition

Unintended loss of weight or weight below 2-3 standard deviations (SDs) of the reference value.

E44.00 Moderate malnutrition

At least one of the following criteria

- Weight loss >10 % in last 3-6 months or >5% in last 2 months
- BMI <18.5 kg/m^2 (>70 years: BMI <20)
- BMI <20.5 kg/m^2 (>65 years: BMI <22) and weight loss >5% in last 6 months
- Food intake <50% of requirements in last week

E44.1 Mild protein-/energy malnutrition

Unintended loss of weight or weight below 1-2 SDs of the reference value.

E46.00 At nutritional risk

At least one of the following criteria:

- Nutritional Risk Screening 2002 (NRS 2002): score >2
- Mini Undernutrition Screening Tool (MUST): score >2
- Mini Nutritional Assessment (MNA): score <11
- Subjective Global Assessment (SGA): grade B
- Nutritional journal, Directorate of Health: 2 points

(132)

WHO criteria

E44 Protein-energy malnutrition of moderate and mild degree

E44.0 Moderate protein-/energy malnutrition

Weight loss in children or adults, or lack of weight gain in children leading to an observed weight that is 2 or more but less than 3 SDs below the mean value for the reference population (or a similar loss expressed through other statistical approaches). When only one measurement is available, there is a high probability of moderate protein-energy malnutrition when the observed weight is 2 or more but less than 3 SDs below the mean of the reference population.

E44.1 Mild protein-/energy malnutrition

Weight loss in children or adults, or lack of weight gain in children leading to an observed weight that is 1 or more but less than 2 SDs below the mean value for the reference population (or a similar loss expressed through other statistical approaches). When only one measurement is available, there is a high probability of mild protein-energy malnutrition when the observed weight is 1 or more but less than 2 SDs below the mean of the reference population.

(133)

11.6 Appendix 6: Participating hospital units

	15-Jan-08[1]	31-Jan-08[2]	5-Jun-08[2]	27-Aug-08[2]	4-Dec-08[2]	19-Feb-09[2]	23-Apr-09[2]	24-Sep-09[2]	19-Nov-09[2]
AFMR p2 Nordås	0	0	+	+	+	+	+	+	+
Gynekologi p1	0	0	+	+	+	+	+	+	+
Gynekologi p2	0	0	+	+	+	+	+	+	+
Hjerte p1S	0	+	+	+	+	+	+	+	+
Hjerte p 2V	0	+	+	+	+	+	+	+	+
Hjerte p 3MIO	0	+	+	+	+	+	+	+	+
Hjerte p 4	0	+	+	+	+	+	+	+	+
Hud p1	0	0	+	+	0	+	+	+	+
Hud pasient hotell	0	0	0	0	0	0	0	+	0
Intensivmedisin	0	+	0	0	+	+	+	+	+
KIH Sengepost 3.et	0	0	+	0	+	+	+	+	+
KIH Sengepost 4.et	0	0	+	0	+	+	+	+	+
Brannskade	0	+	+	+	+	+	0	+	+
Kirurgi p4Endo	0	0	+	+	+	0	0	0	0
Kirurgi p4Plastikk	0	0	+	+	+	+	+	+	+
Kirurgi p1Endo	0	0	0	0	0	0	+	+	+
Kirurgi pt1N	0	+	+	+	+	+	+	+	+
Kirurgi p1V	0	+	+	+	+	+	+	+	+
Kirurgi p2 Kar	0	+	+	+	+	+	+	+	+
Kirurgi p2 Urologi	0	+	+	+	+	+	0	0	+
Kirurgi p3 Ge/Akutt	0	0	+	+	0	+	+	+	+
Kirurgi p3 Ur/Akutt	0	0	+	+	0	0	+	0	0
Kjevekirurgi p1	0	0	+	+	+	+	+	+	+
Kreft p1	0	+	+	+	+	+	+	+	+
Kreft p2S	0	+	+	+	+	+	+	+	+
Kreft p2V	0	+	+	+	+	+	+	+	+
Lunge p1	+	+	+	+	+	+	+	+	+
Lunge p 3	+	+	+	+	+	+	+	+	+
Medisin p1Nefro	0	0	+	+	0	+	+	+	+
Medisin p1Gastro	0	+	+	+	+	+	+	+	+
Medisin p5 Hemat	0	0	+	+	+	+	+	+	+
Medisin p5 Infeksj	0	0	+	+	+	+	+	+	+
Medisin p6 Infeksj	0	0	+	+	+	+	+	+	+
Medisin p8	0	0	+	+	+	+	+	+	+
Nevrokirurgi p1	0	0	+	+	+	+	+	+	+

Nevrologi p1(dag)	0	0	0	0	+	0	0	0	0
Nevrologi p2	0	0	+	+	+	+	+	+	+
Nevrologi p3	0	0	+	+	+	+	+	+	+
Nevrologi p4 Spinal	0	0	+	+	+	+	+	+	+
Ortopedi p1	0	0	+	+	+	+	+	+	+
Ortopedi p2S	0	0	+	+	+	+	+	+	+
Ortopedi p2V	0	0	+	+	+	+	+	+	+
Ortopedi rehab	0	0	+	+	+	+	+	+	+
Ortope rehab/hotell	0	0	0	0	0	0	0	+	+
Rehab p1	0	0	+	+	+	+	+	0	+
Revmatologi hotell	0	0	0	0	+	0	0	0	0
Revmatologi sengep	0	0	+	+	+	+	+	+	+
VS Fellesp kirurgi	0	0	+	+	+	+	+	+	+
VS Fellesp medisin	0	0	+	+	+	+	+	+	+
VS Gynekologi p1	0	0	+	0	0	+	0	0	0
VS Kirurgi p1	0	0	+	+	+	+	+	+	+
VS Kirurgi recovery/intensiv	0	0	0	0	0	0	+	0	0
VS Medisin p1	0	0	+	+	+	+	+	0	+
VS Medisin recover/intensiv	0	0	0	0	0	+	0	+	+
ØNH voksenpost	0	+	+	+	0	+	+	+	+
Øye p1	0	0	0	0	+	0	0	+	+

[1] A pilot study was performed January 15, 2008. These data were not included.
[2] Dates for the pilot study (January 31, 2008) and the subsequent seven surveys.

I

European Journal of Clinical Nutrition (2012) 66, 388–393
© 2012 Macmillan Publishers Limited All rights reserved
0954-3007/12
www.nature.com/ejcn

Open

ORIGINAL ARTICLE

Implementation of nutritional guidelines in a university hospital monitored by repeated point prevalence surveys

RJ Tangvik[1,2,3], AB Guttormsen[4,5], GS Tell[6] and AH Ranhoff[1,3]

[1]*Kavli Research Centre for Ageing and Dementia, Haraldsplass Diacon Hospital, Bergen, Norway;* [2]*Department of Research and Development, Haukeland University Hospital, Bergen, Norway;* [3]*Institute for Internal Medicine, University of Bergen, Bergen, Norway;* [4]*Department of Anaesthesia and Intensive Care, Haukeland University Hospital, Bergen, Norway;* [5]*Department of Surgical Sciences, Section of Anaesthesiology, University of Bergen, Bergen, Norway and* [6]*Department of Public Health and Primary Health Care, University of Bergen, Bergen, Norway*

Background/Objectives: Malnutrition is present in 20–50% of hospitalized patients, and nutritional care is a challenge. The aim was to evaluate whether the implementation of a nutritional strategy would influence nutritional care performance in a university hospital.
Subjects/Methods: This was a prospective quality improvement program implementing guidelines for nutritional care, with the aim of improving nutritional practice. The Nutrition Risk Screening (NRS) 2002 was used. Point prevalence surveys over 2 years to determine whether nutritional practice had improved.
Results: In total, 3604 (70%) of 5183 eligible patients were screened and 1230 (34%) were at nutritional risk. Only 53% of the at-risk patients got nutritional treatment and 5% were seen by a dietician. The proportion of patients screened increased from the first to the eighth point prevalence survey ($P=0.012$), but not the proportion of patients treated ($P=0.66$). The four initial screening questions in NRS 2002 identified 92% of the patients not at nutritional risk.
Conclusions: Implementation of nutritional guidelines improved the screening performance, but did not increase the proportion of patients who received nutritional treatment. Point prevalence surveys were useful to evaluate nutritional practice in this university hospital. In order to improve practice, we suggest using only the four initial screening questions in NRS 2002 to identify patients not at risk, better education in nutritional care for physicians and nurses, and more dieticians employed. Audit of implementation of guidelines, performed by health authorities, and specific reimbursement for managing nutrition may also improve practice.
European Journal of Clinical Nutrition (2012) **66,** 388–393; doi:10.1038/ejcn.2011.149; published online 24 August 2011

Keywords: nutrition guidelines; point prevalence survey; prevalence; nutritional risk screening; hospitals; quality indicator

Introduction

Malnutrition is present in 18–55% of hospitalized patients (Sorensen *et al*., 2008; Imoberdorf *et al*., 2009). Studies show that nutritional support to undernourished patients and those at nutritional risk is advantageous (Stratton and Elia, 2007). European guidelines state that provision of tailored food should be an integral part of patient care (Council of Europe, 2002; Kondrup *et al*., 2003a, b; Norwegian Directorate of Health, 2009). However, nutrition is often not given priority in clinical practice (Mowe *et al*., 2006, 2008). Insufficient knowledge and low commitment among nurses and physicians result in an insufficient focus on nutritional aspects of care (Kondrup *et al*., 2002; Bavelaar *et al*., 2008; Mowe *et al*., 2008). Dietary parameters are seldom monitored during hospital stays; neither are they described in patients' medical records or discharge summaries (Bavelaar *et al*., 2008; Meijers *et al*., 2009). It is a great challenge to

Correspondence: RJ Tangvik, Department of Research and Development, Haukeland University Hospital, Jonas Lies vei 65, Bergen, 5021 Norway.
E-mail: randi.tangvik@helse-bergen.no
Contributors: RJT, ABG and GST developed the nutritional strategy, conception and design of the study. RJT modified the computer tool, prepared and conducted the surveys, processed and analyzed the data and wrote the manuscript. All the authors participated in the interpretation of the data, contributed to writing the manuscript and to the final approval of the submitted version.
Received 21 December 2010; revised 22 July 2011; accepted 23 July 2011; published online 24 August 2011

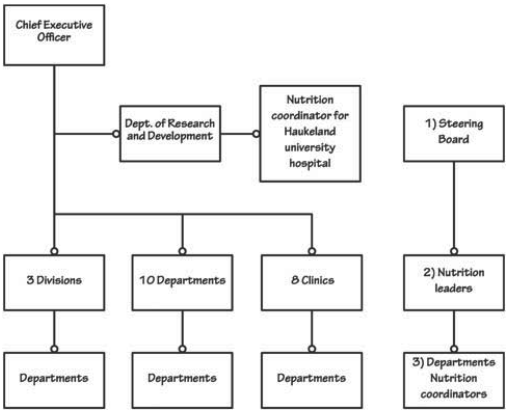


Figure 1 The nutritional network. (1) Steering board: 14 members representing patients, health professionals, kitchen staff and dieticians. (2) Nutrition leaders: 22 physicians and 22 nurses. (3) Department nutrition coordinators: 72 nurses and nurse assistants.

implement nutritional guidelines in hospitals (Llido, 2006; Mowe *et al*., 2006, 2008; Bavelaar *et al*., 2008; Persenius *et al*., 2008; Liang *et al*., 2009).

To improve practice at Haukeland University Hospital, Bergen, Norway, a campaign entitled 'Good nutritional practice' was introduced during 2006. The goals were to increase professional awareness of the importance of nutritional care and to provide proper nutritional care to patients with such needs. To achieve these goals, it was considered necessary to develop guidelines, tools and skills, and to educate nurses and physicians in basic clinical nutrition. Responsibilities were defined and a professional framework was established (Figure 1) to implement these aspects of nutritional care. An important factor was to increase the flexibility of the food services, leading to the provision of more tempting and nourishing food according to patient needs.

The aim of the present study was, by using repeated point prevalence surveys, to evaluate whether the implementation of a new strategy had positive effects on nutritional care in the hospital.

Materials and methods

We performed a prospective quality improvement program implementing nutritional guidelines through the dedicated nutritional network (Figure 1). Repeated point prevalence surveys over 2 years made it possible to assess whether practice changed over time. The first survey was performed on 31 January 2008 in 14 hospital departments. The seven further surveys were conducted in 51 departments between June 2008 and November 2009. All hospital departments participated except obstetrics, children's and the psychiatric wards. Patients were excluded if they were admitted for bariatric surgery, day-surgery or other day-care procedure. Other exclusion criteria were terminal care and age below 18 years.

Implementing of guidelines

The barriers to proper nutritional care identified by the Council of Europe (Council of Europe, 2002) were taken into account when the nutritional campaign was carried out. Health care professionals, kitchen staff, patients' representatives and the hospital management were involved in workshops or the network. The aim was to integrate proper nutrition in patients' care. The nutritional network included 130 physicians, nurses and nurse assistants, and were organized in three levels (Figure 1). They were educated for 2 days in basic clinical nutrition and were then responsible for introducing the guidelines to their units. They were then invited to monthly meetings for 1 year. Kick-off seminars, courses and repeating mini-screening schools were enrolled. Mealtime routines and kitchen services were improved, and supplements were more available. Other amenities included interactive tools like website, e-course in clinical nutrition and dedicated forms in electronic patient journal system.

The point prevalence surveys

At 0800 hours on the day of registration, administrative patient's data (name, date of birth, sex and hospital ward) were transferred to a dedicated database. The patients were first included (Supplementary Information sheet 1, Appendix 1), then screened according to the Nutrition Risk Screening 2002 (NRS 2002) (Supplementary Information sheet 2, Appendix 1). If total score was $\geqslant 3$, additional questions about nutritional support were answered (Supplementary Information Sheet 3, Appendix 1).

Outcomes

The primary outcome in this study was change in clinical practice. This was measured as the proportion of patients screened, proportion of patients at nutritional risk with a nutritional plan, that is, who were either under treatment or for whom treatment was planned, and the proportion of patients seen by a dietician. We used the proportion of patients coded with the diagnoses for under nutrition according to the *International Statistical Classification of Diseases and Related Health Problems* (ICD-10) E44 or E46 (World Health Organization, 2010) to assess the participation by physicians. This information was retrieved from the electronic patient database. The secondary outcome is the prevalence of nutritional risk at the hospital.

Statistics

Statistical evaluation included a descriptive analysis, and estimations of prevalence of undernutrition at each survey

and the proportion of patients who underwent nutritional treatment. Data analysis was performed using the statistical software of SAS Institute Inc., Version 9.1 and SPSS Version 17.0 (SPSS Inc., Chicago, IL,USA).

Ethics

This study was part of a quality improvement project and was exempted from review by Regional Committee for Medical and Health Research Ethics. The study was approved by the data inspectorate and the hospital research board. The patients were not asked to give informed consent, as they were not subject to any experimental interventions.

Results

Of the total number of 5849 inpatients on the eight occasions, 666 (11%) did not meet the inclusion criteria, and for 1579 patients (27%), the screening was not completed. A total of 3604 (70%) patients were screened (Figure 2). The proportion of patients screened increased significantly from the first to the last survey, with a range from 54–77% (Figure 3, $P=0.012$).

