Risk of Malnutrition and Pressure Ulcer in a mixed hospital population.

Nutritional risk screening predicting pressure ulcer.

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Johanne Alhaug

Abstract

Background and aim

Malnutrition and pressure ulcer represent significant health problems for hospital inpatients, in addition to having a considerable impact on local and national health care cost. Sufficient nutritional status is crucial for proper wound healing, and malnutrition is a prominent risk factor for pressure ulcer development. Risk of malnutrition can be identified using standardized screening tools, such as the Nutritional Risk Screening (NRS) 2002. The objective of this study was to examine the prevalence of risk of malnutrition and pressure ulcer, and whether the NRS 2002 could predict risk of pressure ulcer for hospital inpatients.

Methods

The data was collected as part of a larger cross-sectional study conducted at Lovisenberg Diaconal Hospital in Oslo, Norway on 10 pre-selected screening days between September 2012 and May 2014. All adult inpatients (≥18 years) admitted to medical or elective orthopedic surgical wards on the screening days were asked to participate. Patients admitted to Hospice or an intensive care unit, with cognitive impairment or unable to read Norwegian were excluded. Second year nursing bachelor students and ward nurses conducted the NRS 2002 initial screening and skin examinations for pressure ulcer using European Pressure Ulcer Advisory Panel classification (Stage I-IV). A registered clinical dietician conducted all NRS 2002 final screenings**.**

Results

Of the 1082 patients hospitalized on the 10 screening days, 651 (77 %) had complete screening data and skin examinations and were included in the analysis. The sample included 52% women and mean age was 62.9 years (SD 17.3). Based on the initial NRS 2002 screening, 52 % of the sample was at *Possible risk* of malnutrition. Final screening identified 34 % *At risk* for malnutrition. Most (65 %) of the 339 patients identified as *Possible risk* by initial screening were identifies as *At risk* in the final screening.

The skin examinations indicated an 8 % prevalence of pressure ulcer (Stage I-IV).

Patients identified as being at *Possible risk* by the initial screening or *At risk* by the final NRS 2002 screening, were more likely to have pressure ulcer (OR=2.58, p=0.011 and 2.55, p=0.008 respectively) than patients at low nutritional risk after controlling for sex, age, hospital department, and BMI. Among the three initial screening items, the strongest predictors of PU were *Is BMI<20?* (OR 2.73, p=0.006) and *Ate less past week?* (OR=1.91, p=0.046)

Conclusion

This current study confirms that risk of malnutrition and pressure ulcers still are common in a Norwegian hospital setting. In addition it suggests the significance of nutritional risk screening, using the NRS 2002, in predicting the presence of pressure ulcer in the studied hospital population. The prevalence of pressure ulcer was lower and risk of malnutrition higher than expected prior to the study. The final screening was a slightly stronger predictor of pressure ulcer compared to the initial NRS 2002 screening. However, given that the initial screening requires less time from ward personnel, the initial screening is considered to be adequate for identifying patients at risk of developing pressure ulcer. This could enable more efficient screening routines to promote optimal implementation, execution and satisfactory patient safety results.

Abbreviations

A.S.P.E.N	American Society of Parenteral and Enteral Nutrition
BMI	Body mass index
CRP	C-reactive protein
EPUAP	European Pressure Ulcer Advisory Panel
ESPEN	European Society of Clinical Nutrition and Metabolism
HAPU	Hospital acquired pressure ulcer
ICU	Intensive care unit
IPLOS	Individbasert pleie- og omsorgsstatistikk
IRR	Inter-rater reliability
LOS	Length of stay
MNA	Mini Nutritional Assessment
MUST	Malnutrition Universal Screening Tool
NPUAP	National Pressure Ulcer Advisory Panel
NRS 2002	Nutritional Risk Screening 2002
PEM	Protein and energy malnutrition
PU	Pressure ulcer
SGA	Subjective Global Assessment

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1. Introduction

1.1 Malnutrition

1.1.1 Definition

Malnutrition is a complex condition, and the definition and diagnostic criteria for malnutrition has been discussed internationally. The American Society of Parenteral and Enteral Nutrition (A.S.P.E.N.) published in 2012 an approach for universal standardized diagnostic characteristic recognizing malnutrition (1). The consensus statement describes malnutrition as simply any nutritional imbalance, focusing on adult malnutrition, covering malnourished and obese adults at nutritional risk (1).

Malnutrition is defined by the European Society of Clinical Nutrition and Metabolism (ESPEN) (2) in their Consensus Statement of 2015 (2): "Malnutrition due to starvation, disease or ageing can be defined as a state resulting from lack of uptake or intake of nutrition leading to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease". The intention of the ESPEN Consensus Statement is "to provide a consensus based on a minimum set of criteria for the diagnosis of malnutrition to be applied independent of clinical setting and etiology and to unify international terminology" (2).

Both A.S.P.E.N. and ESPEN guidelines are based on earlier joint efforts to develop an etiology-based approach for diagnosing adult malnutrition (3). The approach defines adult malnutrition "in the context of acute illness or injury, chronic diseases or conditions, and starvation-related malnutrition"(1). In addition it might be useful to include "frailty" as a fourth condition of malnutrition.

1. Pure chronic starvation without inflammation (e.g. medical conditions like anorexia nervosa). Malnutrition caused by starvation was brought to attention in the 1960's, due to famine catastrophes in Africa (2). The two most common conditions are;

a. Kwashiorkor, energy deficiency causing major weight loss due to depletion of fat reserves (2).

b. Marasmus, protein deficiency causing hypoalbuminia, ascites and peripheral edema.(2).

Proper nutritional treatment will most likely be beneficial for both conditions.

2. Chronic diseases or conditions that impose sustained inflammation of a mild to moderate degree (e.g. organ failure, pancreatic cancer, rheumatoid arthritis or sarcopenic obesity).

   Proper nutritional treatment will most likely be beneficial.

Disease related malnutrition seen in hospitals is often a combination of the two (1. and 2) (2).

3. Acute disease or injury states with marked inflammatory response (e.g. major infection, burns, trauma or closed head injury). This can be characterized as an acute response that triggers a cascade of reactions leading to elevated resting energy expenditure, impaired utilization of protein, and increased nitrogen excretion (4). This clinical condition has more recently been characterized as part of the condition of cachexia (5, 6).

   Cachexia (Greek: bad condition) can be described as "a multifactorial syndrome characterized by severe loss of body weight, fat and muscle mass in addition to increased protein catabolism due to underlying disease(s)" (5). Clinical conditions contributing to the onset of cachexia are anorexia, metabolic alterations, increased muscle degeneration and impaired macronutrient metabolism (carbohydrate, protein and lipid) together with high levels of infection markers, as C-reactive protein (CRP) and loss of body weight (5).

   Proper nutritional treatment alone is not sufficient to reverse the sever condition (4). Individualized nutritional care in combination with proper medical treatment will most likely be beneficial.

4. Frailty is more often included when describing malnutrition in elderly; a geriatric syndrome resulting from age-related increasing failures in a number of physiological processes. This includes normal age related changes and a homeostatic imbalance which

results in a reduced ability to manage metabolic stress. The clinical condition does make a person more vulnerable to disease and injury (6). Fried et al. developed an accepted definition and a more readily identification of frailty based on physical issues including unintentional weight loss, exhaustion, weakness, slow gait speed and low physical activity. Three or more of these physical characteristics must be present to support the frailty diagnosis. In addition frailty includes assessment of issues like cognitive status, social support and environmental factors (7).

The terms malnutrition and undernutrition is used interchangeably in the literature. Malnutrition describes both overnutrition and undernutrition. The ESPEN consensus chose to use malnutrition when describing deficiencies of macro- and micronutrients in addition to catabolism of protein and energy stores caused by disease or ageing (2). In this thesis the terms malnutrition and risk of malnutrition will be used referring to deficiencies.

1.1.2 Biological effects

Inadequate intake of food over time will have a negative impact on metabolic functions, body composition, physical and psychosocial performance, that together constitute a state of malnutrition, according to Stratton (8, 9). Malnutrition is a multifactorial and complex condition with or without acute or chronic disease. Only a few of the processes will be described in this chapter and they are to a varying degree present in hospitalized patients.

Weight loss is the first visible sign of changing body composition, caused by loss of fat and muscle mass (8, 10). In states of starvation or semi starvation, due to insufficient energy supply, the body will reduce its physical and metabolic activity in order to promote energy balance (8, 11, 12). This will lead to muscle weakness and dysfunction, impaired immune reactions, with increased risk of infection, in addition to reduced capacity of vital organs; heart, lungs, gastrointestinal tract and skin (8, 9, 13). Inactivity will weaken the skeletal muscles causing reduced muscle mass and strength in addition to downgrade protein synthesis (14). During insufficient access of energy and nutrients the body will try to protect the loss of protein mass as long as possible in order to maintain vital body functions (9). However, prolonged semi starvation or starvation will eventually lead to decreased protein mass including those in vital organs. The loss of protein mass will have multiple negative impacts (8, 9, 11, 14) and will affect organ functions like;

- decrease heart volume, reduced cardiac output and increased risk of heart failure
- decreased lung volume/capacity and respiratory muscle strength, reduced breathing capacity and increasing the risk of chest infections
- gastrointestinal mucosa atrophy increasing mucosa permeability, decreasing nutrient absorption and allowing transit of undesired microorganisms, increasing the risk of further nutrient deficiency and infection
- reduced skin thickness and skin capacity as barrier for migrating microorganisms increasing the risk of infection and wounds

Metabolic stress and disease will additionally increase protein turnover, muscle breakdown and decreased muscle mass (11).

In the last two decades, adipose tissue has been described as an endogenous organ (15). The adipose tissue operates as an essential storage of various nutrients and a sensor for nutrient availability in the body, regulating a large number of body functions (15). Faced with insufficient supply of energy and nutrients, especially carbohydrates, adipose tissue will provide nutrients for energy release through excreting hormones for processes like the gluconeogenesis in liver (15). With a reduced amount of adipose tissue the adipocytes, energy storing fat cells, will signal for a reduced metabolic activity and favor low energy consuming activity and downgrading the high cost ones, including immune cell function and response (15). Adipose tissue will release the peptide like pro-inflammatory hormone leptin. Leptin promotes inflammation by, for one, activating pro-inflammatory cytokine production (15). Increase cytokine activity is related to increased thermogenesis and fever, in addition to elevated muscle catabolism and reduced muscle protein synthesis (14). Interestingly, the increased cytokine activity is also described in obese people (BMI>30) by accumulation of pro inflammatory immune cells in the abdominal adipose tissue, making obese patients to the same extent susceptible to disease and disease related malnutrition (15).