The prevalence of nutritional risk was 56% at the first point prevalence survey (January 2008) and varied between 30–36% at the subsequent surveys (Table 1). In total 1230 patients were identified to be at nutritional risk during the eight surveys. Of these, 743 (60%), had a nutritional treatment plan. In 649 cases (53%), the nutritional intervention was started and in 94 cases (7%) nutritional treatment was pending (Figure 2). The proportion of patients receiving a nutritional treatment plan varied between 54 and 68%, and did not increase during the eight surveys ($P=0.66$). Those who already received nutritional treatment varied between 47 and 59% over time, and patients at risk whose nutritional treatment was planned but had not yet commenced varied between 5 and 11% during the surveys. Only 62 (5%) of the patients at nutritional risk were evaluated and followed up by a dietician.

During 2008 and 2009, 1.3% of all adult, somatic inpatients at the hospital were diagnosed with malnutrition diagnoses (E44 or E46). In this study, 649 patients (14.3%) of the eligible patients ($n=5183$) were qualified for this (at nutritional risk and have got nutritional treatment), and 487 (9.3%) more were in need for such treatment (at nutritional risk and did not get nutritional treatment).

NRS 2002 identified 2374 patients (66%) not at nutritional risk. Of these, 2180 were identified by the four initial questions (Figure 2), while the other 194 were considered not at risk according to the remaining NRS 2002 questions, giving a specificity of 92% to identify not-at-risk patients, with the first four questions. The main screening was performed for 1424 patients.

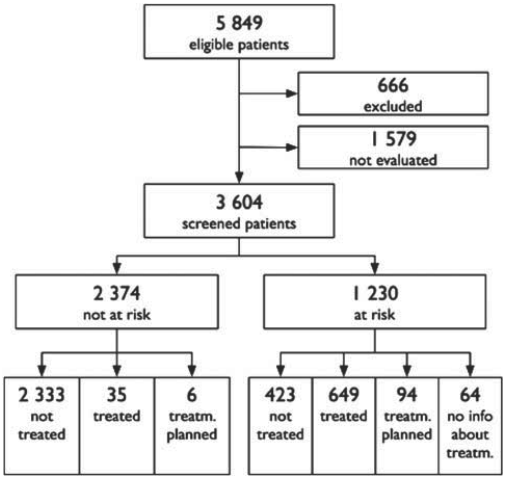


Figure 2 Flow chart: Results from the eight point prevalence surveys.

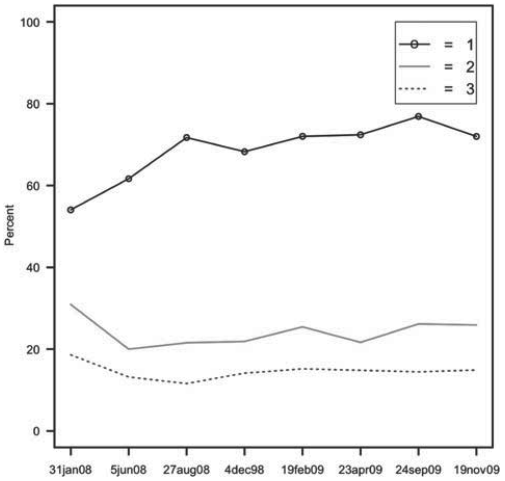


Figure 3 Results from the point prevalence surveys, 2008 and 2009. (1) Percent of patients screened ($n=3604$) ($P=0.012$). (2) Percent of patients at nutritional risk ($n=1230$). (3) Percent of patients at nutritional risk who received nutritional treatment ($n=649$).

Discussion

This study showed improved screening performance after implementing nutritional guidelines in a university hospital. This is an important element to achieve better nutritional

Table 1 Results from the point prevalence surveys 2008 and 2009

	Eligible[a]	*Excluded*[b]	*Available*[c]	*Not screened*[d]	*Screened*[e]	*Not at risk*[f]	*Atrisk*[g]
n	5849	666	5183	1579	3604	2374	1230
(%)	100	11.4	100	30.5	69.5	65.9	34.1
31 Jan 2008	396	63	333	153	180	77	103
(%)	100	15.9	100	45.9	54.1	42.8	56.2
5 Jun 2008	828	108	720	276	444	300	144
(%)	100	13.0	100	38.3	61.7	67.6	32.4
27 Aug 2008	700	88	612	173	439	307	132
(%)	100	12.6	100	28.3	71.7	69.9	30.1
4 Dec 2008	844	81	763	242	521	354	167
(%)	100	9.6	100	31.7	68.3	67.9	32.1
19 Feb 2009	748	76	672	188	484	313	171
(%)	100	10.1	100	28.0	72.0	64.7	35.3
23 Apr 2009	747	73	674	186	488	342	146
(%)	100	9.8	100	27.6	72.4	70.1	29.9
24 Sep 2009	763	79	684	158	526	347	179
(%)	100	10.4	100	23.1	76.9	66.0	34.0
19 Nov 2009	823	98	725	203	522	334	188
(%)	100	11.9	100	28.0	72.0	64.0	36.0

[a]Number and percent of inpatients in the included units.
[b]Number and percent of eligible patients excluded according to the exclusion criteria.
[c]Number and percent of patients available for screening.
[d]Number and percent of available patients who were not screened.
[e]Number and percent of the available patients who were screened.
[f]Number and percent of the screened patients ($n = 3604$) who were found not to be undernourished or at nutritional risk.
[g]Number and percent of the screened patients ($n = 3604$) who were found to be undernourished or at nutritional risk.

care. One in three screened patients were at nutritional risk, but only half of the people at risk received nutritional treatment, with no improvement during the study period.

The strengths of this study include a large sample of patients and almost complete coverage of relevant wards and patient categories. We used a validated screening tool and the screening data were reported by a standardised electronic form designed for this purpose. An important limitation is that the point prevalence surveys were initiated more than 1 year after the start of the nutritional campaign, and initial changes in nutritional practice could then be undetected. Ideally the surveys should have been initiated before the campaign started. A possible limitation is that the point prevalence surveys themselves must be considered to be, at the same time, both interventions and measurements of the results of these interventions, because, as screening is supposed to improve nutritional practice, it is also a reminder of better nutritional practice. This is supported by the fact that results from repeated point prevalence surveys of hospital infections have demonstrated improved clinical practice (Scheel and Stormark, 1999; Sartor *et al*., 2005).

Although screening performance improved, the most important outcome, namely the proportion of patients at nutritional risk who received a nutritional treatment plan did not increase. It could be a problem that information about patients at nutritional risk were not communicated from the nurses who did the screening to the nurses and physicians who were responsible for giving nutritional treatment. Another factor is a limited dietician service in the hospital The number of dieticians/clinical nutritionists in Norwegian hospitals is among the lowest in Western countries (Norwegian Health Directorate, 2007), implying that the physicians and nurses mainly are responsible for the patients nutritional care. Nutrition has low priority in the education of medical students in Norway (Norwegian Directorate of Health, 2007) and Norwegian physicians and nurses reported to have less knowledge and interest for clinical nutrition than their Danish and Swedish colleagues (Mowe *et al*., 2008). The interest in nutritional matters is lower in wards not regularly visited by dieticians (Thoresen *et al*., 2008). Based on the experience from this study and other recent publications (Mowe *et al*., 2008), we suggest that there is a scarcity of nutritional knowledge and of dieticians available. We propose that a greater focus on nutritional education of physicians, both undergraduate and postgraduate, and an increased number of dieticians are important to improve nutritional practice.

In Norway, central health authorities have developed clinical guidelines for nutritional care in hospitals and nursing homes. Performing audits of the implementation of these guidelines and economic incentives, such as Diagnosis Related Groups reimbursement for diagnosing malnutrition, may also help improve practice.

Nutritional screening is recommended (Council of Europe, 2002; Kondrup *et al*., 2003a, b; Norwegian Directorate of Health, 2009 and the hospitals local guidelines) as the first

step to individualized nutritional treatment. One reason for not doing such screening is lack of time. Nutritional screening is one of several time-consuming procedures in a busy hospital and may be easy to neglect. By using the four opening questions in NRS 2002 we identified 92% of the patients not at nutritional risk. As all at-risk patients are screened positive on these first four questions of NRS 2002, there will be no patients at risk who are not detected. The proportion of patients classified to be at nutritional risk, would increase from 34 to 40% when using only the four initial questions. Further studies are needed to investigate whether the screening tool could be simplified.

The prevalence of patients at nutritional risk is similar to previous European studies (Rasmussen *et al*., 2006; Sorensen *et al*., 2008; Lucchin, 2009) but lower than the 44%, shown by a previous Norwegian study (Oppedal *et al*., 2010). The difference can be due to a bias in our study because 1579 patients (27%) eligible for screening were not screened. The healthiest patients may have a higher likelihood of being screened, because it can be difficult to weight bedridden patients and patients in wheelchairs. It is also a challenge to obtain reliable information about previous weight and food intake from certain patients, for example, with delirium and dementia. It has been reported that patients without anthropometric information in the medical records have higher morbidity, mortality and length of stay (Stratton *et al*., 2003; Izawa *et al*., 2007).

This study was not designed to assess patient outcomes or improvements in food provided to the patients, but there might have been some general improvement in nutrition in the hospital owing to better and more flexible food services.

The point prevalence surveys were easy to perform owing to previous experience with similar surveys on infections. Repeated point prevalence surveys allow trend analyses in clinical nutritional practice. It is a suitable method to draw attention to a common and serious problem in health care and it should be considered as a national quality indicator in clinical nutrition.

Conclusion

Implementation of nutritional guidelines in this university hospital improved the screening performance, which is an important element in better nutritional care, but did not increase the proportion of patients who received nutritional treatment. One of the three patients was at nutritional risk, but only half of them got nutritional treatment. In order to improve practice, we suggest using only the four initial screening questions in NRS 2002 to identify patients not at risk. We also suggest better education in nutritional care for physicians and nurses, and more dieticians employed to achieve more knowledge about nutrition audits of implementation of guidelines performed by health authorities, better accordance between the screening tool and the ICD-10 criteria and specific reimbursement for diagnosing malnutrition may also improve practice. We propose repeated point prevalence surveys to become a national quality indicator in clinical nutrition.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgements

This study was supported by grants from the Kavli Research Centre for Ageing and Dementia, Bergen, Institute of Internal Medicine, University of Bergen, Norway, and Haukeland University Hospital, Bergen, Norway. We extend our thanks to the Department of Research and Development, most of all Tore Wentzel-Larsen, Elizabeth Tørressen Nordeide, Kjersti Berge and Kari Sygnestveit for assistance in the planning, acquisition and analyses of the data, Centre of Infection Control and Thor-Ludvig Thorsen for the practical support. We also thank Andreas Henriksen for statistical support and Simon Conroy for important advices in the revision of the manuscript, and the management at Haukeland University Hospital for introducing 'Good nutritional care' and for lending practical support to this.

References

Bavelaar JW, Otter CD, van Bodegraven AA, Thijs A, van Bokhorst-de van der Schueren MA (2008). Diagnosis and treatment of (disease-related) in-hospital malnutrition: the performance of medical and nursing staff. *Clin Nutr* **27**, 431–438.

Council of Europe (2002). *Food and Nutritional Care in Hospitals: How to Prevent Undernutrition*. Strasbourg Cedex, pp 28, 38, 39, 50.

Imoberdorf R, Meier R, Krebs P, Hangartner PJ, Hess B, Staubli M *et al*. (2009). Prevalence of undernutrition on admission to Swiss hospitals. *Clin Nutr* **29**, 38–41.

Izawa S, Enoki H, Hirakawa Y, Masuda Y, Iwata M, Hasegawa J *et al*. (2007). Lack of body weight measurement is associated with mortality and hospitalization in community-dwelling frail elderly. *Clin Nutr* **26**, 764–770.

Kondrup J, Allison SP, Elia M, Vellas B, Plauth M (2003a). ESPEN guidelines for nutrition screening 2002. *Clin Nutr* **22**, 415–421.

Kondrup J, Johansen N, Plum LM, Bak L, Larsen IH, Martinsen A *et al*. (2002). Incidence of nutritional risk and causes of inadequate nutritional care in hospitals. *Clin Nutr* **21**, 461–468.

Kondrup J, Rasmussen HH, Hamberg O, Stanga Z (2003b). Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr* **22**, 321–336.

Liang X, Jiang ZM, Nolan MT, Wu X, Zhang H, Zheng Y *et al*. (2009). Nutritional risk, malnutrition (undernutrition), overweight, obesity and nutrition support among hospitalized patients in Beijing teaching hospitals. *Asia Pac J Clin Nutr* **18**, 54–62.

Llido LO (2006). The impact of computerization of the nutrition support process on the nutrition support program in a tertiary care hospital in the Philippines: report for the years 2000–2003. *Clin Nutr* **25**, 91–101.

Lucchin L (2009). An Italian investigation on nutritional risk in hospital admission: The PIMAY (Project: Iatrogenic MAlnutrition in Italy) study. *e-Spen* **4**, 199–202.

Meijers JM, Halfens RJ, van Bokhorst-de van der Schueren MA, Dassen T, Schols JM (2009). Malnutrition in Dutch health care: prevalence, prevention, treatment, and quality indicators. *Nutrition* **25**, 512–519.

Mowe M, Bosaeus I, Rasmussen HH, Kondrup J, Unosson M, Irtun O (2006). Nutritional routines and attitudes among doctors and nurses in Scandinavia: a questionnaire based survey. *Clin Nutr* **25**, 524–532.

Mowe M, Bosaeus I, Rasmussen HH, Kondrup J, Unosson M, Rothenberg E *et al*. (2008). Insufficient nutritional knowledge among health care workers? *Clin Nutr* **27**, 196–202.

Norwegian Directorate of Health (2007). *Ernæring i helsetjenesten*. Oslo, pp 38, 40. IS-1424, http://www.helsedirektoratet.no/publikasjoner/rapporter/ern_ring_i_helsetjenesten_81004.

Norwegian Directorate of Health (2009). *National Guidelines on Preventing and Treatment of Malnutrition*. Oslo, pp 76, IS-1580, http://www.helsedirektoratet.no/publikasjoner/nasjonale_faglige_retningslinjer/nasjonale_faglige_retningslinjer_for_forebygging_og_behandling_av_underern_ring_443404.

Oppedal K, Nesvåg S, Pedersen B, Skjøtskift S, Aarstad AKH, Ullaland S *et al*. (2010). Health and the need for health promotion in hospital patients. *Eur J Public Health*; e-pub ahead of print 13 October 2010.

Persenius MW, Hall-Lord ML, Baath C, Larsson BW (2008). Assessment and documentation of patients' nutritional status: perceptions of registered nurses and their chief nurses. *J Clin Nurs* **17**, 2125–2136.

Rasmussen HH, Kondrup J, Staun M, Ladefoged K, Lindorff K, Jorgensen LM *et al*. (2006). A method for implementation of nutritional therapy in hospitals. *Clin Nutr* **25**, 515–523.

Sartor C, Delchambre A, Pascal L, Drancourt M, De Micco P, Sambuc R (2005). Assessment of the value of repeated point-prevalence surveys for analyzing the trend in nosocomial infections. *Infect Control Hosp Epidemiol* **26**, 369–373.

Scheel O, Stormark M (1999). National prevalence survey on hospital infections in Norway. *J Hosp Infect* **41**, 331–335.

Sorensen J, Kondrup J, Prokopowicz J, Schiesser M, Krahenbuhl L, Meier R *et al*. (2008). EuroOOPS: an international, multicentre study to implement nutritional risk screening and evaluate clinical outcome. *Clin Nutr* **27**, 340–349.

Stratton RJ, Elia M (2007). Who benefits from nutritional support: what is the evidence? *Eur J Gastroenterol Hepatol* **19**, 353–358.

Stratton RJ, Green CJ, Elia M (2003). *Disease Related Malnutrition: An Evidence-based Approach to Treatment*, 1st edn. CABI Publishing: Cambridge, pp 1–34.

Thoresen L, Rothenberg E, Beck AM, Irtun O (2008). Doctors and nurses on wards with greater access to clinical dietitians have better focus on clinical nutrition. *J Hum Nutr Diet* **21**, 239–247.

World Health Organization (2010). *International Statistical Classification of Diseases and Related Health Problems*, 10th Revision. http://apps.who.int/classifications/apps/icd/icd10online/.

This work is licensed under the Creative Commons Attribution-NonCommercial-No Derivative Works 3.0 Unported License. To view a copy of this license, visit http://creativecommons.org/licenses/by-nc-nd/3.0/

Supplementary Information accompanies the paper on European Journal of Clinical Nutrition website (http://www.nature.com/ejcn)

Good nutritional practice - nutritional assessment

Sheet 1		**Response options**
No screening per se, the patient is	Not selected	No/ Termally ill/ <18yrs

Sheet 2		**Response options**
Weight (kg)	65	
Height (cm)	180	
BMI	20	Automatically calculated
Factors affecting the weight	Not selected	Oedemas/Cast/ Pregnancy/ Amputation
Initial screening		
Is BMI <20,5?	Yes	Automatic
Has the patient lost weight in recent weeks?	Yes	Yes/No
Has the patient been eating less in recent weeks?	Yes	Yes/No
Is the patient seriously ill?	No	Yes/No

Sheet 3		
Disease-related weight-loss		**Response options**
Weight (kg) 3 months ago	70	Earlier weight, if known
Screening for nutritional risk:		
Weight loss (%)	7	Automatically calculated
Food intake in % of normal requirement in the preceding week	25-50	<25%/ 25-50%/ 50-75%/ >75%
Score for impaired nutritional status	2	Automatically calculated
Severity of disease (metabolic stress)	1	0/ 1/ 2/ 3
Age ≥ 70 years?	0	Automatic score of 0 or 1 for age
Total score for nutritional risk	3	Automatically calculated
Nutritional support:		
Is nutritional support given?	Yes	Yes.../ Not yet/ No
Has dietitian been consulted?	Yes	Yes/No
	Save	

1

II

Clinical Nutrition 33 (2014) 634–641

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

Original article

The nutritional strategy: Four questions predict morbidity, mortality and health care costs

Randi J. Tangvik [a, b, *], Grethe S. Tell [c], John A. Eisman [d], Anne Berit Guttormsen [e, f], Andreas Henriksen [b], Roy Miodini Nilsen [a], Jannike Øyen [c, g], Anette Hylen Ranhoff [b, h]

[a] Department of Research and Development, Haukeland University Hospital, Bergen, Norway
[b] Kavli Research Centre for Ageing and Dementia, Haraldsplass Deacon Hospital, Bergen, Norway
[c] Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway
[d] Garvan Institute for Medical Research, St Vincent's Hospital, UNSW & University of Notre Dame, Sydney, Australia
[e] Department of Anaesthesia and Intensive Care, Haukeland University Hospital, Bergen, Norway
[f] Department of Clinical Medicine 1, University of Bergen, Bergen, Norway
[g] Department of Rheumatology, Haukeland University Hospital, Bergen, Norway
[h] Department of Clinical Science, University of Bergen, Bergen, Norway

ARTICLE INFO

Article history:
Received 27 February 2013
Accepted 6 September 2013

Keywords:
Implement
Nutritional guidelines
Nutritional risk
Clinical outcome
Clinical predictor

SUMMARY

Background: Nutritional care for hospital in-patients is potentially important but challenging.
Objective: To investigate the association between nutritional status and clinical outcomes.
Methods: Eight prevalence surveys were performed at Haukeland University Hospital, Norway, during 2008–2009. In total 3279 patients were classified as being at nutritional risk or not according to the Nutritional Risk Screening (NRS 2002) tool. The initial four questions of NRS 2002 assess dietary intake, weight loss, body mass index (BMI) and illness severity.
Results: The overall prevalence of nutritional risk was 29%. Adjusted mean days for hospitalisation was 8.3 days for patients at nutritional risk and 5.0 days for patients not at risk ($p < 0.001$). In adjusted models, patients at nutritional risk had increased one-year mortality (OR 4.07, 95% CI 2.90–5.70), morbidity (OR 1.59, 95% CI 1.18–2.13), and were 1.24 (95% CI 1.16–1.32) times more likely to have had a new admission during the three previous years and the one subsequent year, compared to patients not at risk. A 'positive' response to the initial four questions was associated with increased risk of morbidity and mortality. Patients with a reduced dietary intake during the last weeks had OR 1.72 (95% CI 1.03–2.85) for one-year mortality. Patients with a positive answer on all the initial four questions had ten times increased risk for mortality the following year, OR 13.0 (95% CI 4.52–37.6).
Conclusion: The four initial questions of the NRS 2002 robustly identify nutritional risk and were strong predictors of hospitalisation, morbidity and most importantly mortality among hospitalised patients. Thus, these simpler and short questions are robust indicators for subsequent poor outcomes.
© 2013 Elsevier Ltd and European Society for Clinical Nutrition and Metabolism. All rights reserved.

1. Introduction

Optimal nutrition is an essential part of health. Nevertheless poor nutrition is a common clinical problem in patients in European hospitals.[1,2] Loss of appetite and weight loss are associated with reduced muscle mass,[3] increased morbidity and loss of function even after only one week of illness.[4] Nutritional treatment, such as protein- and energy-enriched food and oral supplements, have been shown to improve nutritional status,[3] prevent loss of body mass and function[4] and reduce inflammation,[5] morbidity and mortality[6–8] in hospitalised patients. Even during a short hospital stay, individualised nutritional care to malnourished patients reduces morbidity and mortality.[9] Implementation of clinical routines which include nutritional evaluation, optimised food composition and monitoring of dietary intake have been shown to increase nutritional intake.[10] The additional costs of this nutritional care are modest.[11]

Better nutritional practice to improve patient care is emphasised in international and national health care guidelines.[12,13] However, the process of structured nutrition care is a challenge in many

* Corresponding author. Department of Research and Development, Haukeland University Hospital, 5021 Bergen, Norway.
E-mail addresses: randi.tangvik@helse-bergen.no, rtangvik@gmail.com (R.J. Tangvik).

0261-5614/$ – see front matter © 2013 Elsevier Ltd and European Society for Clinical Nutrition and Metabolism. All rights reserved.
http://dx.doi.org/10.1016/j.clnu.2013.09.008

hospitals, and routines are not well implemented.[14–16] A survey of nutritional practice in Norwegian hospitals showed poor practice and lack of knowledge among nurses and physicians.[16] It has been suggested that a general increase of number of forms and report requirements in the hospital as well as time-consuming procedures for nutritional assessment may contribute to this poor practice.[15,16]

To address this problem, Haukeland University Hospital introduced a strategy called "Good nutritional practice" in 2006 and recommended nutritional evaluation of all patients at admission.[15] Several methods were considered to identify patients at risk of malnutrition and the NRS 2002 (Nutritional Risk Screening) was chosen.[12] The full NRS 2002 survey includes four simple questions (yes/no) and a scoring procedure for the same questions. Controlled trials have shown that this nutritional evaluation can identify patients who are more likely to benefit from nutritional support.[17] Thus, the aim of this study was to measure if poor nutritional status assessed by NRS 2002, and which components of the assessment, if any, were associated with morbidity, mortality and the use of hospital services during a one-year follow-up in a university hospital.

2. Methods

2.1. Study design

This prospective observational study was conducted at the second largest hospital in Norway; Haukeland University Hospital, as well as the local hospitals Voss Hospital, Hagavik Orthopaedic Hospital and Nordås Rehabilitation Centre. In repeated point prevalence surveys carried out every three months starting January 2008, patients were evaluated according to nutritional risk. Data on the use of in-hospital services and mortality were obtained from the patient administrative electronic database.

2.2. Procedures

The NRS 2002 is designed to identify patients at nutritional risk. The evaluation starts with four initial questions:

Is BMI <20.5 kg/m^2?
Has the patient lost weight within the last weeks?
Has the patient had a reduced dietary intake during the last weeks?
Is the patient severely ill?

A patient is "not at risk" if BMI is $\geq$ 20.5 kg/m^2, food intake is normal, weight has not been declining and the current illness is not severe (i.e. no increased stress metabolism). If at least one of these criteria is met, the evaluation proceeds by giving 0–3 score in relation to BMI, recent weight loss and food intake during the previous weeks. Further, stress metabolism is evaluated with 0–3 score according to illness category. Finally, patients aged 70 years and older get one extra point. A total score $\geq$3, defined as "at nutritional risk", indicates that these individuals should receive individualised nutritional care.[12]

At 8 a.m. on the registration day, information on patient's name, date of birth, gender and hospital ward was exported to a dedicated database. The nurses performed the nutritional evaluation and registration of the data. The head nurses who were responsible for the digital registration were given a time-limited password and had seven hours to perform the registration. This procedure has previously been described.[15]

2.3. Variables

The use of in-hospital services, morbidity and mortality were compared between patients identified to be at nutritional risk by the NRS 2002, as well as separately by the four initial screening questions. Morbidity was assessed as number of ICD-10 diagnosis codes at discharge. The use of in-hospital services was measured as length of stay (LOS), number of subsequent admissions and the total number of days in hospital from inclusion and until the end of year one. Mean number of admissions, irrespective of cause, during the three previous years and the one following, were also recorded. These data were also obtained for patients whose nutritional screening was incomplete.

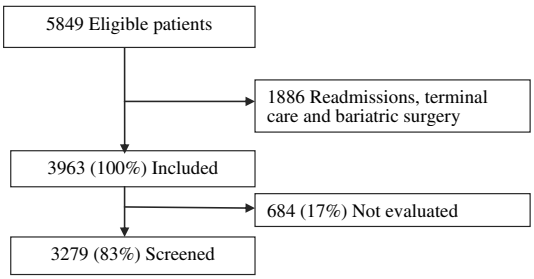


Fig. 1. Flow-chart.

2.4. Participating hospital units

Both medical and surgical inpatient departments and intensive care units participated in the surveys with the exception of departments of obstetrics, paediatrics and psychiatry. After a pilot study in three units, the first point prevalence survey was performed in 14 units in January 2008. The subsequent surveys included 51 units, from 2 to 31 beds. The present study included all hospitalised patients evaluated during eight surveys conducted during 2008 and 2009 ($n = 5949$). Patients who participated in two or more surveys are included with data from the first registration only. Patients admitted for bariatric surgery, day only admissions and foreign patients without a Norwegian personal identification number were excluded ($n = 1220$). Other exclusion criteria were terminal care and age below 18 years ($n = 666$). Through the eight surveys of 3963 eligible patients, 3279 (83%) had their nutritional survey fully completed. There is no information available for why 684 (17%) patients were not assessed (Fig. 1).

2.5. Statistical analyses

Statistical analyses were performed by using SAS (Statistical Analysis System) version 9.2 (SAS Institute, Inc., Cary, North Carolina) and R version 2.15.1 (The R Foundation for Statistical Computing, www.r-project.org). Continuous variables were reported as mean ± SEM and categorical variables as prevalence (%) ± SEM. The chi-square test was used to test for difference in prevalence of categorical variables, while Mann–Whitney *U* test was used to test for difference in medians of continuous variables. One-way analysis of variance was used to test for difference in means of continuous variables.

In hospital-based cross-sectional studies, patients with longer hospital stays are more often likely to be sampled than patients with shorter stays.[18] This oversampling of long-term stayers, i.e. length biased sampling, may influence the means and prevalence of exposures and outcomes as well as the effect estimates of exposure-outcome associations.[18] In order to account for this length bias, individual sampling weights were incorporated into the analyses by giving more weights to patients with shorter

Table 1
Population characteristics according to nutritional status and the NRS 2002 criteria.

	All subjects	Nutritional status		P^a
		At nutritional risk	Not at nutritional risk	
Total	3279 (100)	952 (29.0)	2327 (71.0)	
	Median [range]	**Median [range]**	**Median [range]**	
Age, yr	66 [18–99]	72 [18–99]	64 [18–98]	<0.001
BMI, kg/m^2	24.7 [11.0–55.6]	20.2 [11.0–44.5]	25.8 [18.5–55.6]	<0.001
	n (%)	***n*** (%)	***n*** (%)	
Sex, male	1646 (50.2)	443 (46.5)	1203 (51.7)	
Age, >70 year	1389 (42.5)	532 (55.9)	860 (37.0)	<0.001
Four initial questions[a]				
Is BMI <20.5 kg/m^2?	549 (16.7)	522 (54.8)	22 (0.7)	
Has the patient lost weight within the last weeks?	639 (19.5)	546 (57.4)	93 (2.8)	
Has the patient had a reduced dietary intake last weeks?	772 (23.5)	652 (68.5)	120 (3.7)	
Is the patient severely ill?	419 (12.8)	339 (35.6)	80 (2.4)	
BMI, kg/m^2				
≥20.5, 0 score	2658 (81.0)	418 (44.4)	2240 (98.9)	
≥18.5–<20.5, 2 score	305 (9.3)	279 (29.6)	26 (1.1)	
<18.5, 3 score	244 (7.4)	244 (25.9)	0	
Dietary intake,%				
>75%, 0 score	362 (11.0)	188 (28.3)	174 (73.1)	
50–75%, 1 score	255 (7.8)	195 (29.3)	60 (25.2)	
25–50%, 2 score	170 (5.2)	167 (25.1)	3 (1.3)	
<25%, 3 score	116 (3.5)	115 (17.3)	0	
Weight loss, %				
<5%, 0 score	456 (13.9)	297 (50.8)	159 (84.6)	
5–<10%, 1 score	171 (5.2)	144 (24.6)	27 (14.4)	
10–<15%, 2 score	91 (2.8)	89 (15.2)	2 (1.1)	
≥15%, 3 score	55 (1.8)	55 (9.4)	0	
Illness score				
0 score	127 (3.9)	73 (7.7)	54 (22.5)	
1 score	679 (20.7)	524 (55.0)	155 (64.6)	
2 score	247 (7.5)	216 (22.7)	31 (12.9)	
3 score	139 (4.2)	139 (14.6)	0	

[a] The chi-square test was used to test for difference in prevalence of categorical variables, while Mann–Whitney *U* test was used to test for differences in medians of continuous variables.

hospital stays, analogous to those described by Nowell et al.[19] Patients with the longest hospital stay (250 days) were given a weight of 1, while those with the shortest stay (1 day) were given a weight of 250. The generalised form of weights is weight = 250/LOS.

The associations of nutritional risk and the four introductory questions with mortality (1 year) and morbidity were assessed using logistic regression models. The estimated odds ratios (OR) with the corresponding 95% confidence intervals (CI) were reported crude and after accounting for the individual sampling weights described above, using PROC SURVEYLOGISTIC in SAS. Analyses of mortality were further adjusted for age (continuous), gender (male, female), height (continuous), emergency admission (yes, no), month for inclusion (quarter), number of days from admission to inclusion (continuous), and number of diagnoses (continuous). Analyses of morbidity were adjusted for the same variables except for the number of diagnoses.