1.1.3 Nutritional risk screening

Nutritional risk screening is a rapid and efficient method for detecting patients at risk of malnutrition with the intention to predict a probable beneficial outcome of nutritional treatment (16). Several screening tools are provided world-wide, but there is no consensus on a "gold standard" (17). ESPEN provides guidelines for nutritional risk screening applicable to different health care setting (18). The screening tools are validated (16, 18) and have been reported to be sensitive for detecting patients at risk of malnutrition who can benefit from nutritional support in a hospital, nursing home or home care setting (16, 18-22).

In line with the ESPEN Guidelines, The Norwegian Directorate of Health published in 2009 the «National Guidelines for Prevention and Treatment of Malnutrition» (23). The national guidelines recommend nutritional risk screening within 24 hours for all patients admitted to a health care facility, using validated screening tools. NRS 2002 is recommended for hospital use, Mini Nutritional Assessment (MNA) for elderly and in nursing homes and Malnutrition Universal Screening Tool (MUST) in a community setting (23). The recommended nutritional screening tools include four basic questions: Actual body mass index (BMI), recent weight loss, recent food intake and disease, in an initial screening or a combination initial and final screening (23).

ESPEN Guidelines has increased the attention regarding the importance of nutritional risk screening and assessment (24). A survey among Scandinavian doctors and nurses by Mowé et al (2006), found health professionals recognizing the importance of detecting and treating malnutrition. Nevertheless, serious malpractice due to mainly lack of knowledge and defined responsibility was found in all three countries (24).

The Norwegian National Guidelines for Prevention and Treatment of Malnutrition (2009) (23) has significantly contributed to the enhanced attention of the severity of malnutrition and the need for identification and targeted treatment, both at a national and local level. Despite this the prevalence of malnutrition in different health care services is alarmingly high (25, 26). The detections rate has increased, but it is still low (27-30). Resent research by Mowé et al found improved nutritional screening and assessment practice in Swedish and Norwegian hospitals (30). Available national guidelines and increased focus from health care authority is highlighted (30). Increased focus has led to a rise in implementation of nutritional guidelines, increased nutritional risk screening rates, assessment and patients receiving nutritional treatment (30). Nevertheless proper and targeted treatment still is at alarmingly low levels (27, 28).

Nutritional risk screening has been reported to be time and resource consuming, thus often resulting in it being downgraded in the regular routines (27-29, 31).

1.1.4 Prevalence and risk groups

Malnutrition has an undesirably high prevalence in hospitals world-wide. Although the negative effects of malnutrition have been widely reported and national guidelines for preventing and treating malnutrition are implemented, this condition still remains a low priority in most health care settings (16, 23, 27, 32-34). The prevalence of malnutrition in hospitals, nursing homes and homecare services varies, depending on patient groups studied and cut-off values determined. Different nutritional screening tools are designed for different patient groups resulting in wide span prevalence data for risk of malnutrition. Thus comparison of data might be challenging and requires awareness (17). Despite this, this thesis will refer to a few international and Norwegian prevalence data.

The Norwegian Directorate of Health estimates a 10-60 % prevalence of malnutrition in Norwegian health care settings, including hospitals and nursing homes (23). European estimates use 20-50% prevalence of malnutrition when referring to hospital patients (16, 23, 35). “The German hospital study” by Pirlich et al. found a 27 % prevalence of malnutrition in a mixed hospital population, according to the Subjective Global Assessment (SGA) screening tool (36). Malnutrition figures varied between groups studies; 43 % for patients 70 years and older, 56 %

for geriatric patients, 38 % in the oncology wards and 33 % in the gastroenterology departments. The main risk factors of malnutrition highlighted in this study were high age, comorbidity, polypharmacy and malignant diseases.(36).

Recently published Norwegian data indicate a prevalence of 29 % in a mixed hospital population using the NRS 2002 screening tool (25). The data describe the highest risk of malnutrition in the department of intensive care (ICU) (74%), oncology (49 %) and pulmonary diseases (43 %). Patients 80 years and older were identified with a 40 % risk of malnutrition and patients with infections 51 % (25). Newly published Norwegian data considering malnutrition in a non-demented elderly in-hospital population (age 70 years or older), found that 45 % were at risk of malnutrition, according to NRS 2002, with a prevalence range of 20 – 65 % between the different wards (26).

The above examples of European and Norwegian data indicate the frequency and severity of the condition risk of malnutrition and the need for proper actions regarding detection and treatment.

All patient groups might be at risk of malnutrition. Particularly vulnerable population groups are elderly, patients with dementia, patients living alone, handicapped, long term psychiatric patients, patients with drug abuse, chronic illness like cancer, heart- and lung diseases and arthritis (23), patient groups often associated with high age, comorbidity, increased need of medication and malignant diseases.

1.1.5 Length of stay and health care costs

Risk of malnutrition and malnutrition are associated with a number of negative clinical issues like; reduced immune response, poor wound healing, increased length of stay (LOS), increased morbidity and mortality (8, 23, 32-34, 36-38). Considering the complex nature of malnutrition, the condition will most likely result in increased hospitalization and recovery time (25, 34). Tangvik et al described a 36 % increased LOS for hospitalized patients at risk of malnutrition compared to patients not at risk (37). “The German hospital study” refer to a 43 % higher LOS for malnourished patients versus patients not at risk (36). This is probably partially due to impaired body functions when at risk of malnutrition (8) resulting in reduced immune response, poor wound healing, decreased physical and mental function, morbidity and mortality (8, 23, 32, 33, 36-39).

The condition of malnutrition also represents a considerable cost for the local and national health budgets, most likely responsible for a 24-60 % higher hospital cost compared to patients not at risk of malnutrition (16, 23, 35). An increased LOS by 3,3 days for patients at risk of malnutrition, as found by Tangvik et al, represent a considerable cost. The cost for an extra day in a Norwegian hospital is roughly calculated to about NOK 40.000 (regjeringen.no). Extended hospitalization for 3.3 days would sum up to an extra cost of NOK 132.000 for each patient. Preventing and treating malnutrition could possibly represent an annual saving of 800 million NOK on the national health care budget (40).

1.2 Pressure ulcer

1.2.1 Definition

Pressure ulcer (PU), also referred to as bedsores or decubitus ulcer, has been defined by the National Pressure Ulcer Advisory Panel (NPUAP) and the European Pressure Ulcer Advisory Panel (EPUAP) as “localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure or pressure in combination with shear” (41). PU is a wound that most frequently develops on a bony area of the body. The most common areas are heels, elbows, hips and areas of the lower back (41). PU classifications are presented in a four stage scaling system, referred to as either “Grade”, “Category” or “Stage”. In this thesis “Stage” is used to describe the PU categories, which defines the maximum depth of tissue involvement from Stage I through IV (Figure 1).

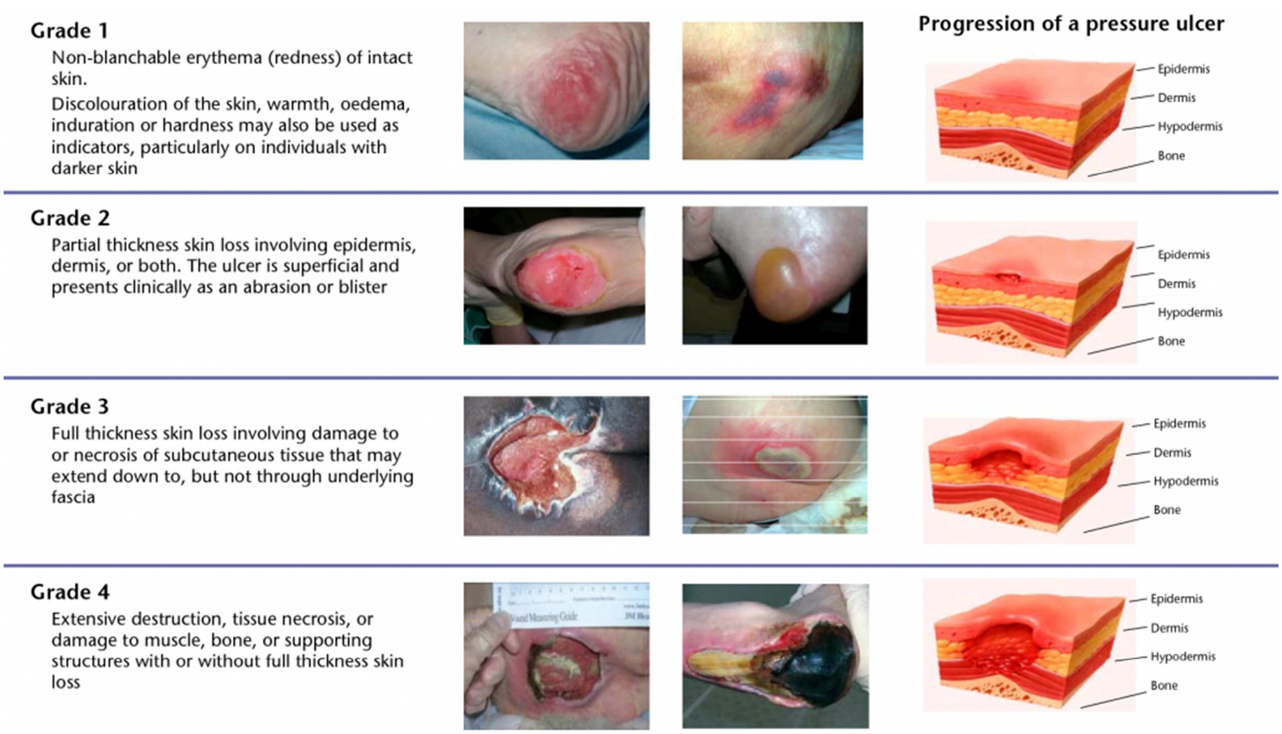

Figure 1 Progression of Pressure Ulcer (NPUAP/EPUAP) (41)

The literature refer to both PU and HAPU (Hospital Acquired Pressure Ulcer) prevalence. HAPU is defined as registered PU with on-set and development when in hospital, and not registered at hospital admission (42). Thus skin examination at a given point in a point prevalence study can be both a PU and a HAPU. Most frequently the literature refers to the prevalence of PU, but some have investigated HAPU in particular, excluding patients with registered PU at hospital admission (42, 43)

The condition of pressure ulcers causes pain, decreased quality of life and increased risk of infections and morbidity, as well as increased LOS, both in hospital, nursing home and rehabilitation settings (41, 44).