The associations of nutritional risk and the four introductory questions with LOS, hospital stay (1 year) and admissions (4 years) were examined using linear regression models. Since the dependent variables were positively skewed, log-transformation was performed to better meet the assumption of normally distributed residuals in the regression models. After model fitting, the estimated slope coefficient B was interpreted on the anti-log scale, exp(B), rather than on the linear scale. This means that for a one unit increase in the independent variable the expected value of the dependent variable changed by the factor of exp(B). The estimated exp(B) with the corresponding 95% CI were reported crude and after accounting for the above mentioned sampling weights, using PROC SURVEYREG in SAS. Analyses of LOS and hospital stay (1 year) were adjusted for age (continuous), gender (male, female), height (continuous), emergency admissions (yes, no), time of year at inclusion (quarter), and number of diagnoses (continuous). Analyses of admission (4 years) were adjusted for the same variables as well as for number of days from admission to inclusion (continuous).

Estimation of hospital costs was based on a mean daily cost for patients ready to leave the hospital of US$ 860[20] and the mean number of days in hospital over one year.

To handle missing values in multiple regression models, we used the method of list-wise deletion. All *p*-values were two-sided, and values below 0.05 were considered statistically significant.

2.6. Ethics

The study was part of a quality improvement project and was therefore exempted from review by the Regional Committee for Medical and Health Research Ethics. The Norwegian Data Inspectorate and the hospital research board approved the study. The patients were not subject to any experimental interventions and thus were not asked to provide informed consent.

3. Results

3.1. Patients' characteristics

A total of 3963 patients were included in eight point prevalence surveys during 2008 and 2009. Among these, the NRS 2002 assessment was completed for 3279 (83%). Of these, 952 (29%) patients were classified as being at nutritional risk (Table 1).

Table 2
Clinical outcome according to nutritional risk status ($n = 3279$).

	Mortality (1 year)	Morbidity[a]	LOS[b]	Hospital stay (1 year)	Admissions (4 years)[c]	Hospital costs (1 year)[d]
	% ± SEM	% ± SEM	Mean ± SEM	Mean ± SEM	Mean ± SEM	Mean ± SEM
Observed estimates						
All subjects	18.9 ± 0.68	44.7 ± 0.87	18.2 ± 0.41	27.2 ± 0.54	4.17 ± 0.07	23 392 ± 464.4
At nutritional risk	37.3 ± 1.57	61.8 ± 1.58	22.7 ± 0.74	33.7 ± 1.00	4.74 ± 0.14	28 982 ± 860.0
Not at nutritional risk	11.3 ± 0.66	37.8 ± 1.01	16.4 ± 0.48	24.5 ± 0.63	3.94 ± 0.08	21 070 ± 541.8
p Value[e]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Corrected estimates[f]						
All subjects	12.5 ± 0.82	24.9 ± 1.06	5.68 ± 0.12	12.3 ± 0.36	4.16 ± 0.14	10 578 ± 309.6
At nutritional risk	30.8 ± 2.42	40.0 ± 2.54	8.32 ± 0.37	17.9 ± 0.82	5.70 ± 0.42	15 394 ± 705.2
Not at nutritional risk	8.03 ± 0.79	21.2 ± 1.15	5.03 ± 0.12	11.0 ± 0.39	3.78 ± 0.14	9460 ± 335.4
p Value[d]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

SEM, standard error of mean.
[a] Morbidity was transformed to a categorical variable defined by >4 diagnoses.
[b] LOS is length of current stay in days.
[c] Number of admissions was recorded the three previous and one following year.
[d] Hospital costs estimates were based on a mean daily cost of 860 US$ and the hospital stay (1 year).
[e] *p* value for difference between nutritional risk groups; chi-square test for categorical variables, 1-way analysis of variance for continuous variables.
[f] Estimates were corrected for length bias using sampling weights as described in the methods.

Compared to patients not at nutritional risk, patients at nutritional risk were older (mean age 67.9 vs. 61.7 years, $p < 0.001$), had lower BMI (mean 21.4 vs. 26.9 kg/m^2, $p < 0.001$) and had 36% more days in hospital during the one-year follow-up (mean 34 vs. 25 days, $p < 0.001$). Patients, ($n = 683$) with incomplete assessment and who were therefore not classified as being or not being at nutritional risk, were intermediate between the two above groups with mean age 64.9 years, 25.3 kg/m^2 BMI and 27 hospital days.

3.2. Clinical outcomes

The one-year mortality rate was 37% among patients at nutritional risk compared with 11% among those not at risk (OR 4.65, 95% CI 3.87–5.58). These results did not change importantly after accounting for sampling weights and further adjusting for age, gender, height, emergency admissions, quarter of inclusion, number of days from admission to inclusion and number of diagnoses (Tables 2 and 3).

Greater morbidity, measured as more than seven diagnoses, was near 5 times more common among patients at nutritional risk compared to patients not at risk. Compared to patients not at risk, twice as many patients at nutritional risk had more than four diagnoses (OR 2.66, 95% CI 2.28–3.11). These results did not change essentially and was still significant after corrections and adjustments (Tables 2 and 3).

Hospital stays of three weeks or longer were observed in 39.6% of the patients at nutritional risk vs. 22.3% of those not at risk ($p < 0.001$). Similarly only 11.4% of the patients at nutritional risk vs.

Table 3
One-year mortality and morbidity according to nutritional risk identified with the NRS 2002 and its four initial questions ($n = 3279$).

Nutritional risk factors	*n*	Mortality (1 year)			Morbidity[a]		
		Crude odds ratio (95% CI)[b]	Adjusted odds ratio (95% CI)[c]	Adjusted odds ratio (95% CI)[d]	Crude odds ratio (95% CI)[b]	Adjusted odds ratio (95% CI)[c]	Adjusted odds ratio (95% CI)[e]
NRS 2002[f]							
At nutritional risk	952	4.65 (3.87, 5.58)	5.01 (3.76, 6.92)	4.07 (2.90, 5.70)	2.66 (2.28, 3.11)	2.48 (1.94, 3.18)	1.59 (1.18, 2.13)
Four initial questions, model 1[g]							
Is BMI <20.5 kg/m^2? (yes)	549	1.67 (1.32, 2.11)	2.04 (1.34, 3.10)	2.15 (1.34, 3.46)	1.31 (1.06, 1.61)	1.28 (0.93, 1.75)	1.16 (0.80, 1.69)
Has the patient lost weight within the last weeks? (yes)	639	1.22 (0.89, 1.66)	1.08 (0.65, 1.80)	1.24 (0.74, 2.08)	1.05 (0.82, 1.36)	0.96 (0.64, 1.46)	1.04 (0.65, 1.66)
Has the patient had a reduced dietary intake in the last weeks? (yes)	772	2.37 (1.76, 3.19)	2.32 (1.43, 3.77)	1.72 (1.03, 2.85)	1.85 (1.46, 2.35)	1.89 (1.29, 2.76)	1.27 (0.83, 1.94)
Is the patient severely ill? (yes)	419	2.34 (1.82, 3.00)	3.88 (2.60, 5.77)	3.54 (2.25, 5.57)	1.81 (1.44, 2.28)	1.75 (1.23, 2.50)	1.65 (1.08, 2.50)
Four initial questions, model 2[h]							
At least one question answered with yes	1174	4.18 (3.48, 5.03)	4.46 (3.29, 6.04)	3.95 (2.85, 5.47)	2.17 (1.88, 2.51)	1.85 (1.47, 2.32)	1.40 (1.08, 1.83)
Four initial questions, model 3[i]							
Only 1 question answered with yes	427	3.10 (2.40, 4.01)	3.12 (2.00, 4.86)	3.05 (1.92, 4.85)	1.61 (1.31, 1.98)	1.33 (0.95, 1.86)	1.10 (0.75, 1.62)
Exactly 2 questions answered with yes	342	3.62 (2.76, 4.75)	3.85 (2.46, 6.01)	3.12 (1.94, 5.03)	2.18 (1.73, 2.75)	2.10 (1.46, 3.03)	1.50 (0.98, 2.29)
Exactly 3 questions answered with yes	315	5.91 (4.53, 7.70)	6.74 (4.36, 10.4)	6.24 (3.84, 10.1)	2.70 (2.11, 3.45)	2.33 (1.61, 3.37)	1.68 (1.11, 2.55)
All 4 questions answered with yes	73	10.3 (6.37, 16.7)	18.1 (8.22, 40.0)	13.0 (4.52, 37.6)	5.92 (3.37, 10.4)	6.21 (2.63, 14.7)	3.46 (1.48, 8.11)

[a] Morbidity was transformed to a categorical variable defined by >4 diagnoses.
[b] Estimate of odds ratio by logistics regression models.
[c] Estimate of odds ratio after accounting for sampling weights as described in the methods.
[d] Estimate of odds ratio after accounting for sampling weights and adjusted for age, gender, height, emergency admissions, month for inclusion, number of days from admission to inclusion, and number of diagnoses.
[e] Estimate of odds ratio after accounting for sampling weights and adjusted for age, gender, height, emergency admissions, month for inclusion, and number of days from admission to inclusion.
[f] NRS 2002: Patients at nutritional risk (yes) were compared with patients who were not at nutritional risk (no).
[g] Model 1: Patients with a positive answer (yes) on one question were compared with those with a negative answer (no) on that question. All four questions were simultaneously entered into the regression model, i.e. mutually adjusted for each other.
[h] Model 2: Patients with at least one positive answer (yes) on the four questions were compared with those with a negative answer (no) on all four questions.
[i] Model 3: Patients with a positive answer (yes) on one or more questions were compared with those with a negative answer (no) on all four questions.

Table 4
Hospitalisations according to nutritional risk identified with the complete NRS 2002 and its four initial questions ($n = 3279$).

Nutritional risk factors	n	LOS[a]			Hospital stay (1 year)			Admissions (4 years)[b]		
		Crude exp(B) (95% CI)[c]	Adjusted exp(B) (95% CI)[d]	Adjusted exp(B) (95% CI)[e]	Crude exp(B) (95% CI)[c]	Adjusted exp(B) (95% CI)[d]	Adjusted exp(B) (95% CI)[e]	Crude exp(B) (95% CI)[c]	Adjusted exp(B) (95% CI)[d]	Adjusted exp(B) (95% CI)[f]
NRS 2002[g]										
At nutritional risk	952	1.65 (1.53–1.78)	1.53 (1.33, 1.75)	1.30 (1.13, 1.48)	1.70 (1.58, 1.84)	1.93 (1.66, 2.23)	1.57 (1.35, 1.82)	1.24 (1.16, 1.32)	1.51 (1.34, 1.70)	1.34 (1.19, 1.51)
Four initial questions, model 1[h]										
Is BMI<20.5 kg/m^2? (yes)	549	1.03 (0.93, 1.14)	1.02 (0.87, 1.20)	0.97 (0.84, 1.12)	1.05 (0.95, 1.16)	1.24 (1.04, 1.48)	1.17 (0.99, 1.39)	1.14 (1.04, 1.24)	1.30 (1.09, 1.54)	1.26 (1.07, 1.48)
Has the patient lost weight within the last weeks? (yes)	639	1.16 (1.02, 1.31)	0.98 (0.79, 1.21)	0.99 (0.82, 1.18)	1.14 (1.01, 1.29)	1.01 (0.79, 1.29)	1.02 (0.80, 1.30)	1.02 (0.93, 1.13)	1.03 (0.87, 1.22)	1.04 (0.88, 1.24)
Has the patient had a reduced dietary intake in the last weeks? (yes)	772	1.32 (1.17, 1.48)	1.53 (1.25, 1.87)	1.38 (1.15, 1.64)	1.38 (1.24, 1.55)	1.65 (1.28, 2.11)	1.47 (1.16, 1.86)	1.12 (1.02, 1.23)	1.10 (0.94, 1.30)	1.04 (0.88, 1.22)
Is the patient severely ill? (yes)	419	1.41 (1.26, 1.59)	1.42 (1.16, 1.75)	1.20 (0.99, 1.46)	1.47 (1.32, 1.64)	1.94 (1.55, 2.42)	1.54 (1.23, 1.93)	1.13 (1.02, 1.24)	1.53 (1.27, 1.85)	1.36 (1.12, 1.64)
Four initial questions, model 2[i]										
At least one question answered with yes	1174	1.53 (1.42, 1.65)	1.44 (1.27, 1.62)	1.25 (1.11, 1.40)	1.63 (1.51, 1.76)	1.85 (1.61, 2.14)	1.60 (1.39, 1.84)	1.25 (1.17, 1.32)	1.48 (1.32, 1.65)	1.38 (1.24, 1.54)
Four initial questions, model 3[j]										
Only 1 question answered with yes	427	1.32 (1.18, 1.47)	1.23 (1.03, 1.47)	1.12 (0.95, 1.33)	1.41 (1.26, 1.57)	1.57 (1.27, 1.95)	1.41 (1.17, 1.71)	1.21 (1.11, 1.32)	1.51 (1.26, 1.81)	1.42 (1.20, 1.68)
Exactly 2 questions answered with yes	342	1.56 (1.39, 1.76)	1.51 (1.24, 1.85)	1.32 (1.10, 1.59)	1.66 (1.48, 1.88)	1.77 (1.43, 2.19)	1.54 (1.24, 1.91)	1.23 (1.12, 1.35)	1.38 (1.19, 1.61)	1.29 (1.12, 1.50)
Exactly 3 questions answered with yes	315	1.66 (1.47, 1.88)	1.60 (1.29, 2.00)	1.34 (1.12, 1.62)	1.88 (1.68, 2.11)	2.59 (2.08, 3.22)	2.10 (1.69, 2.61)	1.36 (1.23, 1.50)	1.63 (1.38, 1.93)	1.46 (1.23, 1.75)
All 4 questions answered with yes	73	2.41 (1.94, 2.98)	2.57 (1.64, 4.01)	1.74 (1.15, 2.62)	2.15 (1.75, 2.65)	2.75 (1.60, 4.70)	1.73 (1.00, 2.98)	1.17 (0.97, 1.41)	1.32 (0.91, 1.92)	1.04 (0.70, 1.56)

[a] LOS is length of current stay in days.
[b] Number of admissions was recorded the 3 previous and 1 following years.
[c] Estimate of exp(B) by linear regression models.
[d] Estimate of exp(B) after accounting for sampling weights as described in the methods.
[e] Estimate of exp(B) after accounting for sampling weights and adjusted for age, gender, height, emergency admissions, month for inclusion, and number of diagnoses.
[f] Estimate of exp(B) after accounting for sampling weights and adjusted for age, gender, height, emergency admissions, month for inclusion, number of diagnoses, and number of days from admission to inclusion.
[g] NRS 2002: Patients at nutritional risk (yes) were compared with patients who were not at nutritional risk (no).
[h] Model 1: Patients with a positive answer (yes) on one question were compared with those with a negative answer (no) on that question. All four questions were simultaneously entered into the regression model, i.e. mutually adjusted for each other.
[i] Model 2: Patients with at least one positive answer (yes) on the four questions were compared with those with a negative answer (no) on all four questions.
[j] Model 3: Patients with a positive answer (yes) on one or more questions were compared with those with a negative answer (no) on all four questions.

22.4% of the patients not at risk had a short hospital stay, i.e. less than four days ($p < 0.001$). Patients at risk were 1.24 (95% CI 1.16–1.32) times more likely as those not at risk to have been admitted during the previous 3 years and the one subsequent year and 1.70 (95% CI 1.58–1.84) more likely for hospitalisation (Table 4). These results did not change materially after accounting for sampling weights and adjusting for age, gender, height, emergency admissions, quarter for inclusion, number of days from admission to inclusion and number of diagnoses.

3.3. Costs of in-hospital services

Hospital cost was 60% higher for patients at nutritional risk compared to patients not at risk, (US$ 15 394 vs. 9460, ($p < 0.001$)) (Table 2).

3.4. NRS 2002 and the four initial questions

The four initial questions of NRS 2002 were strongly associated with increased risk for mortality even after accounting for length of stay sampling weights and adjustment for age, gender, height, emergency admissions, month for inclusion, number of days from admission to inclusion and number of diagnoses (Tables 3 and 4). The adjusted OR for one-year mortality increased progressively with more 'positive' responses to the four question: 3.05 (95% CI 1.92–4.85), 3.12 (95% CI 1.94–5.03), 6.24 (95% CI 3.84–10.1) and 13.0 (95% CI 4.52–37.6) for patients with a positive answer to one, two, three or all four of the initial questions, respectively (Table 3).

The question regarding reduced dietary intake in the previous weeks was associated with 2.37 (95% CI 1.76–3.19) times more likely for mortality the following year, and 1.85 (95% CI 1.46–2.35) for increased morbidity compared to patients not at nutritional risk. Severe illness was associated with 2.34 (95% CI 1.82–3.00) increased likelihood for mortality the following year and 1.81 (95% CI 1.44–2.28) for increased morbidity (Table 3).

The risk for mortality was similar when using the full NRS 2002 and the initial screening only, i.e. patients with a positive answer on one random initial question had OR 4.18 (95% CI 3.48–5.03) for one-year mortality compared to 4.65 (95% CI 3.87–5.58) among patients identified with the full NRS 2002 (Table 3). Of note, the predictive value of these questions was not driven by the question relating to prior ill-health as, interestingly, three of the four questions were alone effective in predicting the adverse morbidity and mortality outcomes (Table 3). The associations with increased mortality was still significant after accounting for sampling weights and adjustment for age, gender, height, emergency admissions, quarter for inclusion, number of days from admission to inclusion and number of diagnoses (Tables 3 and 4). Compared to the more complex scoring questions of the complete NRS 2002, the four initial questions identified all the patients at nutritional risk and 91% of the patients not at risk. Thus, these initial questions only incorrectly 'over-identified' 9% of the patients to be at nutritional risk. Using the full survey did not result in any material improvement in the prediction of subsequent adverse outcomes.

4. Discussion

In this study we evaluated the nutritional state and outcome of 3279 hospitalised patients with a wide variety of diseases in a university hospital. "Nutritional risk" was identified in 29% according to NRS 2002. Nutritional risk, but also its four initial questions were associated with increased morbidity, hospitalisation and importantly mortality. The risk for mortality over the following year was 10-fold increased for patients with a 'positive' answer to all four of these questions compared to patients not at nutritional risk. Patients with a reduced dietary intake during the prior weeks had a 4-fold-increased risk for one-year mortality. Of relevance to clinical implementation, the association with adverse outcome was similar for patients identified with the four initial screening questions versus the more time-consuming comprehensive screening tool NRS 2002.

The strength of the present study is that the surveys were performed in all adult somatic health departments in the second largest hospital in Norway, and that it was mandatory to participate. This allowed us to analyse several outcomes from a large number of patients from different medical specialities. Length bias may occur in prevalence surveys where individuals spend various lengths of time. This was facilitated by correcting for length-bias, i.e. patients with shorter hospital stays were giving more weight. The relatively low number of potential subjects "not registered" reduces the risk for systematic bias. Moreover, the patients with missing nutritional assessment had baseline data intermediate between those at nutritional risk and not at risk, as were their morbidity and mortality outcomes. The main outcome, mortality, is robust and easy to investigate. However, our secondary outcome, morbidity, might be influenced by different practice in the hospital and the fact that they are not entirely prospective measured. A limitation is that due to the nature of the study, any underlying reasons for the poor nutrition are not known. Age, gender, height, emergency admissions, month for inclusion, number of days from admission to inclusion and number of diagnoses were potential risk factors for nutritional risk that were adjusted for. As numbers of diagnoses determine roughly 60 per cent of the hospital reimbursement, this could bias towards more diagnoses being recorded. However, the hospital administrations, for several years, have focused on correct and not to overuse of diagnoses.

The prevalence of nutritional risk, 29.0% identified by NRS 2002 and 35.5% identified by the four initial questions, are both within the range of what has been reported during the last 15 years from studies of hospital populations using comprehensive assessment instruments as the NRS 2002[21] or the Subjective Global Assessment (SGA).[2,22–26] However, reduced food intake and loss of weight was even more common in the European multicentre study Nutrition Day ($n = 16\,455$) than in this study (49% vs. 19.5% and 51% vs. 23.5%, respectively).[27]

Malnutrition adversely impacts every organ system in the body with potentially serious consequences,[28] thus also the length of hospitalisation.[1,2,29]

The cost of undernutrition in the United Kingdom (UK) National Health Service has been estimated to be £13 billion annually, i.e. twice the estimated annual health care costs for obesity.[28] In the present study, the hospital costs were estimated to be 60% higher in the following year for patients at nutritional risk, simply due to increased hospitalisations. Moreover, this is likely to be an underestimate as any increased treatment costs were not included. Accurate diagnosis and coding for malnutrition could positively change the patients' Diagnosis Related Groups (DRG) to one with a higher weighting. This would correctly reflect the resources the hospital spends on these patients as 45% of malnourished patients are found to be hospitalised longer than recommended under the DRG.[2] In some countries, this would increase the amount of reimbursement the hospital received.

Undernutrition is clearly associated with increased use of scarce health care resources. Predicting outcome in hospitals can be important for several reasons, as identifying high-risk patients will impact in decision-making.[30] From the data on the present and previous studies, early nutritional care may be crucial to improve outcomes and health care costs. Thus, recognising nutritional problems at admission could help optimise the patient's treatment. There is evidence that nutritional information may change evaluation and

intervention. In UK and Denmark, nutritional evaluation by admission is mandatory.[31] Nevertheless, in Denmark only 24% of the patients were screened, and only 8% received the mandatory nutritional risk screening without procedural errors.[14] Nutritional evaluation is neither routine in clinical practice in situations and locations in which health care personnel state they consider that it is important.[14,16] Difficult and time-consuming procedures and lack of a gold standard for nutritional evaluation have been proposed as the main reasons for this inconsistence.[14,15] Comparing different assessment tools, wide discrepancies in prevalence of malnutrition can be found.[32] The results from the current study are critically important, as patients identified by four simple questions regarding poor nutrition, have essentially the same strong association with adverse outcomes as patients identified with more complex and time consuming procedures.

Optimal assessment of patients' nutritional status requires clinical judgment and should, ideally, include direct observation, food questionnaires and examination of the patient's physical, functional and mental status as well as identification of symptoms affecting nutritional status. However, when high turnover of patients makes this impractical, simplified admission procedures are required.

The scoring part of the NRS 2002 questionnaire is the time consuming part and that in which mistakes or miss-assignments are most common.[14] The findings of this study indicate that the four introductory questions allow a rapid and robust identification of patients in need for nutritional care, and all the patients at nutritional risk would still be identified.

The question regarding severity of illnesses was associated with increased risk for mortality, morbidity, prolonged hospitalisation and new admissions. Although, some screening tools have excluded this question,[31] we argue that this question is a strong risk factor for morbidity and mortality and thus is highly relevant. However, it should be emphasised that, according to guidelines, illness severity reflects increased nutritional requirement rather than prognostic severity.[12]

In conclusion, the four initial screening questions of the NRS 2002 were strong predictors of hospitalisation, morbidity and mortality among hospitalised patients. The four simple questions are robust indicators of poor subsequent outcomes and substantially greater health care costs and can cost-effectively identify individuals who would benefit from focussed nutritional interventions.

Clinical trial registry

Not relevant. The study was part of a quality improvement project and was therefore exempted from review by the Regional Committee for Medical and Health Research Ethics. The Norwegian Data Inspectorate and the hospital research board approved the study. The patients were not asked to provide informed consent and were not subject to any experimental interventions.

Statement of authorship

RJT, GST, ABG participated in developing the nutritional strategy, conception, design and conduction of the research.

RJT, AHR and RMN had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. RJT drafted the manuscript and had primary responsibility for final content.

All the authors participated in the interpretation of the data, contributed to write the manuscript and the final approval of the submitted version.

Conflict of interest

The sponsors of this study had no role in the study design, data collection, data analyses, data interpretation, or writing the report. The authors, the Kavli Research Centre for Ageing and Dementia and The Western Norway Regional Health Authority have no conflicts of interest to declare.

Acknowledgements

Funding was obtained from the Kavli Research Centre for Ageing and Dementia, Bergen, Norway and The Western Norway Regional Health Authority.

We extend our thanks to Håkon Ersland, Department of Research and Development, Haukeland University Hospital, Bergen, Norway and to Leah McFaul, Garvan Institute for Medical Research, Sydney, Australia for contributions.

References

1. Kondrup J, Johansen N, Plum LM, Bak L, Larsen IH, Martinsen A, et al. Incidence of nutritional risk and causes of inadequate nutritional care in hospitals. *Clin Nutr* 2002;**21**(6):461–8 [Epub 2002/12/07].
2. Lim SL, Ong KC, Chan YH, Loke WC, Ferguson M, Daniels L. Malnutrition and its impact on cost of hospitalization, length of stay, readmission and 3-year mortality. *Clin Nutr*. [Epub 2011/11/30].
3. Cederholm TE, Hellstrom KH. Reversibility of protein-energy malnutrition in a group of chronically-ill elderly outpatients. *Clin Nutr* 1995;**14**(2):81–7 [Epub 1995/04/01].
4. Stratton RJ, Green CJ, Elia M, editors. *Disease-related malnutrition. An evidence-based approach to treatment*. 1. ed. Oxon: CABI Publishing; 2003.
5. Cederholm T, Jagren C, Hellstrom K. Outcome of protein-energy malnutrition in elderly medical patients. *Am J Med* 1995;**98**(1):67–74 [Epub 1995/01/01].
6. Milne AC, Potter J, Avenell A. Protein and energy supplementation in elderly at risk from malnutrition. *Cochrane Database Syst Rev* 2005;**2**:CD003288 [Epub 2005/04/23].
7. Dennis M, Lewis S, Cranswick G, Forbes J. FOOD: a multicentre randomised trial evaluating feeding policies in patients admitted to hospital with a recent stroke. *Health Technol Assess* 2006;**10**(2) [Epub 2006/01/18].
8. Crogan NL, Alvine C, Pasvogel A. Improving nutrition care for nursing home residents using the INRx process. *J Nutr Elder* 2006;**25**(3–4):89–103 [Epub 2007/11/23].
9. Norman K, Stobaus N, Gonzalez MC, Schulzke JD, Pirlich M. Hand grip strength: outcome predictor and marker of nutritional status. *Clin Nutr*.30(2):135–142. [Epub 2010/11/03].
10. O'Flynn J, Peake H, Hickson M, Foster D, Frost G. The prevalence of malnutrition in hospitals can be reduced: results from three consecutive cross-sectional studies. *Clin Nutr* 2005;**24**(6):1078–88 [Epub 2005/10/13].
11. Kruizenga HM, Van Tulder MW, Seidell JC, Thijs A, Ader HJ, Van Bokhorst-de van der Schueren MA. Effectiveness and cost-effectiveness of early screening and treatment of malnourished patients. *Am J Clin Nutr* 2005;**82**(5):1082–9 [Epub 2005/11/11].
12. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. *Clin Nutr* 2003;**22**(4):415–21 [Epub 2003/07/26].
13. Health TNDo, editor. *National guidelines on preventing and treatment of malnutrition – the recommendations* 2009. p. 74. Oslo.
14. Geiker NR, Horup Larsen SM, Stender S, Astrup AV. Poor performance of mandatory nutritional screening of in-hospital patients. *Clin Nutr*. [Epub 2012/04/26].
15. Tangvik RJ, Guttormsen AB, Tell GS, Ranhoff AH. Implementation of nutritional guidelines in a university hospital monitored by repeated point prevalence surveys. *Eur J Clin Nutr* 2012;**66**(3):388–93.
16. Mowe M, Bosaeus I, Rasmussen HH, Kondrup J, Unosson M, Irtun O. Nutritional routines and attitudes among doctors and nurses in Scandinavia: a questionnaire based survey. *Clin Nutr* 2006;**25**(3):524–32 [Epub 2006/05/17].
17. Elia M, Zellipour L, Stratton RJ. To screen or not to screen for adult malnutrition? *Clin Nutr* 2005;**24**(6):867–84 [Epub 2005/05/17].
18. Fluss R, Mandel M, Freedman LS, Weiss IS, Zohar AE, Haklai Z, et al. Correction of sampling bias in a cross-sectional study of post-surgical complications. *Stat Med* 2013;**32**(14):2467–78 [Epub 2012/09/06].
19. Nowell C, Stanley LR. Length-biased sampling in mall intercept surveys. *J Marketing Res* 1991;**28**(4):475–9.
20. Services MoHaC. In: Services MoHaC, editor. *St-meld nr 47. 2008-2009 Samhandlingsreformen*. Oslo: Ministry of Health and Care Services; 2008.
21. Imoberdorf R, Meier R, Krebs P, Hangartner PJ, Hess B, Staubli M, et al. Prevalence of undernutrition on admission to Swiss hospitals. *Clin Nutr*.29(1):38–41. [Epub 2009/07/04].
22. Naber TH, Schermer T, de Bree A, Nusteling K, Eggink L, Kruimel JW, et al. Prevalence of malnutrition in nonsurgical hospitalized patients and its

association with disease complications. *Am J Clin Nutr* 1997;**66**(5):1232–9 [Epub 1997/11/14].
23. Sacks GS, Dearman K, Replogle WH, Cora VL, Meeks M, Canada T. Use of subjective global assessment to identify nutrition-associated complications and death in geriatric long-term care facility residents. *J Am Coll Nutr* 2000;**19**(5):570–7 [Epub 2000/10/07].
24. Persson C, Sjoden PO, Glimelius B. The Swedish version of the patient-generated subjective global assessment of nutritional status: gastrointestinal vs urological cancers. *Clin Nutr* 1999;**18**(2):71–7 [Epub 1999/08/25].
25. Lawson JA, Lazarus R, Kelly JJ. Prevalence and prognostic significance of malnutrition in chronic renal insufficiency. *J Ren Nutr* 2001;**11**(1):16–22 [Epub 2001/02/15].
26. Sorensen J, Kondrup J, Prokopowicz J, Schiesser M, Krahenbuhl L, Meier R, et al. EuroOOPS: an international, multicentre study to implement nutritional risk screening and evaluate clinical outcome. *Clin Nutr* 2008;**27**(3):340–9 [Epub 2008/05/28].
27. Hiesmayr M, Schindler K, Pernicka E, Schuh C, Schoeniger-Hekele A, Bauer P, et al. Decreased food intake is a risk factor for mortality in hospitalised patients: the NutritionDay survey 2006. *Clin Nutr* 2009;**28**(5):484–91 [Epub 2009/07/04].
28. Elia M. The economics of malnutrition. *Nestle Nutr Workshop Ser Clin Perform Programme* 2009;**12**:29–40 [Epub 2009/10/28].
29. Pirlich M, Schutz T, Norman K, Gastell S, Lubke HJ, Bischoff SC, et al. The German hospital malnutrition study. *Clin Nutr* 2006;**25**(4):563–72 [Epub 2006/05/16].
30. Viste A. Predicted morbidity and mortality in major gastroenterological surgery. Gastric Cancer.15(1):1–2. [Epub 2011/10/18].
31. Health DBo. *Guidelines for doctors, nurses and clinical dietitians: screening and treatment of patients at nutritional risk*. Danish Board of Health; 2003.
32. Thoresen L, Frykholm G, Lydersen S, Ulveland H, Baracos V, Prado CM, et al. Nutritional status, cachexia and survival in patients with advanced colorectal carcinoma. Different assessment criteria for nutritional status provide unequal results. *Clin Nutr* 2013;**32**(1):65–72 [Epub 2012/06/15].