1.2.2 Prevalence and risk groups

Pressure ulcers represent a significant health problem for patients admitted hospitals or long-term institutional care. The European Pressure Ulcer Advisory Panel (EPUAP) reported a PU prevalence of 18 % (variation 8–23 %), based on data from a study of 6000 patients in 25 hospitals in five European countries (45). An often referred 30 years old study, by Allman et al. (1986), found a 17 % PU prevalence and risk of PU (using the Norton risk assessment form), with 5 % PU prevalence for hospitalized patients (46). A smaller, multicenter and cross-sectional Brazilian study found prevalence of 17 % (47). Data from the United Kingdom, United States and Canada identified PU prevalence between 5 and 32 %, while Japan and China report 1-3 % prevalence for hospitalized patients (44, 48). There has been limited Norwegian data on PU prevalence in hospitals. Older Norwegian pilot study data (1994) conducted in a university hospital's medical and surgical wards, refers to a PU prevalence of 4 % (49). Research presented from another Norwegian university hospital reported a 7-14 % PU prevalence, during a time span of four years (1998-2002) (50). The same university hospital reported a prevalence of 18 % in 2009 (50) and recent data (2015) indicated a 14 % rate of HAPU, with the highest prevalence in the intensive care units (42). The study suggested a decreased risk of HAPU when patients' safety routines and PU prevention guidelines were implemented and monitored as recommended by The Norwegian Patient Safety Program (42).

Comparing PU prevalence data from different countries might be challenging, partly due to different patient populations, risk factors studied, use of differing PU assessment methods (45) and cut-off values. Nevertheless, the importance of addressing PU risk and assessment at an early stage, to prevent and minimize PU development during hospitalization, is emphasized (51).

Under normal conditions all patients are potentially at risk of developing PU. PU might develop quickly, within a few hours (41, 50-52). Common risk factors have been identified as immobility, friction and shear, moisture, incontinence, poor nutrition, perfusion, high age, skin condition and altered level of consciousness (41, 47, 51, 52).

1.2.3 Risk screening and classification

"The Norwegian Patients Safety Program: In Safe Hands 24-7" (2014)(53) was published after a two year Patient Safety Campaign (2011-1013). PU is one of the first eleven areas of priority. The present national guidelines mirrors the NPUAP and EPAUP guidelines, which are internationally accepted (41). The guidelines provide recommendation for risk assessment tools, classification categories, propose preventive activities and treatment routines in addition to provide educational programs. The Norwegian Patients Safety Program (53) emphasize PU risk screening shortly after admission to all health care setting, maximum 8 hours (53). Validated risk screening tool are recommended (53). Braden scale and Norton scale are the most commonly used PU risk screening tools (51). Both risk screening tools include evaluation of:

- Reaction to stimuli/Mental condition
- Moisture/Incontinence
- Activity/Physical condition
- Mobility

In addition, the Braden includes nutritional evaluation of dietary intake (actual intake in percentage of normal intake) (41).

The intention of PU risk assessment and classification is to detect patients at risk of developing PU and classify the maximum depth of a present PU (41). These actions are to be followed by proper preventive and treatment plans (41). National efforts aimed at reducing PU risk and providing proper treatment do not yet seem to have resulted in significantly lower PU rates (42, 50). PU screening and risk assessment procedures are often not conducted as recommended, which suggests that there still are issues to address to achieve optimal performance and patient safety results (42, 50)Given the severity of PU progression and ensuing complications, it is crucial with early detection and proper treatment to avoid the debilitating complications that typically accompanies PU (41, 51, 52).

1.2.4 Length of stay and health care cost

Pressure ulcers (PU) make a significant independent contribution to excess length of hospitalization (54). Allman et al. (1986) reported incidence of PU being significantly associated with prolonged hospital stay. Patients in the risk of PU and PU groups had 3,5 and 5 times longer hospitalization than patients without PU. The two groups were also associated with clinical conditions including higher age, lower weight, malnutrition, fever, pneumonia, sepsis, anemia and hypoalbuminemia (46). Fifteen years later Allman et al. describes that development of in-hospital PU Stage II or more, resulted in a more than doubled amount of days in hospital (30 vs 13 days) and three times higher treatment costs (55).

A larger German study of elderly patients, 75 years and older, indicated an overall longer hospital stay for PU patients compared to patients without PU (19 vs 10 days) (43). The study included both patients with PU by admission and those who acquired PU during hospitalization. The impact of HAPU on excess length of stay was more pronounced. In addition it was indicated that bedside complication, co-morbidities, social factors and the hospital internal processes of patients care, all were significant for HAPU and LOS (43).

A larger Australian study also reported 4 days increased LOS for patients developing PU when hospitalized (54).

PU treatment is both invasive and costly, which has shown to have a considerable impact on national healthcare budgets (44, 54-58). Treatment cost increases with PU severity. In the UK, the calculated cost is estimated to GBP 1.064 for Stage I to GBP 10.551 for Stage IV (58). The total national expense, conservatively measured, accounting for 4 % of the UK health care budget, is estimated to GBP 1.2-1.4 billion annually (58). The Norwegian annual national health care cost treating PU has been estimated at NOK 700 million in 2008 (50, 57). Norwegian estimates derive from Helsetilsynet using Dutch estimates of PU treatment costs representing 1 % of the total health care budget (57).

1.3 Nutritional risk screening and pressure ulcer

Guidelines, recommendations and research emphasize the significance of poor nutritional status for increased PU risk and development (8, 34, 41, 42, 44, 51). Malnutrition is recognized as one of the major systemic risk factors for poor wound healing and developing PU (4, 8, 59).

Early PU and risk of malnutrition screening represent valuable routines for detecting patients at risk and initiating proper treatment. Screening has been reported to be time and resource consuming, which unfortunately often results in them being downgraded in regular routines (27, 44, 50, 58). Nevertheless a targeted identification of patients at risk of malnutrition would probably be of utmost importance in addressing risk of development and presence of PU (41, 46, 60).

2. Aim

Nutritional risk screening has been implemented at Lovisenberg Diaconal Hospital using the NRS 2002 screening tool. The medical department has included NRS 2002 in their admission procedures. The risk of malnutrition prevalence in the mixed hospital population at Lovisenberg Diaconal Hospital has not earlier been studied.

The Norwegian Patients Safety Program emphasize PU risk screening shortly after admission to all health care settings using validated risk screening tools. Skin examinations should be classified according to NPUAP/EPUAP classification. The prevalence of PU for the mixed hospital population at Lovisenberg Diaconal Hospital has not been studied earlier.

Sufficient nutritional status has shown to be crucial for proper wound healing. Malnutrition is regarded as prominent risk factor for delayed healing of wounds and development of PU. The possible association between risk of malnutrition and PU has not been studied at Lovisenberg Diaconal Hospital. The value of using NRS 2002 nutritional screening tool in predicting PU in a mixed hospital population has to our knowledge never been studies earlier.

The primary objective of this thesis, as part of the Safety in Hospital Study, is to describe the risk of malnutrition and the presence of PU among in-hospital patients at Lovisenberg Diaconal Hospital. The study population is regarded as a mixed hospital population.

The second objective was to examine whether the nutritional risk screening tool NRS 2002 could predict PU in the study's mixed hospital population.

3. Methods

3.1 Design and Setting

The data for this analysis were collected as part of a large cross-sectional study: *Safety in Hospital*, conducted on 10 pre-selected screening days between September 2012 and May 2014. The larger study aimed to assess patients' risk for and prevalence of falls, pressure ulcers, malnutrition, pain in addition to other symptoms and comorbidities. The hospital's medical department treats approximately 7800 patients per year, with pulmonary, cardiovascular, gastro-intestinal and infectious diseases being the main disease groups for which medical patients are treated. The orthopedic surgical department performs elective surgery and about 3000 surgical inpatients are treated annually, including approximately 90 shoulder, 670 hip and 520 knee arthroplasty replacements and 1700 minor orthopedic, ear/nose/throat and other general operations.

3.2 Study population

All adult inpatients (≥18 years) admitted to one of the hospital's medical or orthopedic surgical wards by 7 AM on 10 pre-scheduled days (4 during the first project year and 6 during the second) were asked to participate in the study. Patients admitted to Hospice or the intensive care unit or who were cognitively impaired or unable to read Norwegian were not included. For patients screened on more than one screening day, only data from the date they first consented was included in the analysis. In Year 1 of the study (screening days 1-4), only patients who consented to the study were screened and included in the analysis. However, in Year 2 of the study (screening days 5-10), the hospital implemented routine screening as part of standard clinical procedures, and thus, anonymous screenings of all patients were included in the analysis as part of the hospital's quality assurance register.

Data from excluded patients were used to compare differences between the included and excluded groups regarding nutritional risk and abnormal skin exams. If missing data for the variable examined, the patient’s data was not included in the actual comparison. Thus the NRS 2002 and PU comparisons are based on a varying amount of excluded patients.

3.3 Data collection

Second year nursing bachelor students and ward nurses trained in standardized screening, rigor in research and research ethics conducted the initial NRS 2002 screening and performed the skin examinations. Prior to each pre-schedules screening day the students and ward nurses were tutored in the causes, risk factors, consequences of malnutrition and the importance of detecting risk of malnutrition. Training in practical performance of the initial NRS 2002 screening and information regarding proper treatment for patients at risk was given. A registered clinical dietician was responsible for the tutoring and training.

Clinical experience and past evaluations from the nurse team, experiencing difficulties in performing the final NRS 2002, the registered clinical dietician was made responsible for conducting all final NRS 2002 screenings.

Specially trained nurses were responsible for PU risk screening and skin examination tutoring and training for the students.

Data on age and sex were collected from the patients’ medical records. Height and weight were obtained through the nutritional screening or from the medical record.

3.4 Measures

3.4.1 Nutritional risk screening

An adapted version of the NRS 2002 was used (Attachment 1: NRS 2002 for Lovisenberg Diaconal Hospital - in Norwegian). In the adapted version the BMI cut-off is 20, where the original uses 20.5. The NRS 2002 screening tool consists of two parts: Initial screening to be performed on all patients and final screening to be performed when indicated by the initial screening.

Initial screening

The initial screening consists the following four screening items:

- Is BMI< 20 kg/m^2? Later referred to as *BMI<20*
- Has the patient lost weight within the last 3 months? Later referred to as *Weight loss past 3 months*
- Has the patient had a reduced dietary intake in the last week? Later referred to as *Ate less past week*
- Is the patient severely ill (i.e. intensive care patient)? This item was not used in this study, due to intensive care patients being excluded.

Each screening items is given an answer *Yes* or *No* by the patient, their family member or ward nurse. If all questions are answered *No*, the patient is regarded as being at low risk of malnutrition (*Low Risk*) and weekly re-screening is recommend. When one or more questions are answered *Yes*, the patient is regarded as possible risk of malnutrition (*Possible risk*). All screenings at *Possible risk* are referred to the registered clinical dietician for the final screening.

Final screening

The following factors are evaluated on a 0-3 scale, with 0 indicating "low risk" and 3 "high risk":

- nutritional status, based on initial screening data and
- severity of disease, based on disease related increased nutritional requirements.

A total score is determined by summing the two factor scores. Patients 70 years and older have an additional point added to their total score. Patients with a total score of 3 or more (out of maximum score of 7) are considered to be at risk of malnutrition.