III

Clinical Nutrition xxx (2014) 1–7

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

Original article

Nutritional risk profile in a university hospital population

Randi J. Tangvik [a, b, c, *], Grethe S. Tell [d], Anne Berit Guttormsen [e, f], John A. Eisman [g], Andreas Henriksen [c], Roy Miodini Nilsen [a], Anette Hylen Ranhoff [b, c]

[a] Department of Research and Development, Haukeland University Hospital, Bergen, Norway
[b] Department of Clinical Science 2, University of Bergen, Bergen, Norway
[c] Kavli Research Centre for Geriatrics and Dementia, Haraldsplass Deacon Hospital, Bergen, Norway
[d] Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway
[e] Department of Anesthesia and Intensive Care, Haukeland University Hospital, Bergen, Norway
[f] Department of Clinical Science 1, University of Bergen, Bergen, Norway
[g] Garvan Institute for Medical Research, St Vincent's Hospital, University of Notre Dame and UNSW Australia, Sydney, Australia

ARTICLE INFO

Article history:
Received 23 May 2014
Accepted 3 August 2014

Keywords:
Nutritional risk
Malnutrition
Screening
Hospital
Prevalence
Adults

SUMMARY

Background & aims: The prevalence of nutritional risk varies according to several factors. We aimed to determine the nutritional risk profile in a large Norwegian hospital population, specifically by age, disease category and hospital department.

Methods: Nutritional surveys are performed routinely at Haukeland University Hospital, Norway. During eight surveys in 2008–2009, 3279 patients were categorized according to the Nutritional Risk Screening tool (NRS 2002).

Results: The overall prevalence of nutritional risk was 29%, highest in patients with infections (51%), cancer (44%) and pulmonary diseases (42%), and in the departments of intensive care (74%), oncology (49%) and pulmonology (43%). Further, nutritional risk was identified in 40% of patients aged ≥80 years compared to 21% of age <40 years and 35% of patients with emergency admissions compared to 19% with elective admissions. Related to the tool components, nutritional risk was most common in patients with low BMI (<20.5 kg/m^2) (95%) and/or high comorbidity (>7 diagnoses) (45%). However it was also high in patients with BMI ≥25 kg/m^2 (12%) and in those with fewer than 7 diagnoses (26%).

Conclusions: Nutritional risk was most common among patients with high age, low BMI, more comorbidity, and with infections, cancer or pulmonary diseases, and patients who were discharged to nursing homes. However, the highest number of patients at nutritional risk had BMI in the normal or overweight range, were 60–80 years old, and were found in departments of general medicine or surgery. Importantly, younger patients and overweight patients were also affected. Thus, nutritional risk screening should be performed in the total patient population in order to identify, within this heterogeneous group of patients, those at nutritional risk.

© 2014 The Authors. Published by Elsevier Ltd and European Society for Clinical Nutrition and Metabolism. This is an open access article under the CC BY-NC-SA license (http://creativecommons.org/licenses/by-nc-sa/3.0/).

1. Introduction

Results from observational studies and randomized clinical trials indicate that nutrition plays an important role in the onset and progression of disease and in rehabilitation after disease or injury [1,2]. Nutritional depletion is common in hospitalized patients due to several factors related to disease, drug therapy and limited hospital resources to recognize, prevent and treat malnutrition [3,4]. As disease-related reduction of nutritional status can result in increased morbidity, mortality and hospital costs [3,5–8], its early identification and prevention are important [9]. Low food intakes, underweight and unintentional weight loss due to illness are associated with nutritional risk [5,10]. Nutritional care upon admission to hospital can contribute to improving or maintaining nutritional status and to avoid complications throughout the hospitalization and illness period [1]. Therefore, nutritional guidelines

* Corresponding author. Department of Research and Development, Haukeland University Hospital, Bergen, Norway. Tel.: +47 92209651 (mobile).
E-mail addresses: randi.tangvik@helse-bergen.no, rtangvik@gmail.com (R.J. Tangvik), grethe.tell@igs.uib.no (G.S. Tell), anne.guttormsen@helse-bergen.no (A.B. Guttormsen), j.eisman@garvan.org.au (J.A. Eisman), andreas.h.henriksen@gmail.com (A. Henriksen), roy.miodini.nilsen@helse-bergen.no (R.M. Nilsen), anette.ranhoff@k2.uib.no (A.H. Ranhoff).

http://dx.doi.org/10.1016/j.clnu.2014.08.001
0261-5614/© 2014 The Authors. Published by Elsevier Ltd and European Society for Clinical Nutrition and Metabolism. This is an open access article under the CC BY-NC-SA license (http://creativecommons.org/licenses/by-nc-sa/3.0/).

Please cite this article in press as: Tangvik RJ, et al., Nutritional risk profile in a university hospital population, Clinical Nutrition (2014), http://dx.doi.org/10.1016/j.clnu.2014.08.001

recommend nutritional screening on admission to hospital [2,11]. In some countries; United Kingdom, United States, the Netherlands and parts of Denmark it is mandatory [2,3,12].

Studies have shown that 20–50% of hospitalized patients are at nutritional risk [3,13,14]. The prevalence varies according to patient groups and screening tools [10,15–18]. Using The Nutritional Risk Screening (NRS 2002), the prevalence of nutritional risk was 18% out of 32,837 medical patients in Switzerland [19] and 32% of 5051 hospitalized patients from different specialties and hospitals in Europe [20]. Nutritional routines in hospitals are not sufficient [21,22] and The Council of Europe identified five barriers to proper nutritional care in hospitals [23]; 1. Clearly defined responsibilities; 2. Sufficient education; 3. Influence he patient; 4. Co-operation between various health care groups; and 5. Involvement from hospital managers.

In Norway, prevalence surveys on nutritional risk have been performed routinely at Haukeland University Hospital since 2008. We have previously reported that nutritional risk identified with NRS 2002 predicts poorer outcomes during a 1-year follow-up study [5]. Further, we have found that implementing screening guidelines improved screening performance, but not necessarily improved nutritional interventions [24]. In this study we expand our previous studies in order to identify those patient groups, specifically by disease category and hospital department, in which nutritional risk screening would be of most value.

2. Methods

2.1. Study design

This study is based on repeated cross sectional studies conducted at Haukeland University Hospital in Norway and the three satellite hospitals Voss, Nordås and Hagavik, a total of 975 beds, in order to estimate prevalence of nutritional risk.

2.2. Repeated prevalence surveys

Prevalence surveys were repeated every three months and were part of a quality improvement project. The first prevalence survey was performed in January 2008 in 14 hospital units. The subsequent seven surveys during 2008 and 2009 included 51 units, each with 6–31 beds. On the day of registration, administrative data (age, sex and hospital ward) were recorded in a dedicated database. The screening was performed by staff nurses, as previously described [24,25]. Information about diagnoses was obtained from the patient administrative system.

2.3. Nutritional risk screening (NRS 2002)

The patient's nutritional risk was evaluated by the NRS 2002. According to this instrument the patient is classified as 'not at risk' if body mass index (BMI) is $\geq$20.5 kg/m^2, food intake is normal, weight has not been declining during the last weeks and the current illness is not severe (i.e. no increased stress metabolism). When these criteria are not met, the evaluation proceeds by giving 0–3 points in relation to BMI, recent weight loss and food intake during the previous weeks, 0–3 points according to illness severity and stress metabolism and one extra point for age >70 years. Individuals who receive $\geq$3 points are defined to be "at nutritional risk". The procedures of the screening have been described earlier [2,25]. Administrative data were obtained from the hospital's electronic administrative data system (PIMS).

2.4. Patients

Nutritional risk screening was mandatory for in-hospital patients in all departments (Table 1), except the departments of obstetrics, pediatrics and psychiatry because the NRS 2002 is not designed for these patient groups. Patients who participated in two or more surveys were included with data from the first registration only. Day-care admissions and patients without the Norwegian identification number, unique to each Norwegian resident, were not included. Other exclusion criteria were terminal care, bariatric surgery and age <18 years.

2.5. Diagnoses

The main diagnoses were categorized in groups according to the International Classification of Diseases and related health problems (ICD-10). Some common specific diagnoses such as pneumonia, acute myocardial infarction, chronic obstructive pulmonary disease (COPD), hip fracture and some cancer diagnoses, were analyzed

Table 1
Prevalence of nutritional risk, age and BMI according to hospital departments and units (n = 3279).

	Total screened				At nutritional risk					
	n	Age Mean (SD)	BMI Mean (SD)	Female n (%)	n	Prevalence Crude (95% CI)	Prevalence Adjusted (95% CI)[a]	Age Mean (SD)	BMI Mean (SD)	Female n (%)
Intensive care	57	52.1 (18.6)	26.4 (5.9)	14 (25.0)	44	78.6 (67.5–89.7)	74.4 (60.5–88.3)[b]	52.3 (18.0)	25.6 (5.7)	12 (27.3)
Oncology	259	62.5 (15.8)	24.3 (5.0)	109 (42.1)	120	46.3 (40.2–52.5)	48.6 (42.5–54.8)	65.5 (13.8)	21.9 (4.5)	59 (49.2)
Thoracic medicine	176	70.2 (15.0)	23.1 (5.4)	82 (46.6)	77	43.8 (36.4–51.1)	42.8 (34.7–51.0)	71.4 (13.6)	19.1 (3.4)	35 (45.5)
Otolaryngology	103	58.5 (20.0)	24.2 (4.9)	36 (35.0)	36	35.0 (25.6–44.3)	40.1 (30.8–49.4)	70.3 (15.9)	19.9 (3.3)	12 (33.3)
General medicine	490	64.9 (20.3)	24.8 (5.7)	229 (46.7)	195	39.8 (35.5–44.2)	39.6 (35.1–44.1)	67.0 (20.4)	21.3 (4.6)	101 (51.8)
General surgery	600	64.2 (18.0)	24.8 (5.1)	305 (50.8)	185	30.8 (27.1–34.5)	30.5 (26.9–34.1)	69.3 (16.8)	21.4 (4.4)	108 (58.4)
Cardiology	402	66.7 (15.9)	26.1 (5,3)	151 (37.6)	109	27.1 (22.8–31.5)	27.0 (22.4–31.4)	72.2 (15.9)	23.5 (5.8)	50 (45.9)
Rheumatology	108	67.3 (14.6)	25.3 (5.4)	78 (72.2)	24	22.2 (14.3–30.2)	25.4 (14.5–36.2)	67.1 (18.6)	20.9 (5.3)	17 (70.8)
Neurosurgery	105	55.7 (17.2)	24.7 (3.8)	51 (48.6)	23	21.9 (13.9–30.0)	24.6 (14.8–34.4)	60.8 (14.4)	21.5 (3.4)	13 (56.5)
Neurology	212	60.0 (18.7)	25.4 (5.1)	108 (50.9)	42	19.8 (14.4–25.2)	20.4 (15.0–25.9)	66.1 (18.4)	20.8 (4.4)	28 (66.7)
Orthopedic/traumatology	278	64.8 (19.8)	25.5 (5.7)	157 (56.5)	60	21.6 (16.7–26.5)	18.8 (14.6–23.0)	74.9 (15.5)	20.0 (4.7)	48 (80.0)
Dermato-venereology	57	64.3 (18.4)	28.8 (6.6)	30 (52.6)	6	10.5 (2.3–18.7)	12.2 (4.1–20.2)	76.2 (11.8)	21.9 (6.0)	3 (50.0)
Habilitation/rehabilitation	151	55.7 (15.1)	25.8 (5.0)	58 (38.4)	12	7.9 (3.6–12.3)	7.5 (3.5–11.6)[b]	57.6 (16.1)	19.9 (2.7)	6 (50.0)
Gynecology	115	57.0 (18.4)	26.1 (5.1)	115 (100.0)	8	6.7 (2.2–11.7)	7.0 (2.1–11.9)[b]	50.9 (22.4)	20.9 (6.2)	8 (100.0)
Orthopedic (elective)	152	64.8 (15.2)	27.9 (5.3)	100 (65.8)	11	7.2 (3.1–11.4)	6.4 (2.7–10.1)	74.7 (16.3)	18.9 (1.1)	9 (81.8)
Ophthalmology	15	63.3 (17.8)	27.5 (5.6)	9 (60.0)	0	0	0			
Total	3279	63.4 (18.1)	25.3 (5.4)	1632 (49.8)	952	29.0 (27.5–30.1)		67.8 (17.6)	21.4 (4.8)	509 (53.5)

[a] Adjusted for age and sex using a direct standardized method.
[b] Adjusted for age.

Please cite this article in press as: Tangvik RJ, et al., Nutritional risk profile in a university hospital population, Clinical Nutrition (2014), http://dx.doi.org/10.1016/j.clnu.2014.08.001

separately (see Appendix 1). When the patient had two or more diagnoses, the most relevant diagnosis for the hospitalization was reported by the responsible physician as the main diagnosis.

2.6. Statistical analyses

Continuous variables were categorized, and reported as percentages ± standard error of the mean (SEM). The prevalence of nutritional risk was estimated overall as well as according to disease categories and hospital departments. To allow comparison between disease categories (or hospital departments), prevalence estimates and the corresponding 95% confidence intervals were adjusted for age and sex using a direct standardization method [26]. For this method, firstly, the total population ($n = 3279$) was considered as a standard and was distributed into six possible combinations of age (18–59, 60–79, 80+ years) and sex. For each combination, we estimated the relative frequency or weight (w) from the total population. If one or more cells of the combination variables were empty ($n = 0$), we excluded sex and only standardized for age. Second, the crude prevalence (p) of nutritional risk was estimated for each combination of age, sex, and disease categories (or hospital departments). Finally, the adjusted prevalence of nutritional risk within disease categories (or hospital departments) was defined as the weighted average of the respective prevalence p, weighted by w [27].

The standardization method was performed by using the *dstdize* function in Stata/IC 12.0 for Windows, otherwise statistical analyses were carried out using the statistical software SPSS Version 21.0 (SPSS Inc., Chicago, Illinois).

2.7. Ethics

The Norwegian Data Inspectorate and the hospital research board approved the study, which was exempted from review by the Regional Committee for Medical and Health Research Ethics because it was part of a quality improvement project to improve the nutrition care of hospitalized patients. The prevalence surveys were performed routinely in the hospital. Screening for nutritional risk is mandatory for the patients. The patients were not asked to provide informed consent and were not subject to any experimental interventions. Only clinical data available in the patient administrative system of the hospital were used.

3. Results

3.1. Study population

The flow-chart (Fig. 1) presents the numbers of patients eligible for screening, and who were actually screened. Among the 3962 eligible patients at the eight surveys, 3279 (83%) patients were completely assessed by the NRS 2002 and categorized as being at nutritional risk ($n = 952$, 29%) or not at risk ($n = 2327$, 71%). There was no information available on the 683 patients who were not completely screened.

3.2. General characteristics

Characteristics of the patients are presented in Table 2 and Fig. 2. The study population consisted of 50% men; mean age was 63.0 years and mean BMI 25.3 kg/m^2. Among patients at nutritional risk 53% were women; mean age was 67.8 years and mean BMI 21.4 kg/m^2. The prevalence of nutritional risk increased with age (Fig. 2) and was 40% for patients ≥80 years compared to 21% for patients <40 years (Table 2).

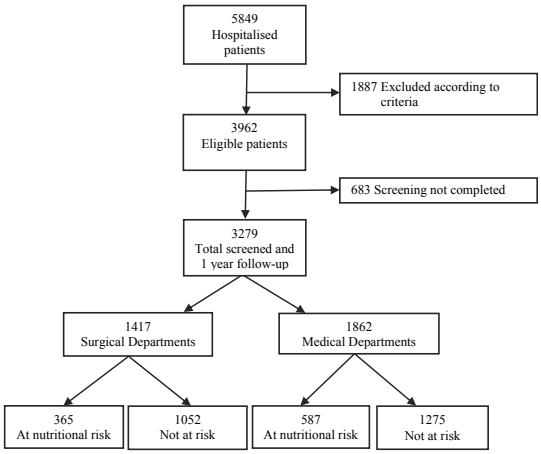


Fig. 1. Flow-chart: results from the eight prevalence surveys.

As might be expected based on the scoring system, the occurrence of nutritional risk was associated with weight; 95% of underweight (BMI <20.5 kg/m^2) patients were at risk. However, 12% of overweight (BMI ≥25 kg/m^2) and 11% of obese (BMI ≥30 kg/m^2) patients were also at nutritional risk (Table 2).

Again as might be expected, compared to patients not at risk, the patients at nutritional risk had more diagnoses (12% versus 25% had more than 7 diagnoses) and also more often emergency admissions (55% versus 74%).

3.3. Diagnoses

The prevalence of nutritional risk was at least 9% in all main categories of the ICD-10 system, and highest among patients with infections (51%), cancers (44%) and pulmonary diseases (42%); see Table 3 and in more detail in Appendix 1. However, cancers and diseases of the circulatory system are the most common categories

Table 2
Characteristics of the study population.

	Eligible patients *n* (%)	Total screened *n* (%)	At nutritional risk	
			n	% (±SEM)
Total	3962 (100.0)	3279 (82.8)	952	29.0 (±0.8)
Gender				
Female	1970 (49.7)	1632 (82.8)	509	31.2 (±1.1)
Male	1992 (50.3)	1647 (82.7)	443	26.9 (±1.1)
Age (years)				
18–39	475 (12.0)	407 (85.7)	87	21.4 (±2.0)
40–59	982 (24.8)	825 (84.0)	177	21.5 (±1.4)
60–79	1636 (41.3)	1331 (81.4)	399	30.0 (±1.3)
≥80	869 (21.9)	716 (82.4)	289	40.4 (±1.8)
Number of diagnoses (*n*)				
1–3	1593 (40.2)	1371 (86.1)	238	17.4 (±1.0)
4–7	1424 (35.9)	1386 (97.3)	478	34.5 (±1.3)
>7	945 (23.9)	522 (55.2)	236	45.2 (±2.2)
BMI (kg/m^2)				
<20.5	Data not available	548	522	95.3 (±0.9)
20.5–24.9		1135	229	35.5 (±1.4)
25.0–29.9		993	131	13.2 (±1.1)
30.0–34.9		363	42	11.6 (±1.7)
35.0–39.9		113	10	8.8 (±2.7)
≥40.0		48	6	12.5 (±4.8)
Admissions				
Elective	1492 (37.7)	1293 (86.7)	249	19.3 (±1.1)
Emergency	2470 (62.3)	1986 (80.4)	703	35.4 (±1.1)

Please cite this article in press as: Tangvik RJ, et al., Nutritional risk profile in a university hospital population, Clinical Nutrition (2014), http://dx.doi.org/10.1016/j.clnu.2014.08.001

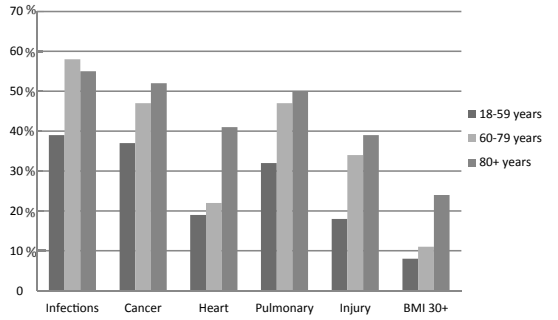


Fig. 2. Prevalence of nutritional risk in different categories of age and diseases (ICD-10).

of the main diagnoses in this hospital, accounting for 37% of the study population. Near half of the patients who were categorized as being at nutritional risk had diagnoses belonging to one of these two groups, i.e., 32% with cancer and 15% with a circulatory disorder (ICD-10-code I00-I99).

Patients with cancer in the gastrointestinal, pulmonary and lymphoid systems had the highest occurrence of nutritional risk (60%, 58% and 50%, respectively). For patients with diseases in the circulatory system (overall prevalence of nutritional risk 27%), a higher prevalence was observed in those with heart failure (46%) versus acute myocardial infarction (26%) and cerebral stroke (25%). Among patients with pulmonary diseases, the highest prevalence of nutritional risk was seen in patients with pneumonia (49%) and chronic obstructive pulmonary disease (COPD) (36%).

Overall, one third of the patients with diseases of the digestive system (K00–K93) were at nutritional risk. The prevalence was highest among patients with inflammatory bowel diseases (56%), celiac disease (50%) and diseases in esophagus, stomach and duodenum (48%).

The prevalence of nutritional risk was 37% among patients with hip fracture compared with 14% in those with an upper extremity fracture. Results for some other single diagnoses are shown in the appendix.

Adjustment for age and sex did not change the main findings (Table 3).

3.4. Departments and units

The prevalence of nutritional risk was significantly higher in departments of medicine (32%) than in departments of surgery (26%) ($p < 0.001$). In medical departments, nutritional risk was most common in the units of oncology (49%), pulmonology (43%), and general medicine (40%). Most (72%) of the 587 patients at nutritional risk in medical departments were found in three units; general medicine ($n = 195$), oncology ($n = 120$), and cardiology ($n = 109$).

The prevalence of nutritional risk in surgical departments was highest in intensive care units (74%), department of otolaryngology (40%) and general surgery (39.6). The relatively high nutritional risk for admissions to the otolaryngeal department was attributable to cancer (48%). Half of the surgical patients at nutritional risk had been admitted to general surgery departments.

3.5. Discharge from hospital

Of the total 3279 patients, 2552 (78%) were discharged from hospital to their own homes and 641 (20%) to nursing homes or to other hospitals, while 85 (3%) died in hospital. Of those patients who were discharged from hospital to home, 25% were at nutritional risk compared with 41% of those who were discharged to nursing homes, and 77% of those who died at the hospital.

4. Discussion

In this study of 3279 patients at Haukeland University Hospital the highest prevalence of nutritional risk was found among patients ≥80 years of age, BMI <20.5 kg/m^2 and among those with multi morbidity (>7 diagnoses). Further, the prevalence was high among patients with infections, cancer and pulmonary diseases. However, at this hospital, most of the patients at nutritional risk were not underweight, had four to seven diagnoses and were 60–80 years old. Even the younger patients, obese patients and patients with few diagnoses were frequently found to be at nutritional risk.

The prevalence of nutritional risk was highest in the intensive care unit and in oncology and pulmonology units; nevertheless, most of the patients at nutritional risk were located in departments of general medicine or surgery. In patients with myocardial infarction, where overweight is a risk factor, one out of

Table 3
Nutritional risk, age and BMI according to main diagnoses (ICD-10).

	Total screened				At nutritional risk					
	n	Age Mean (SD)	BMI Mean (SD)	Female *n* (%)	*n*	Prevalence Crude (95% CI)	Prevalence Adjusted (95% CI)[a]	Age Mean (SD)	BMI Mean (SD)	Female *n* (%)
Infections (A00–B99)	91	62.5 (19.7)	25.3 (7.0)	55 (60.4)	45	49.5 (39.0–60.0)	50.7 (40.4–61.0)	66.3 (18.9)	22.4 (5.4)	25 (55.6)
Cancer (C00–D48)	683	64.8 (15.3)	24.3 (5.0)	303 (44.4)	301	44.1 (40.3–47.8)	44.0 (40.2–47.7)	67.1 (14.6)	21.5 (4.1)	134 (44.5)
Pulmonary diseases (J00–J99)	276	67.5 (19.0)	23.7 (5.3)	125 (45.3)	120	43.5 (37.6–49.4)	41.8 (36.0–47.6)	70.8 (17.5)	20.5 (5.0)	58 (48.3)
Endocrine disorders (E00–E90)	35	56.0 (19.8)	27.0 (8.3)	24 (68.6)	10	28.6 (12.8–44.3)	37.6 (21.9–53.3)	68.1 (20.2)	20.0 (2.9)	7 (70.0)
Digestion diseases (K00–K93)	225	57.9 (20.7)	25.1 (5.4)	118 (52.4)	79	35.1 (28.8–41.4)	36.5 (29.8–43.2)	60.7 (21.0)	22.1 (5.7)	46 (58.2)
Injury (S00–S99)	286	67.3 (20.3)	24.2 (4.9)	173 (60.5)	87	30.4 (25.1–35.8)	27.6 (22.3–33.0)	72.4 (18.5)	20.3 (3.7)	58 (66.7)
Circulatory diseases (I00–I99)	546	67.8 (15.6)	25.8 (5.0)	210 (38.5)	144	26.4 (22.7–30.1)	27.2 (23.1–31.3)	71.9 (16.6)	22.6 (5.2)	80 (55.6)
Uro-genitalia (N00–N99)	138	65.6 (18.3)	25.8 (4.9)	92 (66.7)	22	15.9 (9.8–22.1)	16.9 (8.3–25.5)	73.8 (15.7)	22.5 (6.4)	13 (59.1)
Abnormal findings, not elsewhere classified (R00–R99)	71	55.7 (20.6)	24.9 (4.5)	37 (52.1)	11	15.5 (6.9–24.1)	15.4 (5.9–24.8)	57.8 (25.7)	19.2 (3.3)	7 (63.6)
Neurological diseases (G00–G99)	98	56.1 (17.7)	25.9 (5.0)	45 (45.9)	13	13.3 (6.4–20.1)	13.1 (6.1–20.0)	63.6 (14.8)	19.5 (4.2)	8 (61.5)
Skin and subcutaneous tissue (L00–L99)	74	60.3 (19.3)	27.9 (6.5)	38 (51.4)	9	12.2 (4.5–19.8)	13.0 (5.6–20.3)	64.3 (20.9)	23.0 (7.7)	5 (55.6)
Musculoskeletal and connective tissue (M00–M99)	307	61.6 (17.5)	26.8 (5.2)	178 (58.0)	31	10.1 (6.7–13.5)	10.6 (7.1–14.1)	65.3 (21.3)	21.9 (5.5)	20 (64.5)
Diseases of the blood, blood-forming organs and immune (D50–D89)	18	66.9 (19.0)	26.1 (6.2)	12 (66.7)	3	16.7 (2.4–35.7)	9.1 (0.2–18.1)	79.7 (3.0)	20.4 (4.6)	3 (100.0)
Total	3279	63.4 (18.1)	25.3 (5.4)	1632 (49.8)	952	29.0 (27.5–30.1)		67.8 (17.6)	21.4 (4.8)	509 (53.5)

[a] Adjusted for age and sex using a direct standardized method.

Please cite this article in press as: Tangvik RJ, et al., Nutritional risk profile in a university hospital population, Clinical Nutrition (2014), http://dx.doi.org/10.1016/j.clnu.2014.08.001

four patients were found to be at nutritional risk. Nearly half of the patients discharged from hospital to nursing homes were at nutritional risk.

4.1. Comparisons with findings from other studies

The prevalence of nutritional risk increases with age as has also been shown in previous studies [1,13,19,28]; 40% among patients ≥80 years old. NRS 2002 gives one extra point for age 70 years and older, because older people may have a lower tolerance for reduced nutritional status. Compared to younger patients, older people in hospitals generally have more comorbidity and polypharmacy that affect appetite, food intake and absorption of nutrients from the gastrointestinal tract. Without adding the point for age in NRS 2002, the prevalence of nutritional risk would have been 29% for patients' ≥80 years and 25% for patients 60–79 years old.

Nutritional risk has been shown to be most common in departments of gastrosurgery, cancer, infections, pulmonary, cardiac, and other chronic diseases [14,29–31]. However, in this study, the prevalence of nutritional risk was high in all illness categories, even among patients admitted for overweight-related conditions, such as acute myocardial infarction and stroke. It is demonstrated in previous studies using subjective global assessment (SGA) that malnutrition is common among overweight and obese patients as well [29,32]. In this study, as much as 12% of the overweight and obese were at nutritional risk. Hence awareness of nutrition due to disease-related stress metabolism and elevated protein needs is relevant to all patients, independent of BMI.

In the present study, the departments of gynecology, elective surgery and rehabilitation had low prevalence of nutritional risk and the unit of ophthalmology had no patients identified to be at nutritional risk. This was apparently due to low levels of general morbidity, lack of illnesses with stress metabolism, and younger patients in these units.

4.2. Methodological considerations

The strength of the present study is the relatively large number of patients and that the data were collected as part of hospital-wide prevalence surveys. Prevalence surveys can be of paramount significance for improvement of nutritional management of hospital patients. They show the burden of the problem to the health care managers and politicians, and may sensitize the participating hospital staff to nutritional issues, in particular to the need of nutritional interventions.

A screening tool should be practical, reliable and evidence-based [28]. The NRS 2002 was chosen because it fulfilled these criteria, and it has been validated and is recommended by the European Society for Nutrition and Metabolism (ESPEN) for use in hospitals [2]. NRS2002 is designed to be used in all adult patient categories in somatic hospital wards [10]. However, its usefulness in the Intensive care unit (ICU), were almost all patients get a score of 3 or more due to illness, is debatable. In this survey, 25 out of 57 patients at ICU got four points or more. The conclusion from the EPaNIC study [33] that the ICU patient benefits from less energy, at least i.v., during the early phase of disease has started a debate among nutritionists concerning nutritional management of the ICU patient. The advice in guidelines is also contradictory as early (on day 3) i.v., nutrition is advocated by ESPEN and late (after 8 days) by ASPEN [33] if enteral nutrition fails. Throughout this discussion it should be kept in mind that the clinical rationale for screening is to initiate tailored nutritional treatment to improve outcome.

On the one hand, patients with decreased consciousness and/or who were severely ill were more likely *not* to be screened. One the other hand, the healthiest patients stay at the patient hotel and might be less available for participating in the survey. If the healthiest and the sickest more often were not to be screened, our estimate of the prevalence of nutritional risk probably represents a middle estimate for hospital populations.

A limitation of the study is that psychiatric patients and patients below 18 years old were excluded, and 17% of eligible patients were not screened. However, patients were assessed by the nurses who were responsible for each patient during hospitalization; hence the assessment was performed by the person who knew the patient best.

4.3. Clinical implications

When patients are identified as being at nutritional risk, evidence-based treatment should be introduced to improve clinical outcomes. Our effort to improve patients' outcomes by nutritional treatment needs further action. In this study, patient groups for whom nutritional care would be of most value were identified. However, we found that patients at nutritional risk were a heterogeneous group and were admitted to almost all hospital units, many disease categories, wide categories of age and BMI, and with a single, few or several diagnoses. The heterogeneity of the patients indicates that it is not possible to identify at risk patients without nutritional risk screening or assessment. Hence routine screening on admission according to guidelines appears essential. These repeated nutrition surveys have revealed important data on prevalence and can improve screening performance and remind staff to accord nutrition an appropriate priority [24].