When implementing the NRS 2002 at Lovisenberg Diaconal Hospital, BMI<20 kg/m^2 was set as the cut-off point, a general international consensus for underweight (2, 8, 61). Severity of disease was scored as determined by NRS 2002. In addition minor elective orthopedic surgery was assigned a severity disease score of 1 and major elective orthopedic surgery was assigned a score of 2.

The screening process is illustrated by the following example: Patient admitted for an elective shoulder operation, age less than 70 years, a BMI above 20, no weight loss the last three months, but has eaten less the past week (10 %). The patient will be classified as *Possible risk* of malnutrition because of a 10 % decreased food intake past week. When conducting the final screening a food intake between 75-100 % of a normal portion is regarded as a normal variation (16), given a nutritional score 0. A shoulder operation is regarded as minor elective surgery, given the severity of disease score 1. The total NRS 2002 score will sum up to 1, and the patient will be classified as *Low risk* of malnutrition, according to final NRS 2002.

3.4.2 Skin examinations

The results of all skin examinations were classified according to NPUAP/EPUAP classification (41), which defines the maximum depth of tissue involvement from Stage I through IV (Figure 1). For the purpose of this study, all abnormal skin exams (Stage I-IV) were considered indicative of PU.

3.4.3 Body mass index

Body mass index was calculated as the patient’s weight in kilograms divided by their squared height in meter. Patients were weighted in the morning, to the nearest 0.1 kilogram, wearing thin clothing, on either a digital portable scale (Soehnle – Melody 2.0) or a wheelchair scale (Vetek TI-1200). All scales were calibrated prior to each screening day. A portable digital scale (Seca Alpha – Model 770) was used as the “gold standard” for calibration.

Height was measured standing (Kawe height measure – 94112) or in a supine position on a flat bed, read to the closest 0.5 cm and converted to meters. When height or weight could not be measured and if the patients provided consent, the most recent values were obtained from the patient's medical record.

3.4.4 Socio-demographic characteristics

Data on age and sex were retrieved from the patients' medical record or the quality assurance register using the Qlikview softwear (Qlik Technologies, Inc., Radnor, PA).

3.4.5 Statistics

Completed screenings were scanned into a research database. SPSS version 22.0 (IBM Corp, Armonk, NY) was used for all statistical analyses.

Descriptive statistics (n), frequencies (%) and means with standard deviations (SD), were used to summarize sample characteristics. Analysis of variance (ANOVA) was used for group comparison of continuous variables and the t-test for continuous variables between groups. The chi-square (χ^2) test was used for group comparison of categorical variables. Because of the small sample size of abnormal skin exams the Fisher's Exact test was used to calculate their significance to different BMI categories when expected counts were below 5 in any cell. Logistic regression was used to determine the unique relationships between initial and final screening and abnormal skin exams, while controlling for the effects of demographics and other clinical factors. Sex and age group were included in all multivariate models controlling for any influence they may have.

Sensitivity and specificity was tested for the robustness of our results of the initial and the final NRS 2002 screening predicting the presence of PU.

Sensitivity = *At risk* with PU / (*At risk* with PU + *Low risk* with PU) x 100

Specificity = *Low risk* without PU/(*Low risk* without PU + *At risk* without PU) x 100

A significance level of $p<0.05$ was used for all analyses.

3.6 Ethics

The study was approved by The Regional Ethical Committee for medical and health-related research ethics (REK South-East) and the hospital management (Reference # 2012/980A). Study participants provided written consent to the risk screening and the retrieval of routinely collected clinical data from their medical records (Appendix 1). During the second year of the study (last 6 screening days), the hospital implemented routine risk screening as part of standard procedures and anonymized data for patients who did not consent were available for analysis through the hospital's quality assurance register. REK South-East and the Oslo University Hospital Ombudsman were notified and acknowledge use of the anonymized quality assurance data.

3.7 My contribution to the study

My involvement in the Safety in Hospital study lasted from spring 2012 to fall 2014. I was involved in the planning, training, conduction of the study and data regarding nutritional screening.

- Planning: Evaluating validated nutritional screening tools as a member of the interdisciplinary team planning the study.

- Tutoring and training: Responsible the tutoring and training of second year nursing bachelor students and nurses in standardized initial NRS 2002 screening before each pre-scheduled screening day.

- Initial screening: Participating in the hospital wards on the screening days, coaching students and nurses conducting the nutritional screening.

- Final screening: Conducted all the final screenings.

- Statistical analyses: Controlled the initial nutritional screening data. Recorded final nutritional screening data. Statistical analyses were performed with help from the hospital's statistician.

4. Results

4.1 Sample characteristics

Of the 1082 patients in hospital on the 10 screening days, 843 were eligible for inclusion, 81 of whom did not consent and 44 were unavailable due to early discharge, operation, or other examination. Of the 718 patients included in the screenings, 67 were excluded due to incomplete nutritional screening (n=16), missing BMI (n=18) or missing skin examination (n=33).The final sample included 651 patients (77 % of the eligible patients), with complete nutritional screening data and skin examinations (Figure 2).

Sample characteristics for the 651 included in the analyses are summarized in Table 1. A comparison of the included and excluded patients indicated that the excluded patients were more likely to be hospitalized on a medical ward (76 vs 55 %, p=0.001) and identified as *Possible risk* by the initial NRS 2002 screening (70 vs 52 %, p=0.014) and as *At risk* by the final screening (59 vs 34 %, p=0.001). Excluded patients were also more than twice as likely as included patients to have a PU (18 vs 8 %), but this difference was not statistically significant (p=0.108). There were no age or gender differences between the excluded and included patients.

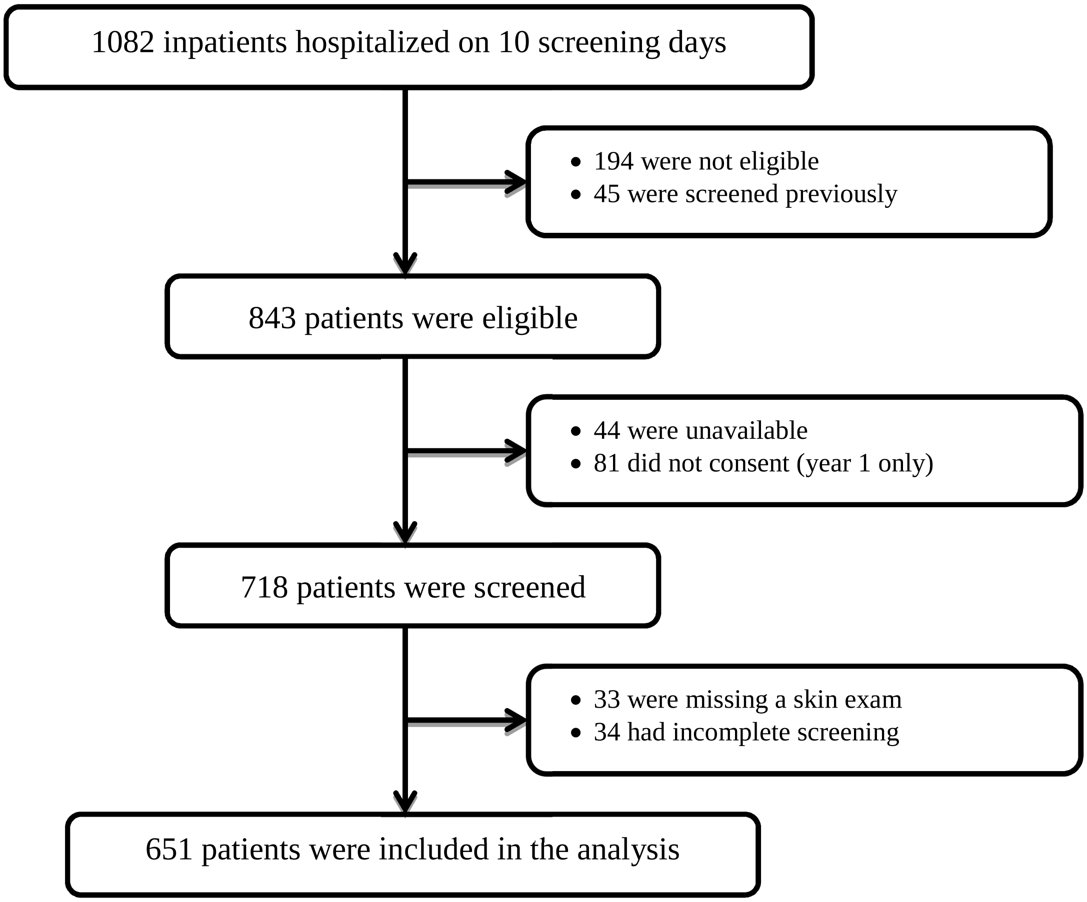

Figure 2. Flow Chart of Study Sample

4.2 Nutritional risk screening

Overall, 34 % of the patients (n=651) were found to be *At risk*, as determined by NRS 2002 final screening (Table 2). The medical patients were more likely to be found *At risk* compared to the elective orthopedic surgical patients, (44 vs 21 %, p<0.001) (Table 2). Patient age was unrelated to initial NRS screening status, but was associated with risk of malnutrition as determined by the final NRS 2002 screening. Figure 3 summarizes the results from the initial and the final screening for medical and orthopedic surgical departments.

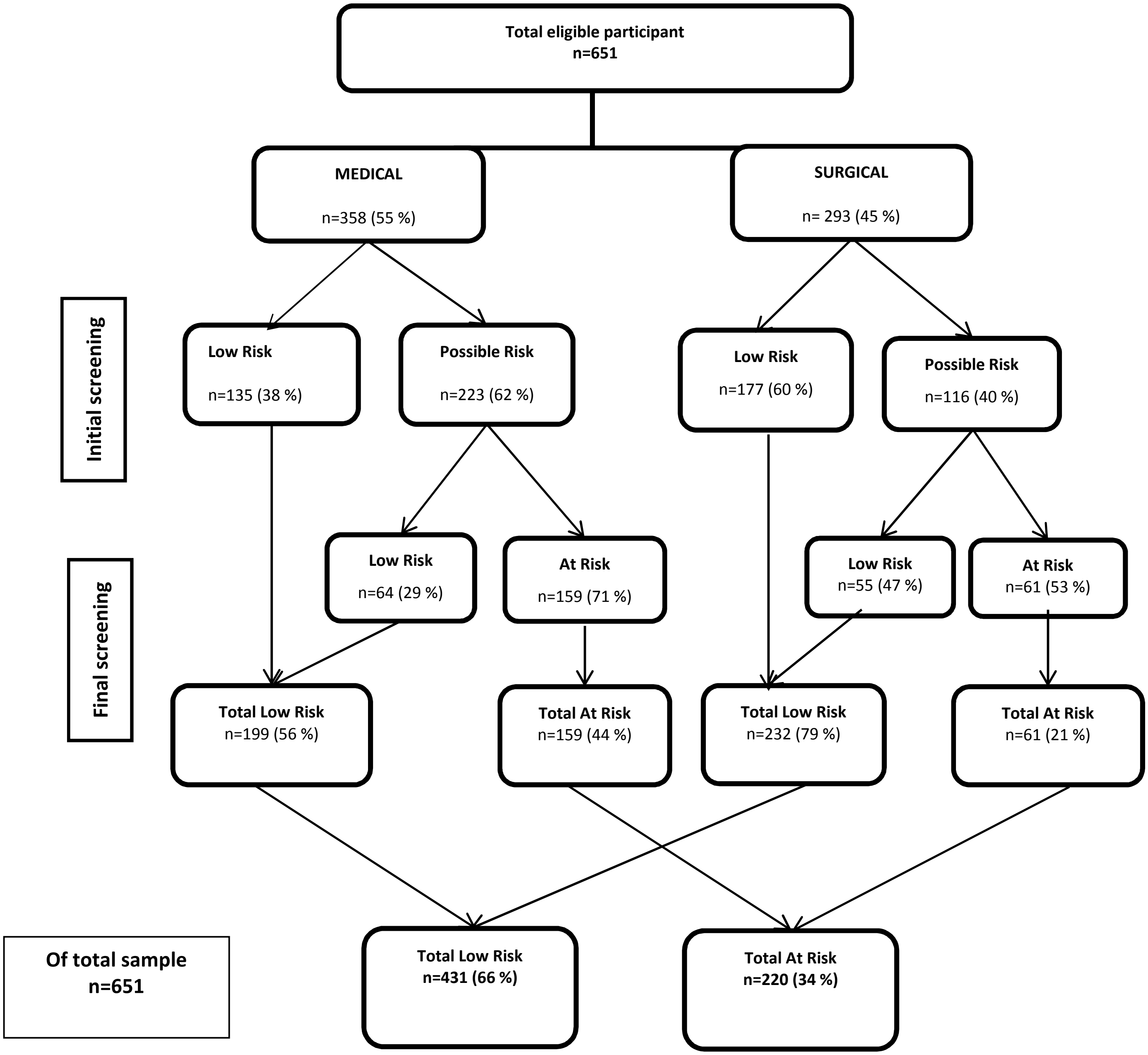

Figure 3: Distribution Risk of Malnutrition in Medical and Surgical Departments Using NRS 2002 Initial and Final Screening

4.2.1 Initial nutritional screening

Of the 651 patients who received the initial NRS screening, 48 % were found to be at low risk for malnutrition. The remaining 52 % were identified as *Possible risk*, based on at least one *Yes* response in the initial screening. The 339 patients at *Possible risk* were referred for the final screening (Table 1). Patients identified as being at *Possible risk* were more likely to be female, have BMI below 20, and be hospitalized in the medical department. Comparing medical and elective orthopedic surgical patients, medical patients were more likely to be found at *Possible risk* (62 vs 40 %, p=0.001). Women were more likely than men to be at *Possible risk* (58 vs 46 %, p=0.002). By definition, 100 % of the patients with BMI <20 (12 %) were found to be at *Possible risk*, as were 45 % of patients with BMI ≥20. Age was unrelated to risk of malnutrition based on the initial NRS 2002 screening.

Table 1. Sample Characteristics by Initial NRS 2002 Screening Status

	Total	Initial Nutritional Screening			
	(n=651)	Low Risk (n=312)	Possible Risk[a] (n=339)	Statistics	p-value
Sex, n (%)					
Male	310 (47.6)	168 (54.2)	142 (45.8)	**$\chi^2(1)=9.31$**	**0.002**
Female	341 (52.4)	144 (42.2)	197 (57.8)		
Age, years					
Mean (SD)	62.9 (17.3)	63.0 (15.6)	62.7 (18.7)	t(643)=0.22[c]	0.824
Range	19 – 100	20 – 99	19 – 100		
Category, n (%)				$\chi^2(1)=1.17$	0.279
<70 years	416 (63.9)	206 (49.5)	210 (50.5)		
≥70 years	235 (36.1)	106 (45.1)	129 (54.9)		
Body mass index (BMI)					
Mean (SD)	25.8 (5.5)	27.0 (4.6)	24.7 (6.0)	**t(628)=5.46**[c]	**<0.001**
Range	13.6 – 56.6	20.0 – 46.4	13.6 – 56.6		
Category n (%)				**$\chi^2(2)=83.9$**	**<0.001**
<18.5	49 (7.5)	0 (0)	49 (100)		
18.5-19.9	31 (4.8)	0 (0)	31 (100)		
≥20	571 (87.7)	312 (54.6)	259 (45.4)		
Hospital department				**$\chi^2(1)=33.3$**	**<0.001**
Surgical n (%)	293 (45.0)	177 (60.4)	116 (39.6)		
Medical n (%)	358 (55.0)	135 (37.7)	223 (62.3)		

a Patients identified as having possible risk of malnutrition on initial screening were referred for final screening.

b Includes the 313 patients identified as low risk of malnutrition in the initial screening.

c Separate variance t-test with adjusted degrees of freedom due to unequal variances

4.2.2 Final nutritional screening

Of the 651 patients included in the final sample, 52 % (62 % of medical patients and 40 % of surgical patients) were referred for the final screening (Table 2). Medical patients were more likely than orthopedic surgical patients to be found *At risk* (44 vs 21 %, p<0.001). Women were more likely than men to be found at risk of malnutrition (39 % vs 28 %, p=0.002). *At risk* was determined for 98 % of the patients with BMI <20 and for 25 % with BMI ≥20. Final screening did show a significant difference (p=0.001) related to age and risk of malnutrition. For patients 70 years or older, 47 % were found to be *At risk*, while only 26 % of patients younger than 70 years were found to be *At risk*.

Table 2. Sample Characteristics by Final NRS 2002 Screening Status

	Total	Final Nutritional Screening			
	(n=651)	Low Risk[b] (n=431)	At Risk (n=220)	Statistics	p-value
Sex, n (%)					
Male	310 (47.6)	224 (72.3)	86 (27.7)	**$\chi^2(1)=9.69$**	**0.002**
Female	341 (52.4)	207 (60.7)	134 (39.3)		
Age, years					
Mean (SD)	62.9 (17.3)	61.1 (15.9)	66.3 (19.3)	**t(375)=3.42**[c]	**0.001**
Range	19 – 100	19 – 99	20 – 100		
Category, n (%)				**$\chi^2(1)=29.7$**	**<0.001**
<70 years	416 (63.9)	307 (73.8)	109 (26.2)		
≥70 years	235 (36.1)	124 (52.8)	111 (47.2)		
Body mass index (BMI)					
Mean (SD)	25.8 (5.5)	27.2 (5.1)	22.9 (5.2)	**t(649)=10.3**	**<0.001**
Range	13.6 – 56.6	19.6 – 56.6	13.6 – 38.2		
Category n (%)				**$\chi^2(2)=165.8$**	**<0.001**
<18.5	49 (7.5)	0 (0)	49 (100)		
18.5-19.9	31 (4.8)	2 (6.5)	29 (93.5)		
≥20	571 (87.7)	429 (75.1)	142 (24.9)		
Hospital department				**$\chi^2(1)=40.1$**	**<0.001**
Surgical n (%)	293 (45.0)	232 (79.2)	61 (20.8)		
Medical n (%)	358 (55.0)	199 (55.6)	159 (44.4)		

a Patients identified as having possible risk of malnutrition on initial screening were referred for final screening.

[b] Includes the 313 patients identified as low risk of malnutrition in the initial screening.

[c] Separate variance t-test with adjusted degrees of freedom due to unequal variances

4.3 Skin examination

Normal skin condition was observed in 597 (92 %) patients, while 54 (8 %) had PU, using EPUAP/NPUAP classification system (Figure 1). Stage I PU was found in 29 patients, while Stage II was observed in 17, Stage III in 5 and Stage IV in 3 patients (Figure 4). As shown in Table 3, factors associated with prevalence of PU included age ≥70 years (16 vs 4 %, $p<0.001$), hospitalized in the medical department (12 vs 4 %, $p<0.001$) and BMI<20 (20 vs 7 %, $p<0.001$), where patients with BMI below 18.5 had the highest prevalence of PU (27 %). There was no significant gender difference regarding PU prevalence.

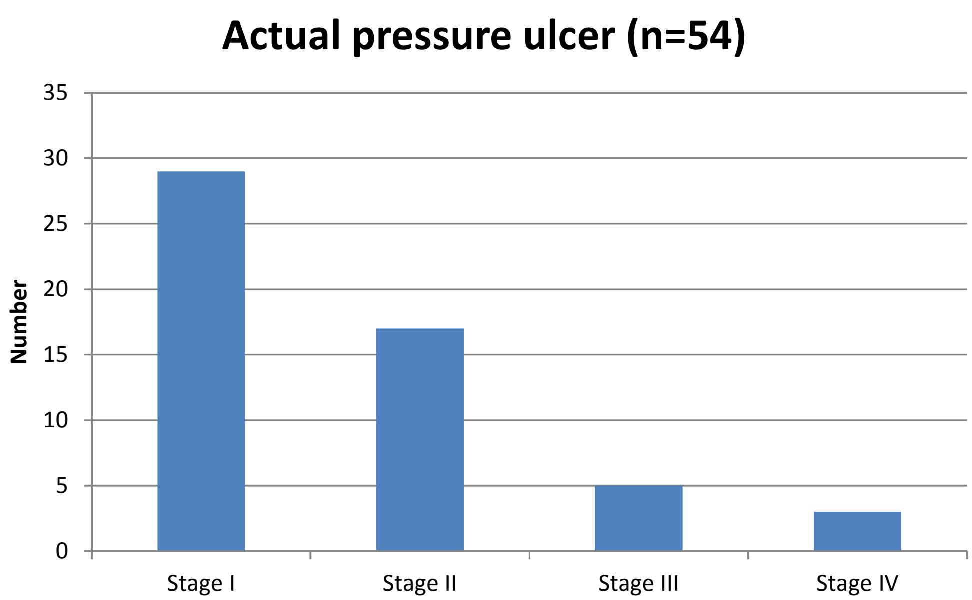

Figure 4: Total Number of Pressure Ulcer Classified as Stage I-IV

4.4 Associations risk of malnutrition and pressure ulcer

Patients identified as being at risk of malnutrition, either on the initial (*Possible risk*) or final screening (*At risk*), were more likely to have PU (OR=2.58 and 2.55, respectively) than patients at low risk. In addition, each of the three initial nutrition screening items was significantly associated with the skin examination results, with *BMI<20* ($p<0.001$) and *Ate less past week* ($p=0.003$) being the two strongest predictors of PU (Table 3). Patients with a BMI<20 had nearly three times higher prevalence of PU compared to patients with BMI≥20

(20 vs 7 %, p<0.001). Having eaten less the past week more than doubled the prevalence of PU (13 vs 6 %, p<0.003), while weight loss the in past 3 months almost doubled PU prevalence (12 vs 7 %, p=0.026).