As many as one of four patients, discharged to their own home, and 40% of the patients, discharged to nursing homes, were at nutritional risk. Adequate transmission of information about nutritional status and intervention from the hospital to the GPs, home care services and nursing homes is important. According to a Dutch study, systematic transfer of relevant nutritional information from the hospital to the primary health career is fragmentary or lacking [13], and this may also be the case in our hospital. Improved reporting of patients' nutritional status, their nutritional plan and goals is an important opportunity for the hospitals to improve health care quality. In countries without dietitians to follow up patients after hospital discharge, as in Norway, the quality of the discharge letters is even more essential [1,6].

4.4. Implications for further research

Clinical studies should be conducted to assess whether structured nutritional work in a hospital organization is effective at improving patients' care, nutritional status and outcomes [34]. Studies of the efficiency and practice of nutritional interventions in different medical and surgical specialties are required.

5. Conclusion

The highest prevalence of nutritional risk was found among the oldest patients, patients with BMI <20.5, multi morbidity, emergency admissions, infections, cancer and pulmonary diseases. However, the largest number of patients at nutritional risk had BMI >20.5, four to seven diagnoses, were 60–80 years old or had been admitted to departments of general medicine or surgery. Nearly half of the patients discharged from hospital to nursing homes were at nutritional risk. Our study reveals that patients at

Please cite this article in press as: Tangvik RJ, et al., Nutritional risk profile in a university hospital population, Clinical Nutrition (2014), http://dx.doi.org/10.1016/j.clnu.2014.08.001

nutritional risk are heterogeneous and we recommend nutritional screening for all hospital patients.

Statement of authorship

RJT, GST, ABG participated in developing the nutritional strategy. RJT, GST, ABG and AHR participated in the conception and design of the study. All the authors participated in the interpretation of the data, contributed to writing the manuscript and the final approval of the submitted version. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Conflict of interest

The authors, the Kavli Research Centre for Ageing and Dementia and The Western Norway Regional Health Authority have no conflicts of interest to declare. The sponsors of this study had no role in the study design, data collection, data analyses, data interpretation, or writing the report. All authors have completed the Unified Competing Interest form and declare that (1) no one have support from any for the submitted work; (2) none of the authors have any relationships with companies that might have an interest in the submitted work in the previous 3 years; (3) nor their spouses, partners, or children have any financial relationships that may be relevant to the submitted work; and (4) no one have any non-financial interests that may be relevant to the submitted work.

Acknowledgments

This study was supported by grants from The Western Norway Regional Health Authority and Kavli Research Centre for Ageing and Dementia, Bergen, Norway. We also extend our thanks to Håkon Ersland, Department of Research and Development, Haukeland University Hospital, Bergen, Norway for contributions.

Appendix 1. Prevalence of nutritional risk according to main diagnoses (ICD-10).

	Total screened *n*	At nutritional risk *n*	Prevalence Crude (95% CI)
Infections (A00–B99)	91	45	49.5 (39.0–60.0)
Sepsis (A40–41)	52	29	55.6 (41.8–69.7)
Cancer (C00–D48)	683	301	44.1 (40.3–47.8)
Lip, oral cavity, pharynx and digestive organs (C00–C26)	172	103	59.9 (52.5–67.3)
Colon, rectum, anus and anal canal (C18–C21)	72	32	44.4 (32.7–56.2)
Respiratory and intrathoracic organs (C30–C39)	59	34	57.6 (44.6–70.6)
Lymphoid, hematopoietic and related tissues (C80–C96)	90	45	50.0 (39.5–60.5)
Sec. neoplasm of lymph nodes, respiratory. and digestive organs (C77–C79)	109	56	51.4 (41.8–60.9)
Central nervous system and endocrine glands (C69–C75)	25	8	32.0 (12.4–51.7)
Breast (C50)	17	5	29.4 (5.3–53.6)
Genital organs and urinary tract (C51–C68)	94	19	20.2 (11.9–28.5)
Prostate (C61)	29	9	31.0 (13.1–48.9)
Bladder (C67)	22	4	18.2 (0.7–35.7)
Pulmonary diseases (J00–J99)	276	120	43.5 (37.6–49.4)
Pneumonia (J12–J18)	129	63	48.8 (40.1–57.6)
COPD (J40–J47)	39	14	35.9 (20.1–51.7)
Diseases of the digestive system (K00–K93)	225	79	35.1 (28.8–41.4)
Diseases of esophagus, stomach and duodenum (K20–K31)	25	12	48.0 (27.0–69.1)
Inflammatory bowel diseases (K50–K52)	27	15	55.6 (35.5–75.6)
Liver (K70–K77)	10	3	30.0 (−4.6–64.6)
Gall bladder and pancreas (K80–K87)	45	15	33.0 (19.0–47.7)
Celiac disease, malabsorption (K90–K93)	8	4	50.0 (5.3–94.7)
Endocrine, nutritional and metabolic diseases (E00–E90)	35	10	28.6 (12.8–44.3)
Injury (S00–S99)	286	87	30.4 (25.1–35.8)
Hip fracture (S70–S72)	95	35	36.8 (27.0–46.7)
Abdomen, lower back, lumbar spine, pelvis (S30–S32)	31	10	32.3 (14.8–49.7)
Shoulder, upper arm and forearm (S42–S52)	48	14	29.2 (15.8–42.5)
Diseases of the circulatory system (I00–I99)	546	144	26.4 (22.7–30.1)
Stroke (I60–I69)	119	30	25.2 (17.3–33.1)
Heart diseases (I11, I20–25, I30–I52)	348	91	26.2 (21.5–30.8)
Heart failure (I50)	48	22	45.8 (31.2–60.5)
Acute myocardial infarction (I21–I25)	100	26	26.0 (17.3–34.8)
Angina pectoris (I20)	62	4	6.5 (0.2–12.7)
Symptoms and abnormal findings, not elsewhere classified (R00–R99)	71	11	15.5 (6.9–24.1)
Diseases of the genitourinary system (N00–N99)	138	22	15.9 (9.8–22.1)
Renal failure (N17–N19)	30	8	26.7 (9.9–43.5)
Urinary tract infection (N39)	22	5	22.7 (3.7–41.8)
Glomerular and renal tubulo-interstitial diseases (N00–N16)	10	3	30.0 (−4.6–64.6)
Diseases of the blood, blood-forming organs, disorders involving the immune mechanism (D50–D89)	18	3	16.7 (2.4–35.7)
Diseases of the nervous system (G00–G99)	98	13	13.3 (6.4–20.1)
Diseases of the skin and subcutaneous tissue (L00–L99)	74	9	12.2 (4.5–19.8)
Diseases of the musculoskeletal and the connective tissue (M00–M99)	307	31	10.1 (6.7–13.5)
Rehabilitation (Z50.80–Z50.89)	189	28	15.1 (9.9–20.2)
Total	3279	952	29.0 (27.5–30.1)

Please cite this article in press as: Tangvik RJ, et al., Nutritional risk profile in a university hospital population, Clinical Nutrition (2014), http://dx.doi.org/10.1016/j.clnu.2014.08.001

References

[1] Stratton RJ, Green CJ, Elia M. Disease-related malnutrition: an evidence-based approach to treatment. UK: CABI Publishing; 2003. p. 824.
[2] Kondrup J, Allison SP, Elia M, Vellas B, Plauth M, Educational, et al. ESPEN guidelines for nutrition screening 2002. Clin Nutr 2003 Aug;22(4):415–21. PubMed PMID: 12880610. Epub 2003/07/26. eng.
[3] Barker LA, Gout BS, Crowe TC. Hospital malnutrition: prevalence, identification and impact on patients and the healthcare system. Int J Environ Res Public Health 2011 Feb;8(2):514–27. PubMed PMID: 21556200. Pubmed Central PMCID: 3084475.
[4] Kondrup J, Johansen N, Plum LM, Bak L, Larsen IH, Martinsen A, et al. Incidence of nutritional risk and causes of inadequate nutritional care in hospitals. Clin Nutr 2002 Dec;21(6):461–8. PubMed PMID: 12468365.
[5] Tangvik RJ, Tell GS, Eisman JA, Guttormsen AB, Henriksen A, Nilsen RM, et al. The nutritional strategy: four questions predict morbidity, mortality and health care costs. Clin Nutr 2014 Aug;33(4):634–41. PubMed PMID: 24094814.
[6] Mudge AM, Kasper K, Clair A, Redfern H, Bell JJ, Barras MA, et al. Recurrent readmissions in medical patients: a prospective study. J Hosp Med 2011 Feb;6(2):61–7. PubMed PMID: 20945294.
[7] Gariballa S, Forster S. Malnutrition is an independent predictor of 1-year mortality following acute illness. Br J Nutr 2007 Aug;98(2):332–6. PubMed PMID: 17391564.
[8] Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clin Nutr 2003 Jun;22(3):235–9. PubMed PMID: 12765661.
[9] Somanchi M, Tao X, Mullin GE. The facilitated early enteral and dietary management effectiveness trial in hospitalized patients with malnutrition. J Parenter Enteral Nutr 2011 Mar;35(2):209–16. PubMed PMID: 21378250.
[10] Kuzu MA, Terzioglu H, Genc V, Erkek AB, Ozban M, Sonyurek P, et al. Preoperative nutritional risk assessment in predicting postoperative outcome in patients undergoing major surgery. World J Surg 2006 Mar;30(3):378–90. PubMed PMID: 16479353.
[11] *National guidelines on preventing and treatment of malnutrition.* In: Directorate NH, editor. http://www.helsedirektoratet.no/publikasjoner/nasjonal-faglig-retningslinje-for-forebygging-og-behandling-av-underernering/Publikasjoner/nasjonal-faglig-retningslinje-for-forebygging-og-behandling-av-underernering.PDF2010.
[12] Mueller C, Compher C, Ellen DM. American Society for P, Enteral Nutrition Board of D. A.S.P.E.N. clinical guidelines: nutrition screening, assessment, and intervention in adults. J Parenter Enteral Nutr 2011 Jan;35(1):16–24. PubMed PMID: 21224430.
[13] van Bokhorst-de van der Schueren MA, Klinkenberg M, Thijs A. Profile of the malnourished patient. Eur J Clin Nutr 2005 Oct;59(10):1129–35. PubMed PMID: 16015259.
[14] Rasmussen HH, Kondrup J, Staun M, Ladefoged K, Kristensen H, Wengler A. Prevalence of patients at nutritional risk in Danish hospitals. Clin Nutr 2004 Oct;23(5):1009–15. PubMed PMID: 15380890.
[15] Thoresen L, Frykholm G, Lydersen S, Ulveland H, Baracos V, Prado CM, et al. Nutritional status, cachexia and survival in patients with advanced colorectal carcinoma. Different assessment criteria for nutritional status provide unequal results. Clin Nutr 2013 Feb;32(1):65–72. PubMed PMID: 22695408.
[16] Ranhoff AH, Gjoen AU, Mowe M. Screening for malnutrition in elderly acute medical patients: the usefulness of MNA-SF. J Nutr Health Aging 2005 Jul–Aug;9(4):221–5. PubMed PMID: 15980922.
[17] Elia M, Zellipour L, Stratton RJ. To screen or not to screen for adult malnutrition? Clin Nutr 2005 Dec;24(6):867–84. PubMed PMID: 15893857.
[18] Neelemaat F, Meijers J, Kruizenga H, van Ballegooijen H, van Bokhorst-de van der Schueren M. Comparison of five malnutrition screening tools in one hospital inpatient sample. J Clin Nurs 2011 Aug;20(15–16):2144–52. PubMed PMID: 21535274.
[19] Imoberdorf R, Meier R, Krebs P, Hangartner PJ, Hess B, Staubli M, et al. Prevalence of undernutrition on admission to Swiss hospitals. Clin Nutr 2010 Feb;29(1):38–41. PubMed PMID: 19573958.
[20] Sorensen J, Kondrup J, Prokopowicz J, Schiesser M, Krahenbuhl L, Meier R, et al. EuroOOPS: an international, multicentre study to implement nutritional risk screening and evaluate clinical outcome. Clin Nutr 2008 Jun;27(3):340–9. PubMed PMID: 18504063.
[21] Mowe M, Bosaeus I, Rasmussen HH, Kondrup J, Unosson M, Irtun O. Nutritional routines and attitudes among doctors and nurses in Scandinavia: a questionnaire based survey. Clin Nutr 2006 Jun;25(3):524–32. PubMed PMID: 16701921.
[22] Mowe M, Bosaeus I, Rasmussen HH, Kondrup J, Unosson M, Rothenberg E, et al. Insufficient nutritional knowledge among health care workers? Clin Nutr 2008 Apr;27(2):196–202. PubMed PMID: 18295936.
[23] Food and nutritional care in hospitals: how to prevent undernutrition. Strasbourg: Council of Europe Publishing; 2002. p. 176.
[24] Tangvik RJ, Guttormsen AB, Tell GS, Ranhoff AH. Implementation of nutritional guidelines in a university hospital monitored by repeated point prevalence surveys. Eur J Clin Nutr 2012 Mar;66(3):388–93. PubMed PMID: 21863042. Pubmed Central PMCID: 3303136. Epub 2011/08/25. eng.
[25] Rasmussen HH, Kondrup J, Staun M, Ladefoged K, Lindorff K, Jorgensen LM, et al. A method for implementation of nutritional therapy in hospitals. Clin Nutr 2006 Jun;25(3):515–23. PubMed PMID: 16698137.
[26] Rothman K. Measures of effect and measures on association. In: Rothman KG, editor. Modern epidemiology. Philadelphia, PA: Lippincott-Raven Publishers; 1998. p. 47–64.
[27] Nilsen RM, Vollset SE, Gjessing HK, Magnus P, Meltzer HM, Haugen M, et al. Patterns and predictors of folic acid supplement use among pregnant women: the Norwegian mother and child cohort study. Am J Clin Nutr 2006 Nov;84(5):1134–41. PubMed PMID: 17093167.
[28] Kyle UG, Kossovsky MP, Karsegard VL, Pichard C. Comparison of tools for nutritional assessment and screening at hospital admission: a population study. Clin Nutr 2006 Jun;25(3):409–17. PubMed PMID: 16356595.
[29] Pirlich M, Schutz T, Norman K, Gastell S, Lubke HJ, Bischoff SC, et al. The German hospital malnutrition study. Clin Nutr 2006 Aug;25(4):563–72. PubMed PMID: 16698132.
[30] Stratton RJ, Elia M. Who benefits from nutritional support: what is the evidence? Eur J Gastroenterol Hepatol 2007 May;19(5):353–8. PubMed PMID: 17413283.
[31] Lugli AK, Wykes L, Carli F. Strategies for perioperative nutrition support in obese, diabetic and geriatric patients. Clin Nutr 2008 Feb;27(1):16–24. PubMed PMID: 18023508.
[32] Planas M, Audivert S, Perez-Portabella C, Burgos R, Puiggros C, Casanelles JM, et al. Nutritional status among adult patients admitted to an university-affiliated hospital in Spain at the time of genoma. Clin Nutr 2004 Oct;23(5):1016–24. PubMed PMID: 15380891.
[33] Casaer MP, Mesotten D, Hermans G, Wouters PJ, Schetz M, Meyfroidt G, et al. Early versus late parenteral nutrition in critically ill adults. N Engl J Med 2011 Aug 11;365(6):506–17. PubMed PMID: 21714640.
[34] Omidvari AH, Vali Y, Murray SM, Wonderling D, Rashidian A. Nutritional screening for improving professional practice for patient outcomes in hospital and primary care settings. Cochrane Database Syst Rev 2013;6:CD005539. PubMed PMID: 23744516.

Please cite this article in press as: Tangvik RJ, et al., Nutritional risk profile in a university hospital population, Clinical Nutrition (2014), http://dx.doi.org/10.1016/j.clnu.2014.08.001