As shown in Table 3, the initial NRS 2002 screening was more sensitive than the final NRS 2002 screening (78 vs 67 %), but less specific (50 vs 66 %), to the presence of PU.

Table 3. Skin Examination Results in Relation to Demographic, Clinical, and Nutritional Factors

	Total (N=651)	Skin Examination: Normal (n=597) (91.7%)	Skin Examination: PU Stage I-IV (n=54) (8.3%)	Statistics	p-value
Demographic Variables					
Sex, n (%)					
Male	310 (47.6)	284 (91.6)	26 (8.4)	$\chi^2(1)=0.01$	0.935
Female	341 (52.4)	313 (91.8)	28 (8.2)		
Age, years					
Mean (SD)	62.8 (17.4)	61.7 (17.2)	75.2 (14.8)	**t(650)=5.62**	**<0.001**
Range	18 - 100	18 - 100	30 - 99		
Category, n (%)				**$\chi^2(1)=26.8$**	**<0.001**
<70 years	416 (63.9)	399 (95.9%)	17 (4.1)		
≥70 years	235 (36.1)	198 (84.3)	37 (15.7)		
Clinical Variables					
Body mass index (BMI)					
Mean (SD)	25.5 (5.5)	25.7 (5.4)	23.9 (6.3)	t(59.5)=1.99	0.052[a]
Range	13.6 – 56.6	14.0 – 56.6	13.6 – 42.7		
Category, n (%)					
<18.5	49 (7.5)	36 (73.5)	13 (26.5)	Fisher's Exact=17.4	<0.001
18.5-19.9	31 (4.8)	28 (90.3)	3 (9.7)		
≥20	571 (87.7)	533 (93.3)	38 (6.7)		
Hospital department, n (%)				**$\chi^2(1)=12.4$**	**<0.001**
Surgical	293 (45.0)	281 (95.9)	12 (4.1)		
Medical	358 (55.0)	316 (88.3)	42 (11.7)		
Nutritional Screening					
Initial screening, n (%)				**$\chi^2(1)=15.6$**	**<0.001**
Low risk of malnutrition	312 (47.9)	300 (96.2)	12 (3.8)		
Possible risk	339 (52.1)	297 (87.6)	42 (12.4)		
Final screening, n (%)				**$\chi^2(1)=28.4$**	**<0.001**
Low risk of malnutrition[b]	431 (66.2)	413 (95.8)	18 (4.2)		
At risk of malnutrition	220 (33.8)	184 (83.6)	36 (16.4)		
Initial screening items, n (%)					
Body mass index (BMI)				**$\chi^2(1)=16.0$**	**<0.001**
<20	81 (12.4)	65 (80.2)	16 (19.8)		
≥20	570 (87.6)	532 (93.3)	38 (6.7)		
Weight loss past 3 months?				**$\chi^2(1)=4.99$**	**0.026**
Yes	191 (29.3)	168 (88.0)	23 (12.0)		
No	460 (70.7)	429 (93.3)	31 (6.7)		
Ate less past week?				**$\chi^2(1)=8.84$**	**0.003**
Yes	240 (36.9)	210 (87.5)	30 (12.5)		
No	411 (63.1)	387 (94.2)	24 (5.8)		

[a] Separate variance t-test with adjusted degrees of freedom due to unequal variances

[b] Includes the 312 patients identified as low risk of malnutrition in the initial screening

4.4.1 Multivariate models predicting pressure ulcers

Multivariate models were used to evaluate the usefulness of the initial and final nutritional screening for identifying patients with PU, while controlling for demographic and other clinical characteristics. Given the differences between medical and orthopedic surgical patients with respect to risk of malnutrition and PU prevalence, hospital department was also included as a covariate. As shown in Table 4, risk of malnutrition as determined by the initial screening was a significant predictor of PU (OR 2.58, CI:1.24-5.35) even after controlling for sex, age, hospital department, and BMI. Similar findings were observed for the final nutritional screening (OR 2.55, CI:1.27-5.13).

To determine which of the three initial NRS 2002 screening items were most useful for determining PU risk when controlling for demographic and other clinical factors, they were evaluated in two multivariate models (Table 5). Table 5 presents a multivariate analysis predicting PU from initial screening items, *BMI<20*, *Ate less past week* and *Weight loss last 3 months* In Model 1, all three initial screening items were included and both *BMI<20* (OR 2.73, CI: 1.33-5.59) and *Ate less past week* (OR1.91 CI: 1.01-3.59) were significant predictors of PU. Given the correlation between weight loss in the past 3 months and eating less in the past week (r=.33, p<0.001), these items were combined into a composite item which was included with *BMI<20* in Model 2. Using this approach, it was determined that patients who had eaten less the past week or had lost weight the past 3 months had significantly greater risk of PU than patients who had neither (OR 2.75, CI:1.42-5.22), even when controlling for the known risk factors of older age, hospitalization in the medical department and BMI<20. The combined item was an even stronger predictor of PU than BMI<20.

Table 4. Multivariate Analysis Predicting Pressure Ulcer with Initial and Final NRS 2002 Screening (n=651)

Model	Variables	Odds Ratio	95% CI	P	Overall model
1	INITIAL NUTRITION SCREENING				$\chi^2(6)=55.2$, $p<0.001$
	Covariates				
	Male sex (ref: female)	1.36	0.73, 2.53	0.329	
	Age ≥70 (ref: <70)	4.54	2.438.49	**<0.001**	
	Medical patient (ref: surgical)	2.05	1.00, 4.18	0.050	
	BMI (ref: ≥20)			0.051	
	<18.5	2.71	1.21, 6.11	**0.016**	
	18.5-19.9	1.07	0.29, 3.99	0.918	
	At risk of malnutrition based on *initial* screening (ref: low nutrition risk)	2.58	1.24, 5.35	**0.011**	
2	FINAL NUTRITION SCREENING				$\chi^2(6)=55.2$, $p<0.001$
	Covariates included in both models				
	Male sex (ref: female)	1.347	0.72, 2.49	0.358	
	Age ≥70 (ref: <70)	3.93	2.09, 7.41	**<0.001**	
	Medical patient (ref: surgical)	2.067	1.00, 4.22	**0.049**	
	BMI (ref: ≥20)			0.132	
	<18.5	2.30	0.99, 5.36	0.053	
	18.5-19.9	0.94	0.25, 3.55	0.923	
	At risk of malnutrition based on *final* screening (ref: low nutrition risk)	2.55	1.27, 5.13	**0.008**	

Note: ref= reference group

Table 5. Multivariate Analysis Predicting Pressure Ulcer from Initial NRS 2002 Screening Items (n=651)

Model	Variables	Odds Ratio	95% CI	P	Overall model
1	ALL 3 INITIAL SCREENING ITEMS				
	Covariates				$\chi^2(6)=50.5$, $p<0.001$
	Male sex (ref: female)	1.41	0.76, 2.62	0.276	
	Age ≥70 (ref: <70)	4.52	2.43, 8.41	**<0.001**	
	Medical patient (ref: surgical)	2.20	1.07, 4.50	**0.032**	
	Initial Nutrition Screening Items				
	BMI<20 (ref: ≥20)	2.73	1.33, 5.59	**0.006**	
	Weight loss in last 3 months (ref: no weight loss)	1.03	0.53, 2.00	0.933	
	Ate less in past week (ref: ate normally)	1.91	1.01, 3.59	**0.046**	
2	COMBINED SCREENING ITEMS				
	Covariates				$\chi^2(5)=55.7$, $p<0.001$
	Male sex (ref: female)	1.42	0.77, 2.65	0.263	
	Age ≥70 (ref: <70)	4.55	2.44, 8.50	**<0.001**	
	Medical patient (ref: surgical)	2.09	1.03, 4.26	**0.042**	
	Initial Nutrition Screening Items				
	BMI<20 (ref: ≥20)	2.51	1.23, 5.12	**0.011**	
	Weight loss OR ate less (ref: no weight loss and ate normally)	2.74	1.42, 5.33	**0.003**	

Note: ref= reference group

5. Discussion

To our knowledge this cross-sectional point prevalence study is the first to show that NRS 2002 predicts PU. The results revealed that both the initial and the final NRS 2002 screening were significant predictors of PU. The initial screening was more sensitive than the final screening in correctly identifying patients with actual PU. And the initial screening was less specific to the presence of PU than the final screening by not rejecting patients with no actual PU. Moreover the initial NRS 2002 screening did identify nearly half of all the patients as being at low risk of PU, which allows PU preventive procedures to be focused on those who most need them.

5.1 Nutritional risk screening

National and international research and guidelines refer to an average 30 % prevalence risk of malnutrition in hospitals, ranging from 20 %–50 % (8, 16, 23, 25, 26, 34, 36, 62). This current study confirms the undesirable high prevalence of risk of malnutrition, where one third of the hospitalized patients at Lovisenberg Diaconal Hospital were *At risk*, according to NRS 2002. Initial screening was conducted on all included patients. One or more *Yes* on the initial screening items were applicable for 52 % of the patients and these were considered at possible risk of malnutrition (*Possible risk*). One third of patients at *Possible risk* were considered as *Low risk* when conducting the final NRS 2002 screening. A final NRS 2002 screening score ≥ 3, classified for at risk of malnutrition (*At risk*) and was applicable for 34 % of the total patient population. As expected, the initial screening included a larger amount of patients at *Possible risk* of malnutrition than those who were *At risk* of malnutrition by the final screening. Not including patients admitted to the Hospice, ICU, those with cognitive impairment or not Norwegian speaking in this present study, has most likely influenced our data showing a lower prevalence of risk of malnutrition than actually present in the hospital.

Patients hospitalized in the medical ward were more likely to be *At risk* of malnutrition than patients hospitalized for elective orthopedic surgery. More than two thirds of the patients *At risk* were hospitalized in the medical wards. Tangvik et al presented similar data in their study where 40 % of the medical patients were at risk of malnutrition compared to the 29 % overall risk (25). Patients hospitalized in the medical wards are often in an emergency situation influenced by disease requiring acute medical treatment (8). The state of acute disease will make a patient more vulnerable to nutritional impairment, metabolic stress and disease related malnutrition compared to an elective admitted patient (33, 36). When admitted for elective orthopedic surgery, the patients are likely to be less affected by acute illness, as shown by their lower severity of disease and risk of malnutrition when screened. However, considering the metabolic stress following surgery, a catabolic state prior to surgery will make elective orthopedic surgery patient as vulnerable to impaired nutritional status and outcome (63).

Data from the present study showed that risk of malnutrition increases with age. Half of the patients 70 years or older were found to be *At risk*, while one out of four patients younger than 70 were *At risk*. New data from Tangvik and Eide confirmed this by showing increased risk of malnutrition in the hospitalized elderly population (25, 26). Increased risk of malnutrition in elderly has been described earlier (8, 32, 36, 64-66). Elderly are particularly vulnerable to disease, metabolic stress and injury (7, 22, 66, 67). This is accounted for in the final NRS 2002 screening by adding an extra point to the total NRS 2002 score for patients 70 years and older (16). Risk of malnutrition and malnutrition are associated with a number of negative clinical conditions, which will have a negative impact on the patient’s recovery and health status (8, 23, 32-34, 36-38). Early detection of risk of malnutrition for initiation of proper treatment is particular important for the elderly as age is regarded as a risk factor for malnutrition.

The current study revealed an unexpected high overall risk of malnutrition, even when not including particularly vulnerable patient groups. This might be due to an increased threshold for hospital admission and/or higher patient morbidity by admittance. From the hospital’s quality assurance register it was possible to perform sub-analysis and compare the study population to excluded groups of patients. The analysis showed excluded patients to be more likely identified as *At risk* by the final NRS 2002 screening. This supports the assumption of an actual higher risk of malnutrition prevalence than shown in the studied hospital population.

Data from the current study indicate that risk of malnutrition is common in medical and elective orthopedic surgery wards, thus nutritional screening and assessment must be performed for all patients admitted.

5.2 Skin examination

Skin examination was conducted for all eligible patients and abnormal skin examinations classified according to EPUAP classification system. Following international and national guidelines it was considered appropriate to regard all abnormal skin exams as PU Stage I-IV (52, 53). The current study revealed an 8 % prevalence PU, where more than half of them were classified as Stage I. More than two thirds of the patients with PU were 70 years and older, three fourths were hospitalized in the medical department and one third had BMI below 20. Patients admitted for elective orthopedic surgery had significantly lower incidence of PU. Recognizing the low incidence of PU it was chosen to group all abnormal skin exams in one group to give more strength to our data, despite the differences of related factors in medical and surgical patients. In addition, knowing the rapid development of PU it is recommended providing PU Stage I with the same attention as more severe PU, with an early initiation of proper preventive actions. Early targeted treatment will most likely prevent further PU development (50-52, 68).

The PU results in this study indicate a lower prevalence than reported by EPUAP and other research (25, 45, 47, 69, 70). Using varying methodologies, patient population, exclusion criteria and cut-off values does lower the comparability of prevalence data. By launching of the NPUAP/EPUAP PU classification system, classification of PU staging would be easier to compare (41). Thus comparison of research data on prevalence of actual PU would likely be more valuable.

Guidelines for PU prevention have been implemented at our hospital. Satisfactory PU risk assessment routines might have resulted in an early identification and conduction of preventive procedures causing lower PU prevalence than revealed in cited research. But we are aware the fact that our prevalence data might be influenced by this study's inclusion criteria. The comparison of included and excluded patients did indicate an increased PU prevalence in the excluded patients, although the differences were not statistically significant.

Regardless, PU and PU treatment is invasive for the patients, time consuming for health care professionals and financially costly for the hospital and the national health economy. Thus early detection and initiation of proper treatment is valuable. Minimizing PU incidents requires continuous efforts from all health care professionals in the hospital.

5.3 Nutritional risk screening predicting pressure ulcer

This study found an association between risk of malnutrition and presence of PU. It shows that both the initial and the final NRS 2002 screening were significant predictors of PU, even after controlling for age, sex, BMI and hospital department. When a patient is admitted to the hospital it is likely that factors like age, sex and department are known. Thus adding nutritional risk screening may be a useful indicator of PU beyond the already known risk factors.

In the multivariate analysis of factors related to PU (Table 4, Model 1), the three initial NRS 2002 screening items are evaluated individually. *BMI <20* and *Ate less past week* were significant risk factors, but *Weight loss past 3 months* was not. The reason might be due to multicollinearity amongst the initial screening items, which can result in reduced significance when the correlated items are included in the same model. However, a combination of the nutritional items, *Weight loss past 3 months OR Ate less past week*, (Table 5, Model 2) proved useful for predicting PU (OR=2.7, CI 1.42,5.33), even after controlling for the effects of age ≥70 years, being a medical patients and having BMI <20. The initial nutritional screening items will identify patients with possible risk of malnutrition despite a normal BMI. Given this, the combination of decreased intake past week and/or weight loss the past 3 months seems to be useful for identifying patients with increased risk of PU, due to possible risk of malnutrition, regardless of the patient's BMI and other known risk factors.

The fact that the initial NRS 2002 screening is useful for predicting PU suggests that nutritional screening can contribute to the identification of patients at risk for future PU. Although the final NRS 2002 screening was also predictive of PU, use of the initial screening will allow for a less time and resource consuming screening procedure, resulting in more rapid and targeted assessment and treatment.

The initial NRS 2002 screening was more sensitive, but less specific to the presence of PU than the final NRS 2002 screening. The disadvantage of using the less specific initial NRS 2002 screening as an indicator of PU risk is that many of the patients identified as being at risk will not develop PU. Nonetheless, given the negative impact of PU on both patients and health care costs, it would likely be an acceptable trade-off to initiate PU preventive procedures for some patients who may not need them than to fail to provide such preventive measures to some of those who do.

The value of SGA, MNA, and MUST in predicting PU in elderly and hospital population has been described recently (47). Malnourished patients (determined by SGA) had a higher prevalence of PU. For older patients, with an average age of 85 years, MNA score >8 was found to be more sensitive than SGA in predicting PU development. Using MUST in a hospital setting, including older age, BMI<18,5, reduced food intake in the past week and unintentional weight loss in the past 3 months were strongly related to manifestation of PU (71).

A closer look at the individual initial NRS 2002 screening items might give guidance to their value in predicting PU.

Patients with *BMI <20* from the current study had a significantly higher incidence of PU versus patients with BMI >20, OR 2.7. Low BMI was a consistently strong predictor of PU in the current analyses. Our findings were similar to other studies where low BMI has been reported to have a negative impact on a large number of health aspects (2). BMI <18.5 alone is established by ESPEN guidelines as one diagnostic criterion for malnutrition (2). Using NRS 2002, this criterion will place all patients with BMI <18.5 in the *At risk* group, as determined by the final NRS 2002 screening. BMI <18.5 was also recently found to be a strong predictor of PU (71). Therefore low BMI as a risk factor requires close attention in all health care facilities.

Weight loss past 3 months applied to almost half the patients with PU. Recent weight loss leaves the body in a catabolic stage, which has a negative impact on the healing process (72). Disease related weight loss is common, as about 70% of hospitalized patients are discharged with a lower body weight than at admission (8). Thus, health care professionals are strongly encouraged to limit in-hospital weight loss due to its negative impact on health aspects such as increased risk of poor healing, additional infections, malnutrition and longer hospitalization (8). Weight loss is recommended for some obese patients, prior to elective orthopedic surgery. With the purpose to reduce risk of poor wound healing and PU, it might be suggested to cease weight loss before surgery to stimulate a preoperative anabolic stage (63).

Eating less past week was applicable to 60 % of patients with PU. This indicates that the patients most likely were in a catabolic stage when screened, a common situation when admitted to hospital. Decreased dietary intake has shown to be inversely related to patient' recovery, both for medical and elective orthopedic surgery patients (8, 63) and should be addressed for immediate proper nutritional care. A decrease in nutritional status will most likely decrease the healing process and increase length of stay. Longer hospitalization due to PU and/or malnutrition has an indisputable negative impact on the patient and ward personnel, as well as local and national health care budgets (4, 36, 38, 47, 71).

National guidelines for screening of risk of malnutrition and PU in addition to clinical assessment guidelines for targeted identification and treatment are provided for all health care settings (23, 53). National efforts aimed at reducing risk of malnutrition and PU do not yet seem to have resulted in a desirable improvement in prevalence of risk of malnutrition and PU (27-29, 42, 50). However, resent research has shown promising improvement in nutritional screening and assessment practice in Swedish and Norwegian hospitals (30). Available national guidelines and increased focus from health care authority, have led to a rise in implementation of nutritional guidelines, increased screening rates including assessment of patients energy intake and needs, and patients receiving nutritional treatment (30) .

The Council of Europe (32) and The National Directorate of Health (23) has pointed out five common issues that might delay implementation and execution of proper nutritional care and support for hospitalized patients:

- lack of clearly defined responsibilities
- lack of sufficient education
- lack of influence of the patients
- lack of co-operation among all staff groups
- lack of involvement from the hospital management (32)

The above issues would most likely be applicable for ensuring proper hospital support for all diseases, including PU care. Solving these barriers will require a collaborative effort of all health care staff involved in the nutritional and PU care and support.

5.4 Study design and population

The *Safety in Hospital Study* is a cross-sectional point prevalence study. Knowing the possibility of a single point prevalence not showing a representative patients population, the point prevalence was repeated at 10 pre-scheduled days over a two years period. The study design allowed nutritional screening and PU examination in a larger hospital population, including medical and surgical patients. The analysis reflects the risk of malnutrition and incidents of PU for 77 % of the eligible patients. In this thesis the aim was to describe the prevalence of PU and risk of malnutrition for the hospital population at Lovisenberg Diaconal Hospital, consisting of medical and elective orthopedic surgical patients.

The inclusion criteria allowed data from 651 patients to be analyzed. By excluding cognitively impaired and non-Norwegian speaking patients, in addition to patients admitted to ICU and Hospice, we recognize the effects this will have on our analysis. Taking this into account, the results most likely refer to a healthier group of patients and should only be used for generalizing in the included patient groups.

5.5 Data collection

Second year nursing bachelor student and ward nurses conducted the initial NRS 2002 screening and all skin examinations. Nutritional screening has not been included in the regular bachelor nursing program as PU risk screening and skin examination have. The tutoring and training prior to the screening days was considered as well-functioning and sufficient educational program for students and nurses. Making the registered clinical dietician responsible for all final screenings, was regarded as limiting sources of error providing a more consistent assessment of screening result. Any misinterpretations would likely apply to all screening.

The rating of inter-rater reliability (IRR) of NRS 2002 screening and PU classification was not included in this present study. Considering the relatively large number of raters involved it is possible that the reliability of our data has been affected. But the invariability of supervising specially trained nurses and registered clinical dietician was considered to reduce misinterpretations.

Kondrup et al do refer to a strong IRR between health care professionals conducting NRS 2002 screenings, indicating little disagreement on a patient's risk of malnutrition status (16). A Norwegian study found a good IRR between nurses and bachelor nursing students conducting the initial NRS 2002 screening, but only fair IRR on the final screening. The need of extensive training in order to achieve reliable screening results was indicated (73). The latter could support our clinical experience and nurses' response on the difficulties in conducting the full NRS 2002 screening. Making ward personnel responsible for conducting the initial screening while specially trained nurses perform the final screening might be necessary in order to ensure satisfactory screening results.

Specially train nurses were responsible for the training in PU risk screening and assisted in preforming all skin examinations. Kottner et al found a strong IRR for nurses classifying PU stages, with somewhat higher disagreement on classifying Stage I PU (74). The European Reliability Study by Beekman et al, found a low IRR for nurses classifying PU (75). A stronger reliability was reported for specially trained nurses, indicating the need of creating high quality educational programs on how to differentiate various PU stages (75).

Involving nursing bachelor students enabled the conduction of this larger cross-sectional point prevalence study in the hospital, normally not feasible on a hectic hospital ward. The students tutorial program and study participation, may have given them an improved awareness, knowledge in research, research methods, the clinical aspects of malnutrition and PU in addition to an overall better clinical practice (76, 77).

5.6 NRS 2002 screening and skin examination

Following national recommendations (23), the NRS 2002 was used in this study for nutritional risk screening of all patients. The screening tool is validated (16, 18) and has shown to be sensitive for detecting patients at risk of malnutrition who can benefit from nutritional support in a hospital settings (16, 18-22).

When implementing NRS 2002 at Lovisenberg Diaconal Hospital, BMI <20 was chosen as cut-off for risk of malnutrition, instead of BMI <20.5 (moderate degree of malnutrition) as in the original version. In our analysis only 18 patients had a BMI between 20-20.49, where one third were found to be at *Low risk* and two thirds at *Possible risk* of malnutrition in the initial screening, thus referred for a final screening. In the final screening half of the patients with BMI 20-20.49 were found to be at *Low risk* and half *At risk* of malnutrition. These results do not seem to have a misleading impact on our final analysis.

To our knowledge the original BMI<20.5 was based on a trial of the positive physiological effects of nutritional support and steroids to patients with chronic obstructive pulmonary disease using BMI <90 % of normal (≈ BMI<20.5) as an inclusion criterion (18, 78). The ESPEN expert group considered other studies showing positive effects of nutritional support for patients with moderate degree of malnutrition and mild degree of severity of disease (18). For this reason the BMI < 20.5 cut-off was chosen in the original NRS 2002.

NRS 2002 screening tool was never intended to be used for classification of nutritional status, but designed to identify patients at nutritional risk who could benefit from nutritional treatment (16, 18). Using a wide range screening tool, including only the initial screening items, the risk of diagnosing more patients at risk of malnutrition than those at actual risk has to be considered. Nevertheless, misclassification of hospital patients for being at risk of malnutrition when not would be of less concern than not identifying the patients that are at risk.

Skin examination of actual PU using the EPUAP classification system will most likely to a less extent allow individual interpretation of PU categories and give room for misclassification. However research has shown that classification of nonblanchable erythema, Stage I PU, often is misclassified, especially on the heal area, (79-81). To distinguish a blister from a nonblanchable erythema has proven to be the most challenging compared to classification of Stage II-IV PU (79, 81). Knowing the importance of an accurate identification of Stage I PU in preventing further PU development, proper educational programs and repeated tutoring and training of ward staff seems to be crucial (77, 79, 81).

6. Conclusion

This current study confirms that risk of malnutrition and PU still are common in a Norwegian hospital setting. In addition it suggests the significance of nutritional risk screening, using the NRS 2002, in predicting the presence of PU for medical and elective orthopedic surgical patients. The prevalence of PU was lower and risk of malnutrition higher than expected prior to the study. Both the initial and the final NRS 2002 screening were significant predictors of PU. The initial NRS 2002 screening items proved to significantly predict PU, with *BMI<20* and *Ate less past week* being the two strongest predictors. However, a combination of *Ate less past week OR Weight loss past 3 months* was strongly associated with PU results.

Because of the significance of the initial NRS 2002 screening in predicting PU it might be considered adequate for detecting patients at risk of malnutrition and PU. The initial screening is thought easier, less time consuming and rapid. Futhermore, it enables more efficient screening routines which could promote optimal implementation, execution and satisfactory patient safety results.

7. Future Perspectives

Malnutrition and PU represent a significant health problem for patients admitted to hospitals. National guidelines point out the importance of risk screening, assessment and initiation of targeted treatment in order to prevent development of malnutrition and PU.

In the current study national guidelines were followed screening patients for risk of malnutrition and classification of PU. The analysis identified the predictive value of NRS 2002 in predicting actual PU in our hospital population. This study suggests that the initial NRS 2002 screening items can be useful for an early detection of patients at risk for malnutrition and PU.

The importance of risk of malnutrition and PU screening, risk assessment and preventive procedures still need to have excessive priority for proper reinforcement in the hospital. A regular audit using the actual study design, could encourage the continuous quality assurance efforts needed.

At present, there is no standardized method for collecting nutrition screening data in Norwegian hospitals. This hampers implementation and use of national screening guidelines. In the future, electronic availability of validated screening tools will enable nutritional screening to be conducted and documented as determined by The Norwegian Directorate of Health (23), thus enabling national data collection.

By January 2016 The Norwegian Directorate of Health introduced nutritional variables in the national statistics of health and human services through IPLOS (Individbasert pleie- og omsorgsstatistikk), implementing electronic registration of the variables. Electronic data collection will enable national statistics on nutrition related measures; nutritional screening variables, the amounts patients at risk of malnutrition, documentation of initiated targeted nutritional treatment and treatment evaluation. Publication of the first national data will be available 2017. As of today the IPLOS registry only applies for the national community health services (nursing homes and homecare services). However, it is a valuable tool that should be considered for national electronic hospital data collection. In the meantime, simplifying screening routines will most likely be helpful for increasing screening rates and identification of hospitalized patients at risk of malnutrition and PU.

Further research aimed at rapid identification and targeted treatment for best patient outcome will be of significance and beneficial for patients, health care services and national health care economy.

Lovisenberg Diaconal Hospital has made an effort to simplify screening for risk of malnutrition, risk of PU and risk of falls, by including crucial screening items from each screening tool into one screening tool. This is made available in the electronic medical record. The initial NRS 2002 screening items, *Is the BMI<20* kg/m^2 *?, Has the patient lost weight within the last 3 months?* and *Has the patient had a reduced dietary intake in the last week?* are included. Future research using this simplified screening tool, studying the effect on screening rates and identification of patients at risk will be needed.

The significance of rapid risk identification for targeted initiation of treatment and patient outcome has not yet been studied at Lovisenberg Diaconal Hospital. Research aiming at this will be valuable to ensure patient safety in hospital.

Do the best

You can until

You know better.

Then, when

You know better

Do better.

Maya Angelou

8.References

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Appendix

Appendix 1: Letter of Consent

Appendix 2: NRS 2002, initial screening in Norwegian

Appendix 1: Letter of Consent

Forespørsel om deltakelse i forskningsprosjektet

Symptomer, samsykdommer og risiko hos pasienter innlagt på sykehus

Bakgrunn og hensikt

Dette er en forespørsel til deg om å delta i en forskningsstudie for å undersøke forekomsten av symptomer og risiko for fall, trykksår og underernæring hos pasienter som er innlagt på sykehus og i hvilken grad dette har sammenheng med samsykdommer og symptomer. Deltakelse er frivillig. Lovisenberg Diakonale Sykehus er ansvarlige for gjennomføringen av studien. For å få et så riktig bilde av situasjonen som mulig er det viktig at også de som ikke har symptomer eller risiko deltar.

Hva innebærer studien?

Du blir bedt om å fylle ut et kort spørreskjema. I tillegg vil du bli intervjuet av sykepleierstudenter og ansatte om temaene smerter, fall, trykksår og ernæringsstatus, samt faktorer som er relatert til deres forekomst. Det vil ta om lag 15 minutter å svare på disse spørsmålene. Vi ber også om tillatelse til innhente opplysninger fra din journal om behandling og resultater av undersøkelser du har gjennomgått.

Mulige fordeler og ulemper

For pasienter hvor det avdekkes betydelig risiko for fall, trykksår og underernæring, vil det i samarbeid med pasienten bli iverksatt forebyggende tiltak. Vi forventer at noen av spørsmålene vil oppleves som lite relevante for flere av pasientene.

*Hv*a skjer med informasjonen om deg?

Informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. Opplysninger som registreres er data fra spørreskjemaene samt data fra din journal som omhandler din aktuelle sykdom, behandling, helsetilstand og eventuelle komplikasjoner. Alle opplysningene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger gjennom en navneliste.

Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som kan finne tilbake til deg og alle har taushetsplikt. Når studien avsluttes 31. desember 2015 vil navnelisten slettes og informasjonen om deg anonymiseres. Resulter fra studien vil bli publisert i vitenskapelige artikler og kan bli brukt i master- og doktorgradsavhandlinger. Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres. Lovisenberg Diakonale Sykehus ved administrerende direktør er databehandlingsansvarlig.

Frivillig deltakelse

Det er frivillig å delta i studien. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta i studien. Dette vil ikke få konsekvenser for din videre behandling. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke uten at det påvirker din øvrige behandling. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du kontakte prosjektkoordinator Tove Irene Granheim, tlf. 2322 6291. Ansvarlig for studien er professor Anners Lerdal.

Rett til innsyn og sletting av opplysninger om deg

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

Finansiering

Studien er finansiert gjennom forskningsmidler fra Lovisenberg Diakonale Sykehus og fra Lovisenberg Diakonale Høgskole.

Forsikring

Vanlig forsikring ved sykehusinnleggelse

Samtykke til deltakelse i studien

Jeg er villig til å delta i studien

____

(Signatur fra studiedeltager og dato)

Navnelapp pasient:

Jeg bekrefter å ha gitt informasjon om studien

____

(Signatur og dato)

Appendix 2: NRS 2002 Initial screening

MÅLING AV ERNÆRINGSSTATUS
Nutrition risk screening 2002

Høyde ________ cm

Vekt ________ kg

Veid på sykehusvekt nr. ___________

Har pasienten BMI under 20?

Nei

Ja

Har pasienten hatt vekttap siste 3 md?

Nei

Ja

_________ **antall kg**

Har pasienten spist mindre siste uke?

Nei

Ja

Har spist 50-75 % av vanlig porsjon

Har spist 25-50 % av vanlig porsjon

Har spist 0-25 % av vanlig porsjon

Er pasienten intensivpasient?

Nei

Ja

Er noen av spørsmålene over besvart med ja så taes kopi av dette skjemaet og legges til ernæringsfysiolog for sekundærscreening.

Skal pasienten sekundærscreenes?

Nei

Ja